ABSTRACT

Title of Dissertation: RECIPROCAL RELATIONS BETWEEN PERCEIVED STRESS AND LITERACY ACHIEVEMENT IN SCHOOL-AGE CHILDREN OVER TIME

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Stress has a negative impact on academic achievement, but it is unclear whether achievement impacts stress. Most stress research utilizes a unidirectional design (e.g., stress affects achievement). Recent research has begun to examine cross-lagged models in which social-emotional variables and achievement affect one another; however, associations have typically been found at the between-person level of analysis. In contrast, within-person effects may provide information about the state- or trait-like nature of an individual's, versus a group's (between-person effects), growth over time. This short-term longitudinal study examined the direction of relations between the social-emotional variable of perceived stress and literacy among diverse elementary students. In addition, this study was the first to examine stress-literacy achievement relations at both the between-person and within-person levels. Participants included upper elementary students (N = 397; M_{age} = 9.61; 56% female;

57% Dual Language Learners; 12% Black, 6% Asian, 30% Latinx, 7% Multiracial; 43% White) from three schools. Measures were collected at three timepoints over four months, including student-reported perceived stress (two factors: stress-coping and stress-distress) and a literacy achievement performance task (Test of Silent Reading Efficiency and Comprehension, TOSREC). Latent variable path analyses revealed that stress-coping was a significant predictor of later literacy achievement. Reverse relations also held true with literacy achievement as a negative predictor of later Time 2 stress-distress, and a positive predictor of later Time 2 coping, when previous stress was not a control. In contrast, no significant stress-literacy achievement relations (i.e., direct, reverse, or cross-lagged) were found when a latent curve model was used at the residual level, which suggests that the relations between stress and literacy achievement were more trait-based than state-based for students across a short period of time. Results are discussed in the context of reciprocal and between-person versus within-person mechanisms of change between stress and literacy achievement.

RECIPROCAL RELATIONS BETWEEN PERCEIVED STRESS AND LITERACY ACHIEVEMENT IN SCHOOL-AGE CHILDREN OVER TIME

by

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Chapter 1: Introduction and Literature Review

The academic achievement gap begins with an opportunity gap in literacy that has negative implications across the developmental lifespan. Children who are not reading proficiently by the end of third grade are four times less likely to graduate from high school (Hernandez, 2011). Family and neighborhood poverty further exacerbate the risk of high school drop-out, with struggling third-grade readers being nearly nine times less likely than their peers to graduate from high school, if they are growing up in poverty (Hernandez, 2011). By upper elementary school, reading becomes fundamental to the process of academic learning. Yet, the most recent National Assessment of Educational Progress (NAEP, 2021) data showed, in 2019, that only 35% of fourth graders read at a proficient level. In addition, children (O'Neal, 2018) and adolescents (Schmeelk-Cone & Zimmerman) who report high levels of perceived stress are at increased risk for academic underachievement. The present study focuses on the perceived stress of children during the pivotal period in upper elementary school when students begin to use their foundational reading skills to learn in other subject areas (Toste & Ciullo, 2017). Stress-achievement relations warrant investigation in this age group, in part, because students' perceived ability to cope with stress holds important implications for lessening the progression of the academic opportunity gap in literacy.

Stress Frameworks

Stress has been defined and measured in many ways throughout the literature and across disciplines, with biological, environmental, and psychological frameworks emerging as common models of stress. The biological model defines stress as a physiological response to an external event or experience that gives rise to a state of distress (Suldo et al., 2008). Biological indicators of stress include elevated blood pressure, increased heart rate, and the presence of hormones and

neurotransmitters (e.g., cortisol, adrenaline) that increase arousal in an organism (Cohen et al. 1997; McEwen, 2000; Selye, 1993). The environmental perspective defines stress as an external event or experience that is typically associated with increased adaptive demands (Compass, 1987). Environment, or external stress, is often measured using stress inventories. These inventories are checklists of events that are believed to be arduous for an individual, such as living in a home with too many people, having difficulty making friends, or experiencing communication problems with parents (e.g., Hispanic Children's Stress Inventory; Padilla et al., 1988). Lastly, the psychological framework focuses on the concept of perceived stress, or an individual's subjective evaluation of their ability to manage demands that result from aversive events or experiences in their lives (Cohen et al., 1997). Stress is perceived when an event or experience causes distress in an individual that exceeds their ability to negate its harmful effects (Suldo et al., 2008). A psychological conceptualization of perceived stress allows for consideration that one might possess resources, like coping, that allow them to experience external stress without compromised functioning (Suldo et al., 2008). Despite differences in how stress is conceptualized and measured, stress has been associated with similar negative outcomes (e.g., academic underachievement, decreased life satisfaction, psychopathology) in children and adolescents across biological, environmental, and psychological models (e.g., Alva & de Los Reyes, 1999; Berry et al., 2012; Evans et al., 1998; Jaser et al., 2005; Martin et al., 1995; Mayberry & Graham, 2001; McKnight et al., 2002; O'Neal, 2010; Schmeelk-Cone & Zimmerman, 2003).

Perceived Stress

The present study uses a psychological framework to conceptualize stress as the degree to which situations in one's life are judged as uncontrollable, emotionally upsetting, or

overwhelming (Cohen et al., 1997). The focus on perceived, general life stress, rather than an event-specific perspective, removes the assumption that an increase in the number of stressful life events leads to increased levels of perceived stress. Moreover, a psychological model places emphasis on an individual's subjective evaluation of threat that may arise from the environment. A stress response only occurs when an individual perceives that environmental demands have exceeded their available coping resources (Lazarus & Folkman, 1984). By conceptualizing stress from a psychological framework, the present study takes into consideration that individuals may respond differently in the face of stress, based on their evaluation of their ability to cope with the event or experience.

Theoretical Framework

This study relies on Lazarus and Folkman's (1984) stress-appraisal framework. Lazarus and Folkman (1984) posit that the impact of stressful events on an individual's functioning is determined by an individual's perception of the event's stressfulness. The Perceived Stress Scale (PSS; Cohen & Williamson, 1988) was developed, using Lazarus and Folkman's (1984) framework, out of need for a measure that captures this subjective process, also known as the appraisal element of stress (i.e., the cognitive process by which individuals evaluate the potential threat of a stressor and then determine their ability to cope with it).

Stress appraisal. Lazarus and Folkman's (1984) framework posits that stress is experienced through appraisal, which is a cognitive process that is triggered by exposure to a specific event or stressor. There are two types of appraisal: primary and secondary appraisal (Lazarus & Folkman, 1984). Primary appraisal is an individual's subjective evaluation of an event as a threat to their well-being. When an event is appraised as a threat, the cognitive process of secondary appraisal occurs, through which an individual evaluates their available resources

and ability to handle, or cope with, the event. Coping is defined as the process of eliminating or lessening the negative effects of the stressful event. It can involve changing the threatening environment (e.g., fight or flight response), or evoking thoughts or actions to relieve the emotional stress response (Lazarus & Folkman, 1984). The stress-appraisal model postulates that no stress response will occur if one perceives that coping resources are adequately available. In this situation, coping acts as a buffer in the face of distress, such that one's exposure to a stressor does not necessarily compromise their functioning. Alternatively, a state of stress is experienced when one is uncertain of their ability to cope with a situation that has been appraised as harmful or threatening. If an individual determines that coping resources are not adequately available to them, the stress response will materialize and affect their functioning. This appraisal process occurs both at the onset and through the duration of the stressful event, such that an individual is consistently reevaluating and reappraising threat and their potential state of stress (Lazarus & Folkman, 1984).

Perceived Stress Scale

Studies have consistently identified that the PSS-10 (Table 1) has a two-factor structure (e.g., Baik et al., 2019; Barbosa-Keiker et al., 2013; Cohen, 1988; Lu et al., 2017; Taylor, 2015). Cohen (1988) originally postulated that the distinction between the two factors is irrelevant because it relates only to the direction in the phrasing of the PSS-10 items. According to Cohen (1988), therefore, the PSS-10, assesses a single stress construct. More recently, researchers have argued that the distinct factors reflect two separate elements of the stress experience (i.e., distress and coping), thus measuring two factors (Barbosa-Leiker et al., 2013; Golden-Kreutz et al., 2004; Roberti et al., 2006). The distinction between distress and coping is important because the stress-appraisal theory (Lazarus & Folkman, 1984) posits that no stress response will occur if

one perceives that coping resources are adequately available to them. In the present study, it is expected that the PSS-10 will have a two-factor structure, given stress-appraisal theory (Lazarus & Folkman, 1984) and the consensus among psychometric researchers that the factor structure of the PSS corresponds to the distress and coping components of the stress response.

Stress and Achievement

Stress has a negative effect on academic performance (e.g., LePine et al., 2004) and is an understudied contributor to the academic opportunity gap (Levy et al., 2016). The stress and achievement literature is limited in that it focuses mainly on the effect of academic stress on achievement, often in samples of college students (e.g., Lui & Lu, 2010), and does not explore the relation between stress and achievement among elementary-aged children, when the achievement gap begins to widen (Burchinal et al., 2011). By focusing primarily on academic stress, the literature does not capture the overall experience of stress for students across their lives. Rather, there is a need for achievement research to move beyond the focus on academic-related stressors to reflect the impact of overall stress on student achievement. Elementary-aged children spend a considerable amount of their time at school, and as a result, stress from all sources and areas of a child's life may impact their academic performance.

Only three studies (O'Neal, 2018; Schmeelk-Cone & Zimmerman, 2003; Suldo et al., 2008) examine the relationship between perceived psychological stress and achievement in children and adolescents. Across these studies, stress had a negative impact on overall grades (Schmeelk-Cone & Zimmerman, 2003) and reading achievement (O'Neal, 2018), or when it did not impact achievement negatively, stress coexisted with deficits in mental health and coping strategies (Suldo et al., 2008). Studies that measured environmental (i.e., stressful life events; Alva & de Los Reyes, 1999; Cunningham et al., 2008; Gillock & Reyes, 1999) and biological

stress (i.e., salivary cortisol; Berry et al., 2012) in children and adolescents also established that stress has a negative impact on achievement, and are reviewed in further detail in Appendix B. Thus, stress has been linked to lower achievement across biological, environmental, and psychological perspectives.

Psychological stress. Few studies have examined patterns of perceived, general life stress over time. In one study, researchers used the PSS to measure perceived stress in a large sample of at-risk African American students (i.e., initial GPAs of 3.0 or lower in the 9th grade) throughout their high school experience. Schmeelk-Cone and Zimmerman (2003) found that adolescents with high levels of perceived stress received lower grades and were less likely to graduate from high school than those with lower stress levels over time. The researchers were predominantly interested in psychosocial outcomes of stress (e.g., anxiety, depression, antisocial behavior), though the study did establish links between perceived stress and lower achievement in youth, over time. The present study aims to extend this work to the elementary-age population, with a distinct focus on achievement as an outcome of perceived stress. More recently, a short-term longitudinal study found that stress, measured using the PSS, had a negative impact on the literacy achievement of largely Latinx, dual-language learner (DLL) elementary students (O'Neal, 2018). Results indicated that stress negatively influenced literacy achievement by impacting the mediator of emotional engagement among third through fifth grade students in the sample (O'Neal, 2018). Stress' impact on later literacy achievement was not mediated by grit. O'Neal (2018) established stress' impact on later literacy, via the mediator of emotional engagement, in one of the three schools used in the present dissertation. However, the study was primarily focused on the social-emotional mediators (e.g., engagement, grit). The present study builds on this work by examining reciprocal relations between stress and literacy, and by

incorporating additional schools into the dataset to better generalize results to the elementary-age population, overall.

Despite the benefits of longitudinal research, the impact of stress on achievement has predominantly been examined in cross-sectional studies. In one study that adopted a psychological perspective, the PSS-15 was used to compare the perceived stress of academically advanced high school students in an International Baccalaureate (IB) program to general education students at the same school (Suldo et al., 2008). Results indicated that students in the IB program had higher levels of stress than students in general education, but IB students also had higher achievement, as measured through their GPA (Suldo et al., 2008). This finding stands in contrast to the majority of stress studies that have demonstrated a negative relation between stress and achievement; however, it is important to note that students in IB programs are typically higher performing, and it is unlikely that the higher stress they experienced caused higher academic performance. Despite superior achievement, higher perceived stress among the students in the IB program co-occurred with compromised mental health and coping strategies (Suldo et al., 2008). In addition, the sample consisted primarily of White students at one school, demonstrating the need for studies that focus on perceived stress in diverse samples of students, and with younger students.

Stress and literacy achievement. When examining stress-achievement relations in elementary populations, it is worth narrowing in on literacy achievement. Reading strongly influences later educational and occupational opportunities for students (Hernandez, 2011). In addition, literacy ability is particularly important during upper elementary-school years, while GPA is often not as important. In fact, researchers have established the importance of mastering reading by the end of third grade (e.g., Hernandez, 2011; Toste & Ciullo, 2017). Students who

have not mastered reading by this pivotal point face barriers to success in later grades, as reading becomes fundamental to the process of learning in all subject areas. Despite the importance of literacy achievement for upper elementary students, only one study (O'Neal, 2018), reviewed above, focuses on the relation between stress and literacy achievement in children. By building on this study, the present study will contribute the gap in the literature by examining stress-literacy achievement relations in upper elementary students.

In sum, the present study focuses on literacy achievement because reading is a crucial skill that underlies achievement in other content areas. Reading also predicts future achievement and is widely a precursor to success in Western society (Hernandez, 2011). It is, therefore, necessary to identify key social-emotional factors that may impede students' reading abilities at the critical time when students are expected to read difficult material to obtain grade-level content knowledge (Toste & Ciullo, 2017). In examining stress as a social-emotional factor, largely due to its coping component, research can move towards reducing the academic opportunity gap for students. It is critical to do so, given that the opportunity gap is impacted by a gap in literacy ability that disproportionately affects certain minority groups (Murphy, 2014), and has lifelong, negative implications (Hernandez, 2011).

Direction of Relations between Stress and Achievement

Stress studies are often designed to understand the direct effects of stress on achievement, rather than the reverse effects of achievement on stress. Perhaps, for upper elementary students experiencing difficulty with reading, their lower literacy achievement leads to stress. The transition from *learning to read* to *reading to learn* occurs in upper elementary school (Hernandez, 2011; Toste & Ciullo, 2017). It is intuitive to assume that students struggling with reading at this crucial period, when they are no longer being taught to read but are expected to

read to learn, may appraise situations in their lives as more stressful, especially since school is such a big part of children's lives. The possibility that unidirectional relations between stress and achievement could also occur in the reverse is, therefore, worth exploring to determine whether achievement impacts later perceived stress. It is important to focus on the effect of literacy achievement on general stress, rather than academic stress, because reading is a critical skill that is necessary for success across many different environments (Hernandez, 2010). Moreover, reading does not only occur in school, so it is likely that literacy problems could result in generalized stress, both at school and in other environments.

Reciprocal effects. A reciprocal model between stress and achievement might be more informative than focusing solely on direct or reverse effects, as described above. Social-emotional skills (e.g., coping) and achievement are constructs that mutually develop over time (Marsh et al., 2017), and reciprocal models may be better able to capture the effects of "co-developmental" processes (Curran & Hancock, *in press*). No studies, to my knowledge, have examined cross-lagged models with stress and achievement. Most stress research is unidirectional (e.g., stress impacts achievement), but recent research has begun to examine cross-lagged models with achievement and other social-emotional variables. For example, cross-lagged relations have been found between effortful engagement and reading achievement (Hughes et al., 2008). Cross-lagged relations between grit and literacy achievement have also been found in a short-term longitudinal study (O'Neal et al., 2018) as well as in a recent dissertation (Boyars, 2019). This dissertation will build on the work that O'Neal's Emotions, Equity, and Education lab has done on grit-literacy relations by extending reciprocal modeling to stress and literacy achievement. Other recent research has begun to examine reciprocal relations between literacy achievement and social-emotional variables that are similar to stress, like life satisfaction. One

short-term longitudinal study established a reciprocal relation between subjective life satisfaction (which is similar to the global coping component of stress) and achievement (cumulative GPA in English, Math, and Science) in a sample of diverse middle school students (Ng et al., 2015). Similarly, Quinn and Duckworth (2007) found that subjective well-being positively predicted later academic performance, and that earning better grades also predicted later subjective well-being, in a sample of fifth grade students. There may be similar, but negative, reciprocal effects between stress and achievement.

Between-person versus within-person effects. It has been historically difficult for researchers to separate between- and within-person effects, especially when modeling constructs that are mutually developing over time, as may occur in this study with perceived stress and literacy achievement (Curran & Bauer, 2011; Curran & Hancock, *in press*; Pekrun, *2021*). Many traditional models, like the autoregressive cross-lagged models described in the literature above, tend to conflate within- and between-person effects (Curran & Hancock, *in press*). Between-person effects examine "trait-like differences" between separate individuals in the sample. A within-person effect, on the other hand, is a measure of how much an individual in the sample varies over time, relative to themselves (e.g., Curran & Hancock, *in press*), similar to more of a state, rather than a trait.

The present study focuses on state-like differences in stress-literacy relations, or the within-person variability in distress and coping for an individual in the sample relative to themselves, over time. This is due, in part, to the item phrasing of the PSS-10. The modified version of the PSS-10, which was adapted for use with children, is phrased to capture distress and coping within the last week. An individual's stress item responses could, therefore, differ

depending on when the PSS-10 is administered. As a result, at each timepoint, the PSS-10 captures distress and coping processes that have occurred within participants' in the past week.

Stress-appraisal theory (Lazarus & Folkman, 1984) also supports that stress-literacy achievement relations occur at the level of within-person processes. Lazarus and Folkman (1984) postulate that regardless of the specific stressor, an individual will only reach a state of stress if they (a) appraise the event as a threat, and (b) perceive that coping resources are not sufficiently available to them. Stress is further conceptualized as a transaction, or the relation, between an individual and their constantly changing, complex environment (Lazarus and Folkman, 1984). This state-based transaction, as well as the cognitive stress-appraisal process following exposure to an environmental stressor, suggests that stress occurs at the within-person level with fluctuations in stress over time, relative to their typical stress level, rather than at the between-person level. Stress measurement should capture fluctuations in stress that one experiences relative to themselves (i.e., within-person effects), since an individual may differ in their appraisal of a situation as a threat and their coping resources, based on their changing environment.

Within-person effects may also be more appropriate in capturing children's perception and appraisal of stress, as well as their literacy abilities. Children's social-emotional functioning at young ages can often be a temporary state that may depend on short term frustrations with peers, or the school environment (e.g., Dodge, 1991). As a result, children may be more likely to respond to stress measures at the within-person level, and trait-based differences in constructs (i.e., between-person effects) may be more likely to be firmly established with age. The focus on within-person effects has also been recommended to better understand temporal relations between processes that are jointly unfolding and growing across development (e.g., Curran &

Bauer, 2011; Curren et al., 2014; Curran & Hancock, *in press*; Long et al., 2019; Pekrun, 2021), like social-emotional competencies (e.g., coping) and literacy abilities often are for elementary children. This developmental perspective, as well as stress theory and the nature of the PSS-10 item wording, provide rationale for the within-person measurement of stress-literacy relations over time.

Research Questions and Hypotheses

1. Does a correlated two-factor perceived stress model fit the data, with stress-coping and stress-distress as the two factors?
    a. *Hypothesis:* Confirmatory factor analysis will confirm that the data fits a correlated two-factor model, with coping and distress as the two factors at Time 1, Time 2, and Time 3.
2. Does perceived stress predict students' later literacy achievement?
    a. *Hypothesis:* Time 1 latent distress will have a negative relation with Time 2 and Time 3 observed literacy achievement among students. Time 1 latent coping will have a positive relation with Time 2 and Time 3 observed literacy achievement among students.
3. Does literacy achievement predict students' later perceived stress?
    a. *Hypothesis:* Time 1 observed literacy achievement will have a positive relation with Time 2 and Time 3 latent coping, and a negative relation with Time 2 and Time 3 latent distress among students.
4. Are there cross-lagged (i.e., reciprocal) effects between stress and literacy achievement over time?

a. *Hypothesis:* There will be cross-lagged (i.e., reciprocal) effects over time between latent stress and literacy achievement.

b. *Exploratory:* Is there a differential role of between- and within-person effects in the cross-lagged model between latent stress and literacy achievement, reflecting state- versus trait-based differences in the relations between constructs over time?

Chapter 2: Method

Participants

Three hundred and ninety-six students participated in the study (M_{age} = 9.62, 56% female; 57% dual language learners (DLL); 12% Black, 6% Asian, 30% Latinx, 7% Multiracial; 43% White; see Table 2). Students were identified as DLL if they or their parents reported that a parent spoke a language other than English at home (Child Trends, 2014). In cases where the child- and parent-reported ethnicity and/or DLL status differed, researchers used the parent report as the correct indicator of ethnicity and/or DLL status. Thirty percent of the sample was in third grade, 29% were in fourth grade, and 35% were in fifth grade. Fifty-five percent of the students from School 1 and 36% of the students from Schools 2 and 3 agreed to participate in the study. The recruitment rate per class in School 1 ranged from 33% to 70% per class, with most classes near 55% to 60% recruitment per class. In Schools 2 and 3, the recruitment rate ranged from 12% to 67% per class. It is possible that some teachers may have provided more reminders to students to return consent forms, depending on their level of interest in the study. Analysis therefore controlled for potential class cluster effects on model testing. In all three schools, participating students' demographics were proportional to that of the schools' total student body.

The school district did not permit researchers to ask students or parents about their socioeconomic or immigrant generational status. However, school-level estimates of free and reduced meal status provide a suggestion of socioeconomic status of the population of each school, and the estimates indicated differences between the schools. One of the schools was a Title 1 elementary school in which 95% of the students received free or reduced meals. The school served primarily low-income, dual-language families. Additionally, all the participants from this school identified as ethnic minority students. The other two schools were comparable

on demographics, with about 14% of students receiving free or reduced meals in each school. These schools were located in a more affluent area, with less than 5% of White students, 6% of Latinx students, and 7% of Black students eligible for free and reduced meals. This suggests that only a small number of the White and ethnic minority groups from the second and third schools came from low-income families.

Demographic variables, such as DLL and ethnic minority status, may affect students perceived stress levels and achievement. Ethnic minority children are disproportionally exposed to stressful life conditions (e.g., family poverty, diminished community resources, racial discrimination) and are regarded as at higher risk for mental health problems compared to their White peers (e.g., Gonzalez & Kim, 1997). Similarly, DLL students face a significant amount of stress and may be at elevated academic risk throughout elementary school (National Academy of Sciences, Engineering, and Medicine, 2017). The rationale for controlling for DLL status and ethnic minority status was that these demographic variables may affect levels of stress and literacy achievement, and over half the sample is comprised by each group, with 56% of participants identifying as ethnic minority students and 57% of students categorized as DLLs. In addition, about 13% of the students in the sample were enrolled at a gifted center, where they took advanced coursework. The gifted center was located at the second school. Note that students who were not enrolled at the gifted center were also included in the sample from that school. Since participation in more advanced courses might also affect perceived stress and literacy achievement, the present study controlled for gifted center participation in all analyses.

Procedure

This short-term longitudinal study used existing data from Time 1, Time 2, and Time 3 of a larger study over three months. Data from the first school was collected from January to June

2014, while data from the second and third schools were collected from March to June 2015. The research was approved by the University of Maryland IRB and the participating schools' district. Researchers recruited participants by visiting with teachers during team meetings to discuss participation in the study, along with visiting students' classrooms to explain the study. Parent consent and student assent were obtained. Demographic data were collected on consent forms, including participants' age, race/ethnicity, sex, and language spoken at home.

There was approximately one month between students' interviews at each timepoint, on average. At Time 1, which occurred during a single designated school day, students completed a self-report measure of perceived stress as well as a three-minute literacy achievement performance task. Researchers read the perceived stress measure aloud and one-on-one to each participant, and answer options were presented on a printed scale so that the participant could read along. Students had the opportunity to point out their answer on the printed sheet, if desired. At the first school, students with limited or no English language skills ($N = 6$) were interviewed by Spanish- and French-speaking researchers. Due to time constraints, 14% of students' Time 1 data from all three schools were collected in a small group setting. As a result, analyses will control for interview format to ensure that one-on-one versus group data collection does not influence stress-literacy relations. The same procedures were conducted with participants at Time 2 and Time 3. Similarly, 1.5% of students' Time 2 data and 3% percent of students' Time 3 data were collected in a small group setting due to time constraints.

Measures

Perceived stress. Perceived stress was assessed using a modified version of the 10-item Perceived Stress Scale (PSS-10; Cohen & Williamson, 1988). Students rated how often their lives felt uncontrollable, emotionally upsetting, or overwhelming within the last week (1= Never,

5 = Very Often). Questions focused on general, perceived life stress (e.g., "How often did you feel like you could not do anything to change the way things were going?"). Positively stated items (items 4, 5, 7 and 8) were reverse coded. For these reverse coded items (i.e., the coping subscale), the results of analyses will be inversely interpreted (e.g., a negative relationship should be interpreted positively).

Minor adaptations in item phrasing were made to the scale to make it more accessible to the sample of elementary students, given that the original PSS-10 was designed for individuals with a junior high school education or above (see Table 1). During this process, the PSS-10 was also piloted in School 1 to improve item phrasing to make it more accessible for DLL students. The modified version of the PSS-10 also asked students to reflect on stressful experiences over the past week rather than the past month. This change was made because the researchers expected it would be easier for younger students to accurately reflect on their stressful experiences in a shorter time frame.

Researchers have conducted factor analysis on the PSS-10 among different populations and the scale has consistently demonstrated a two-factor structure (Lee, 2012). The PSS-10 has repeatedly demonstrated adequate internal consistency reliability with a Cronbach's alpha of .74 - .91 (Lee, 2012). Test-retest reliability of the PSS-10 has been conducted in multiple studies and has been found to be adequate (r = .74 - .77; Lee, 2012). These studies considered an alpha value of .70 as the minimum measure of adequate internal consistency (Lee, 2012; Nunnally & Bernstein, 1994). At the same time, the PSS was used as a latent factor in model testing in the present study, which makes lower alpha coefficients less of a concern (e.g., Bollen, 2002).

Literacy achievement. Literacy achievement was assessed through the Test of Silent Reading Efficiency and Comprehension (TOSREC; Wagner et al., 2010). The TOSREC is a

standardized reading performance task designed to test students' silent reading decoding (accuracy), fluency (speed), and comprehension. Each participant took the TOSREC at Time 1, Time 2, and Time 3.

The TOSREC consists of logical and illogical sentences that get longer and more difficult to read as the student proceeds through the test. Students had three minutes to read as many sentences as they could to themselves and mark whether each sentence was true or false (e.g., "An apple is blue."). Raw scores were calculated by summing the correct items, and then subtracting the number of incorrect items from the total. Then, raw scores were converted to standard index scores ($M = 100$, $SD = 15$). Standardized index scores were used for data analysis, which is consistent with other studies that have used the TOSREC (e.g., Durwin et al., 2018; Kim et al., 2011; Johnson et al., 2011;).

TOSREC response booklets were normed by grade (e.g., Grade 3) and form, which corresponded to the point in the school year (e.g., Form B was administered during the second third of the school year, December through February). In other words, the TOSREC forms provide more specific norming beyond the grade-level of the student, such that a raw score on the TOSREC in the first third of the school year would be a different number than in the second, and last, third of the school year. The present study did not control for participants' age, as a result of the fine-grained norming by grade and form on the TOSREC. This is consistent with other studies that have used different forms on the TOSREC, depending on the point in the school year, and subsequently did not control for participant age (e.g., Kim et al., 2011; Durwin et al., 2018). The decision to use separate forms was also based upon the test's administration guidelines.

Although there was a short time span of about a month and a half in between each timepoint in the present study, it was expected that there would still be change in standardized scores on the TOSREC across time, due to the nature of the sample; over half of the sample was comprised of DLL students (56% DLL). It is likely that the literacy achievement of DLL students, who are relatively new to the English language, would vary over a short period of time (National Academies of Sciences, Engineering, and Medicine, 2017). Standardized assessments of DLLs provide evidence of their learning, and experts recommend the use of assessments at multiple time points at the elementary level to identify children's reading development, progress monitor, and improve the effectiveness of strategies to support their learning (National Academies of Sciences, Engineering, and Medicine, 2017). For these reasons, in the current study, the literacy achievement of students may show growth over time, even though there is only about a month and a half in between each time point.

The TOSREC has strong reliability and convergent validity with other measures of literacy achievement, such as the Woodcock-Johnson Tests of Academic Achievement, 3rd ed. (WJ-III; Wagner et al., 2010). The TOSREC also has strong correlations with the Dynamic Indicators of Basic Early Literacy Skills (DIEBLS) Oral Reading Fluency (ORF; r = 0.81; Kim et al., 2010). Previous studies have found that reliability coefficients exceed .85 across third through fifth grades (Wagner et al., 2010).

Analytic Approach

First, the data was reviewed in IBM SPSS Statistics version 27 (SPSS Inc., 2021). Cases that had missing data at all timepoints were removed from analysis (n =13). These cases reflect students whose parents returned consent forms to researchers, but the students did not end up participating in the study. After these cases were removed, it appeared that the remaining missing

data was largely from the first school and specifically, from participants who were interviewed in a group format for their responses to the PSS-10 (n = 50). Previous studies using this data have controlled for school placement and group format to manage this missing at random (MAR) data mechanism (e.g., Boyars, 2019; Meyering, 2016). Other missing data appeared to be missing completely at random (MCAR) in that it did not seem to have any patterns (n = 24). The remaining missing data can likely be explained by attrition or students who were absent from school on one of the data collection days. In Mplus, a restricted maximum likelihood robust standard error estimation approach (i.e., MLR) was used to manage missing data (Muthen & Muthen, 2020).

Prior to model testing in Mplus, preliminary descriptive statistics and psychometric analysis (i.e., alpha coefficients, means, ranges, standard deviations) of perceived stress and its subscales were assessed to determine if the data was consistent with previous research. Alpha coefficients of .65 or higher were considered to meet an acceptable internal reliability level (DeVellis, 2003).

Subsequent analysis was conducted using Mplus version 8.6 (Muthén & Muthén, 2021). Analyses controlled for ethnic minority status (White vs. non-White), DLL status, sex, school placement, gifted center participation, and interview format (individual vs. group interview administration). Analyses used a design-based approach (e.g., McNeish & Harring, 2017) to adjust for cluster sampling between classrooms. In all models, fit indices were examined to evaluate model fit, including Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), and Standardized Root Mean Squared Residual (SRMR). Model fit was assessed with cutoffs used in previous studies that have considered RMSEA values of less

than 0.06, SRMR values of less than 0.08, and CFI values of greater than 0.95 as evidence of good model-data fit (e.g., Hu & Bentler, 1999; Sass, 2011).

Hypothesis 1. A confirmatory factor analysis (CFA) was conducted to determine if the PSS-10 data fit the expected factor structure. Model fit of the Time 1, Time 2, and Time 3 factor structures was compared using AIC Indices, with lower AIC indices indicating better model fit (Wagenmakers & Farrell, 2004). As a two-correlated factor model was supported, two latent perceived stress subscale factors (distress and coping) were used in all subsequent analyses. A CFA was also completed at Time 2 and Time 3 to cross-validate the results. Lastly, a temporal measurement invariance process was conducted to assess the stability of the factor structure over time (Putnik & Bornstein, 2016). Specifically, a baseline "configural" model was compared to a "metric" model in which the factor loadings were constrained to be equivalent across time. Scalar invariance was then tested by constraining item intercepts to be equivalent across time and comparing the "scalar" model to the "metric" model (Putnik & Bornstein, 2016).

Hypothesis 2 and 3. Path analyses were conducted to examine direct (i.e., the relation between perceived stress and later literacy achievement) and reverse (i.e., the relation between literacy achievement and later perceived stress) effects. First, latent variable path analyses (LVPA) were run with T1 latent scores of the PSS-10 subscales (distress and coping) predicting observed T2 and T3 TOSREC scores, with T1 and T2 TOSREC scores entered as a control for previous literacy achievement. To determine reverse-effects, another LVPA was run with T1 TOSREC scores predicting T2 and T3 latent scores of the PSS-10 subscales (distress and coping), with T1 and T2 latent stress factors as a control for previous stress. Note that these path analyses are not necessary as a precursor to examining cross-lagged effects between stress and literacy achievement (hypothesis four); however, I conducted these preliminary analyses, as I am

also interested in the direct and reverse effects of distress and coping on literacy achievement among students.

Hypothesis 4. An LCM-SR model was run with the direct, reverse, and cross-lagged relations between latent perceived coping, latent perceived distress, and observed literacy achievement residuals. The model integrated relations among the repeated perceived stress and literacy achievement measures at three time points, simultaneously (see Figure 1). The LCM-SR builds on the commonly used autoregressive cross-lagged (ARCL) panel model, but the key difference is its use of a residual structure and isolation of between-person and within-person effects. The residuals (i.e., error terms) represent "time-specific deviations" from the growth trajectories of individuals (Bainter & Howard, 2016). Within-person variability is captured by the structured residuals that are associated with the repeated measures, while between-person variability is captured by the latent curve factors (Curran et al., 2014). The LCM-SR includes autoregressive and cross-lagged regressions in the within-person portion of the model, without affecting the underlying latent growth curve (i.e., the between-person part of the model; Hawes et al., 2015). The autoregressive and cross-lagged paths (i.e., estimates), therefore, represent within-person change, or state-like "fluctuations within individuals from their own predicted average-level scores across time" (Long et al., 2019). The random intercepts correspond to between-person differences in initial levels of stress and literacy achievement, while the random slopes represent between-person "trajectories of change" in each variable (Long et al., 2019). Finally, the correlation between the random slopes indicates the degree to which between-person differences in stress are linked with between-person differences in literacy achievement. (Long et al., 2019) In sum, the autoregressive cross-lagged regressions were estimated between the residuals (i.e., individuals' fluctuations, at specific points in time, from their own predicted

mean-level growth trajectory) of the variables in the LCM-SR, which allowed for the separation of between-person and within-person variability in stress-literacy achievement relations over time (Curran & Hancock, *in press*).

The LCM-SR model-building strategy followed the recommendations of Curran et al. (2014) and was conducted in a series of steps. First, growth models including intercepts and slopes were run with distress, coping, and TOSREC, separately. Distress and coping were run as second order growth models, since stress was a latent variable. In contrast, TOSREC was run as a first order growth model, since literacy achievement was an observed variable. Once the univariate models were established, the separate models were combined into a single growth model that included distress, coping, and TOSREC. Then, a separate intercept-only model (slope factor loadings set to 0) was run to determine whether there was between-person variability in the overall levels of distress, coping, and literacy achievement (Curran et al., 2014). We then ran a growth model that included latent factors for the residuals of distress, coping, and TOSREC. Lastly, we added autoregressive and cross-lagged regressions to the residual structure that was defined in the previous step. In the final model, we allowed the residuals to covary at T1, but not at T2 or T3, to fix an initial convergence problem. The autoregressive and cross-lagged effects in the final model correspond to within-person change in stress-literacy achievement relations over time; however, the LCM-SR also parses apart between-person effects. As a result, the slopes of distress, coping, and TOSREC, as well as their means and variances, were assessed in the LCM-SR model results to determine whether the relations between stress and literacy achievement were also operating at the between-person level.

Chapter 3: Results

Descriptive Statistics

Table 3 of Appendix A presents the means, ranges, standard deviations, and alpha reliability coefficients of stress and achievement. According to the suggested cutoff of 0.65 (DeVellis, 2003), the PSS-10 demonstrated adequate internal consistency for the full scale (α = .76 - .78) and distress factor (α = .71 - .76). The coping factor had adequate internal consistency at T3 (α = .69), but not at T1 (α = .61) or T2 (α = .63). The lower alpha coefficients for the coping factor are less of a concern, due to this study's use of latent variables (e.g., Bollen, 2002).

The mean stress scores were similar at each timepoint for the full scale, distress factor, and coping factor. Means were as expected, although the total sum scores found in the sample were somewhat higher than previously reported adult samples for the full 10-item scale (e.g., Cohen & Williamson, 1988), as well as for the distress and coping factors (e.g., Roberti et al., 2006). There was a wide range in literacy achievement across the sample, ranging from a standardized index score of 0 (1st percentile) to 146 (99th percentile). The mean TOSREC score across all schools was slightly higher at T2 (104.80, *SD* = 23.49, 56th percentile) and T3 (103.10, *SD* = 21.62, 53rd percentile) than at T1 (*SD* = 21.41, 53rd percentile).

Correlations

Bivariate correlations were examined for all variables of interest using total scores in SPSS. A correlation matrix for the observed variables of interest is displayed in Table 4. Perceived coping and TOSREC were significantly, positively correlated with one another across all timepoints (r = .13 - .23, p < .05). Perceived distress and TOSREC were significantly correlated with one another across most timepoints, as expected. T1 distress was negatively correlated with T2 TOSREC (r = -.16, p < .01), but not with T1 or T3 TOSREC. T2 distress was

negatively correlated with TOSREC at all three timepoints (r = -.18 - -.23, p <.01). Similarly, T3 distress was negatively correlated with TOSREC across all timepoints (r = -.16 - -.19, p <.01).

Hypothesis 1: Factor Structure

Confirmatory factor analyses (CFA) were conducted to answer the following research question: Does the data fit a correlated two-factor perceived stress model, with stress-coping and stress-distress as the two factors?

CFA were conducted with T1 data, and then later with T2 and T3 data to see if the data fit the expected two-factor structure of the PSS-10. At all timepoints, a two-correlated factor model demonstrated adequate model fit (see Table 5). In all models, the positively phrased items loaded on to the stress-coping factor, and the negatively phrased items loaded on to the stress-distress factor of the PSS-10. It should be noted that there is no overlapping content between the two factors; coping items are not simply the reversal of the distress items. Rather, the phrasing and loading of the items matched up with the two separate elements of the stress experience (i.e., distress and coping), as expected. All of the expected items loaded well onto their respective factors (e.g., all item loadings were ≥ .43).

Since later LCM-SR analyses examined stress-literacy achievement relations at all three timepoints, simultaneously, a final model included T1, T2, and T3 data and was supported by the CFA. The distress and coping factors were set to be correlated with one another at each timepoint. Due to similar item phrasing, items 10 and 6 of the distress factor were also set to be correlated with one another at each timepoint. All of the expected items loaded well onto their respective factors (e.g., all item loadings were ≥ .44). The two-factor model fit was adequate (see Table 5).

In the temporal measurement invariance process, metric and scalar invariance were both supported. Temporal invariance testing suggested that the factor structure of the PSS-10 was not significantly different across time, as expected (see Table 6). These results confirm that participants conceptualized the measures similarly at each timepoint, and thus, the measures can represent the same latent factors across time (Putnik & Bornstein, 2016). In sum, CFA and measurement invariance testing supported a two-factor structure (stress-distress and stress-coping) of the PSS-10 that was consistent across time.

Hypothesis 2: Direct Effects of Stress on Literacy Achievement

LVPA were run to answer the following research question: Does perceived stress predict students' later literacy achievement?

A LVPA was run with T1 distress and T1 coping predicting observed T2 and T3 TOSREC scores, with T1 TOSREC entered as a control for previous literacy achievement. Model fit was adequate, RMSEA = 0.02, CFI = 0.99, SRMR = 0.03. Analysis revealed that T1 perceived coping was significantly related to T3 TOSREC (Estimate = -3.28(1.62), $p < .05$, 95% CI = [-6.45, -.11]); see Table 7. These results indicated that coping was a positive predictor of literacy achievement, as expected. T1 perceived coping was not, however, significantly related to T2 TOSREC. Given the short time frame between when T2 and T3 measures were administered, these results suggest that positive relation of coping on literacy achievement may develop sometime after 1.5 months, and within 3 months after students perceived that they were high on coping. Perceived distress was not significantly related to TOSREC at either timepoint; see Table 7 for estimates and *p*-values. Thus, the hypothesis was partially supported in that perceived coping had a positive relation with achievement, but contrary to expectations, perceived distress did not have a negative relation with achievement, among students.

Hypothesis 3: Reverse Effects of Literacy Achievement on Stress

Another set of LVPA were run to answer the following research question: Does literacy achievement predict students' later perceived stress?

To examine reverse effects, a LVPA was run with T1 TOSREC scores predicting latent T2 and T3 distress and coping, while controlling for previous T1 and T2 stress (distress and coping). Model fit was adequate, RMSEA = 0.03, CFI = 0.95, SRMR = 0.05. Results revealed that TOSREC did not have a significant effect on distress, or on coping, at either timepoint; see Tables 8 and 9 for estimates and *p*-values. It is possible that these findings are due to the measures being administered so close together, with only a month and a half in between. Previous stress (T1 distress and coping) and stress outcomes (T2 and T3 distress and coping) were also strongly correlated (see Table 4). Due to this, another LVPA was run without previous stress as a control. Model fit was adequate, RMSEA = 0.03, CFI = 0.95, SRMR = .05. In the model, T1 TOSREC significantly predicted T2 distress (Estimate = -.01(.003), $p = .01$, 95% CI = [-.013, -.002]) and T2 coping (Estimate = -.01(.002), $p < .01$, 95% CI = [-.01, -.001]). In sum, literacy achievement was a negative predictor of distress, and positive predictor of coping among students at T2 only, when previous stress was not a control.

Hypothesis 4: Cross-lagged Effects between Stress and Literacy Achievement

An LCM-SR was used to answer the following research question: Are there cross-lagged (i.e., reciprocal) effects at the residual level between stress and literacy achievement over time? The LCM-SR is a model where the direct, reverse, and cross-lagged effects are examined at the residual level (i.e., "time specific deviations" within individuals from their own predicted growth trajectory), which reveals both between-person and within-person effects (Curran et al., 2014). The cross-lagged paths between the stress and literacy achievement residuals, described below,

refer to direct, reverse, and reciprocal effects at the within-person level, while an assessment of the random slopes provides information about between-person effects (Long et al., 2019).

Within-Person Effects. To examine stress-literacy achievement relations at the within-person level, autoregressive cross-lagged regressions were run between the residuals (i.e., error terms) of distress, coping and TOSREC at all timepoints, simultaneously (see Figure 1). The LCM-SR demonstrated nearly adequate model fit, RMSEA = 0.03, CFI = 0.94, SRMR = 0.05. However, within the LCM-SR, there were no significant relations between the residuals of stress and literacy achievement. Analyses revealed that distress and coping residuals did not have a significant effect on TOSREC residuals (i.e., the direct effect), and that TOSREC residuals did not have a significant effect on distress and coping residuals (i.e., the reverse effect) at either timepoint; see Table 10 for estimates and *p*-values. In sum, no within-person, bidirectional effects were found between stress and literacy achievement over time, which suggests that stress-literacy achievement relations are not state-based for students.

Between-Person Effects. The random slopes in the LCM-SR results were examined to determine whether there was between-person change in stress-literacy achievement relations over time. The means of the slopes of distress, coping, and literacy achievement were not significant; see Table 10 for estimates and *p*-values. Similarly, the variances of the slopes of the variables were not significant. These results correspond to the between-person effects and indicate that there were not individual differences in rates of growth in distress, coping, and literacy achievement between students in the sample, when modeling at the residual level. In addition, the random slopes did not significantly covary, which suggests that the between-person trajectory of change in stress was not associated with the between-person trajectory of change in literacy achievement; see Table 10 for estimates and *p*-values. These findings, which are based

on the LCM-SR model, stand in contrast to the LVPA results from hypotheses 1 and 2 which also examined between-person effects and demonstrated that perceived coping has a positive effect on later T3 literacy achievement (i.e., the direct effect), and that literacy achievement predicts later T2 stress (i.e., the reverse effect). In sum, there were no stress-literacy relations at the between-person level, when within-person effects were also accounted for in the model.

Overall, it was expected that there would be within-person, cross-lagged (i.e., reciprocal) effects between stress and literacy achievement over time. Results from the LCM-SR, however, revealed that there were no significant within-person direct, reverse, or cross-lagged (i.e., reciprocal) relations between stress residuals and literacy achievement residuals, over time. In other words, stress did not predict within-person change in later literacy achievement, and literacy achievement did not predict within-person change in later stress. An assessment of the slopes indicated that, when modeling at the residual level, there were no significant differences in rates of growth in distress, coping, and literacy achievement *between* individuals in the sample. Thus, LCM-SR revealed that there were no significant stress-literacy achievement relations at the between-person or within-person level.

Chapter 4: Discussion

This short-term longitudinal study contributed to the limited child stress literature by examining stress-literacy achievement relations over time, at both the between- and within-person levels. It is important to isolate within-person effects to elucidate the short-term changes or stability of an individuals' growth over time, which can inform larger state- or trait- questions around growth in stress-literacy achievement relations.

Initial results revealed that the PSS-10 had a two-factor structure, with distress and coping as its factors, and that the perceived coping factor predicted later literacy achievement. These results suggest that the coping component of the stress experience is particularly important, and that one's ability to deal with general problems or frustrations may even lead to increased achievement over time. This study was also the first to assess the reverse relation, or the impact of literacy achievement on student's perceived stress levels. Reverse relations indicated that literacy achievement predicted distress and coping about one and a half months later, but not three months later, and when previous stress was not a control.

When using latent curve modeling to examine the variables of interest at the residual level, however, no direct, reverse, or cross-lagged (i.e., reciprocal) effects between stress and literacy achievement were found. These results were not necessarily contradictory, but rather, suggested that stress-achievement relations were not operating at the within-person level. The importance of this finding is the implication that stress-literacy achievement relations appear more trait-based than state-based within elementary students over a short period of time.

PSS-10 Factor Structure

This study adds to the psychometric literature on the PSS-10 by suggesting that the scale has a two-factor structure when used with child populations. The PSS has consistently exhibited

a two-factor structure in adults (e.g., Baik et al., 2019; Barbosa-Keiker et al., 2013; Cohen, 1988; Lu et al., 2017; Taylor, 2015), but the factor structure of the scale had only been systematically tested in elementary-aged children in one recent thesis by O'Neal's Emotions, Equity and Education lab, using data from this sample (Meyering, 2020). The present investigation utilized an additional timepoint and, therefore, conducted a confirmatory factor analysis to determine whether distress and coping held over the three timepoints. Results of the present study align with Meyering (2020) and suggest that the two different aspects of the stress appraisal process hold true for elementary-age students, similar to findings for youth and adults. The PSS-10 has a distress factor, which captures general feelings of distress that emerge from one's perception that their experiences in the past week have been unexpected, overwhelming, or stressful. The second factor includes items that capture one's ability to cope with problems or frustrations in the past week. The psychometric distinction of the coping factor aligns well with stress-appraisal theory (Lazarus & Folkman, 1984), which posits that a stress response will only occur if an individual perceives that they do not have coping resources available to them. Despite psychometric and theoretical support for the two-factor structure, published psychological stress studies that utilize the PSS-10 tend to analyze the coping and distress items as a unidimensional stress construct (e.g., O'Neal, 2018; Schmeelk-Cone & Zimmerman, 2003). These results suggest that future studies consider teasing apart the distress and coping components of the stress experience for children, given that the two factors fit the data best and differentially predicted achievement outcomes in the present dissertation. Support for the two-factor model offers a more comprehensive way of examining psychological stress in children, overall, by focusing on the distinctive influence of distress and coping in relation to achievement outcomes.

Coping and Achievement

In the present study, coping was a positive predictor of later literacy achievement when examining the constructs at the between-person level; note that distress was not significantly related to later literacy achievement. In other words, individuals who were high on perceived coping also had high literacy achievement later on, relative to others. These results fit with previous research that has demonstrated that stress has a negative impact on the achievement of students (Alva & de Los Reyes, 1999; Berry et al., 2012, Cunningham et al., 2008; Gillock & Reyes, 1999; O'Neal, 2018; Schmeelk-Cone & Zimmerman, 2003). An individual's perception of their ability to cope with stressful experiences may help prevent academic underachievement, and even lead to positive literacy achievement outcomes. It is possible, based on stress-appraisal theory (Lazarus & Folkman, 1984), that students high on self-reported coping did not experience a distress response that could have led to academic underachievement, as they were successfully able to cope with exposure to distressing life experiences. One explanation for this finding is that students high on self-reported coping may be better able to regulate their negative thoughts and emotions related to general life stress, and as a result, their working memory capacity can be reserved for school and completing cognitively challenging tasks, like a literacy achievement performance task (Schmader et al., 2008). It is also likely that these students with high coping are responding to distressing situations in their lives more productively (e.g., problem-solving) than students that have lower self-reported coping abilities. As a result, students who are high on coping may be more available for learning and better able to concentrate on reading to gain content knowledge in their classes (Skinner & Saxton, 2018). Given the differential impact of coping on literacy achievement, future research should use moderation modeling to explicitly examine how the negative impact of distress on achievement may be dependent on coping.

Reverse Relation of Literacy Achievement on Stress

This study makes a novel contribution to the literature by assessing the reverse relation of the impact of literacy achievement on student's later perceived stress. As expected, literacy achievement was a negative predictor of later distress, and a positive predictor of coping, one and a half months (T2), but not three months (T3), after the initial literacy achievement performance task. This is the first study to find reverse effects of any achievement on stress, much less literacy achievement on later stress; however, contrary to expectations, reverse effects were not found when previous stress was a control in Model 1. The findings of Model 2 (i.e., reverse effects without previous stress as a control) tentatively suggest that a lack of literacy skills may initially trigger stress and negative emotions in an elementary student who is struggling to read in the classroom. Indeed, the finding that literacy achievement negatively impacts stress aligns with research that has suggested that children might develop negative emotions, like anxiety, in response to experiencing repeated failures in the classroom (Grills-Taquechel et al., 2012). For students that lack literacy abilities, it is possible that general distress or negative emotions are triggered in the short-term, but that later on, students become disengaged and use avoidance coping (e.g., denial) as a way to deal with problems, which may lead them to believe that they are no longer experiencing distress. This could explain why reverse effects (i.e., literacy achievement affecting stress) were found at Time 2, but not at Time 3, in the present study.

With respect to coping, findings tentatively suggest that individuals who have higher literacy achievement later perceive that they also have higher abilities to cope with general stressors, relative to others. The reverse impact of achievement on coping aligns with a recent finding that literacy achievement impacts the later social-emotional factors of engagement and

grit (O'Neal et al., 2018). Since children spend a majority of their time in school, it is possible that possessing literacy skills (e.g., decoding, comprehension, vocabulary development, fluency) frees up cognitive resources that students can then use to solve non-school-related problems and cope with short-term frustrations in their lives (Schmader et al., 2008). Future research could examine specific mediation pathways to gain insight into exactly how literacy achievement influences perceived coping abilities. Reverse effects of literacy achievement on coping also hold important implications for intervention development. Results of the current study suggest that, by promoting students' literacy abilities, educators may also hold consequences for students' ability to cope with general stressors in their lives. This finding may tentatively reinforce the importance of literacy interventions for students, as achievement in this area may affect later social-emotional processes.

Reciprocal Effects and Within-Person Processes

The present study found that there were no bidirectional effects between stress and literacy achievement over time. These LCM-SR results stand in contrast to existing studies that employed autoregressive cross-lagged (ARCL) panel models and demonstrated reciprocal effects between constructs that are similar to the social-emotional factor of stress (e.g., life satisfaction, subjective well-being) and achievement. Similarly, results stand in contrast to recent, within-person examinations of reciprocal effects between stress reduction practices (e.g., mindfulness) and distress (McClintock et al., 2019) using LCM in adults, though this line of research did not consider achievement. Yet, in the present study, bidirectional relations were not found at the between- (i.e., associations that exist across a group of individuals) or within-person level (i.e., associations that represent an individuals' deviation, at a specific point in time, from what is typical for them) (Curran et al., 2014). Since stress management aligns with relevant social-

emotional frameworks (e.g., CASEL, 2020), and stress-coping is thought to be a critical factor in the potential stress response (Lazarus & Folkman, 1984), it was expected that there would also be positive reciprocal effects between coping and achievement, as well as negative, reciprocal effects between distress and achievement. Future studies can build on the present study by examining stress-literacy achievement relations using additional timepoints, and by allowing a longer period of time between each timepoint, to draw more firm conclusions about the lack of reciprocal effects. Assuming, however, that the non-significant reciprocal effects were not due to the short-term design of this study, then one could conclude that the relation between stress and literacy achievement is more trait-based than state-based within individuals across time.

Reciprocal effects between social-emotional variables and achievement have typically been found at the between-person level, through use of autoregressive cross-lagged (ARCL) panel models (e.g., Boyars, 2019; Hughes et al., 2008; Ng et al., 2015; O'Neal et al., 2018; Quinn & Duckworth, 2007). This type of analytic approach focuses on the "trait-like" differences between individuals in the sample, even though psychological theories often refer to processes that occur within individuals (e.g., Kassel et al., 2010; Lazarus & Folkman, 1985; Pendedo & Dahn, 2005; Rohen & Cohen, 1986). More importantly, prior investigations into reciprocal effects have interpreted their findings in the context of within-person change over time, even though ARCL panel models confound within-person and between-person variance (Curran et al., 2014; Long et al., 2019). It is possible that reciprocal relations between stress and literacy achievement would have been found in this study through ARCL; however, it is more important to parse out stress-literacy achievement relations at the between-person and within-person levels to draw accurate conclusions.

The non-significant findings in the current study help solve the conceptual problem that researchers have recently brought to light where between-person and within-person effects are confounded and interpreted as one (e.g., Curran & Bauer, 2011; Curran & Hancock, *in press*; Pekrun, 2021). In the present study, direct (i.e., coping predicting literacy achievement) effects between stress and literacy achievement were found through path analyses and when controlling for previous achievement. However, these findings were not evident through a latent curve model when reciprocal, and both between-person and within-person perspectives were carefully considered. To fully evaluate the impact of psychological theories (e.g., stress-appraisal theory; Lazarus & Folkman, 1984), it is critical to properly separate between-person and within-person effects within the same model, because examining the same data from these two different perspectives may yield different results. If researchers do not carefully consider the nature of the patterns operating, then significant results may be misleading and lead to inaccurate inferences that influence theory and educational practice (Pekrun, 2021).

It was theorized that stress-literacy relations would be operating at the level of within-person processes, yet within-person mechanisms of change were not supported by the LCM-SR in the short time frame of three months. It is possible that stress-literacy achievement relations would be more state-based, rather than trait-based within students over longer periods of time. Nonetheless, the lack of within-person results were not expected based, largely, on the psychological theories which often explain state-based, within- processes that occur within an individual. For example, stress-appraisal (Lazarus & Folkman, 1984) theory explains a process within an individual that may or may not result in the stress experience. In order to experience distress, an individual must appraise a situation as a threat, and then perceive that they do not possess coping resources to handle that threat (Lazarus & Folkman, 1984). The wording of the

PSS-10 items also taps into a more fluid state of stress, which would correspond to a within-person process because individuals could have variable responses to distress and coping items at different timepoints, based on their subjective experience of stress at that time. It is important to recognize, however, that LCM-SR analyses examined stress-literacy relations at the between-person and within-person levels, not just stress as a psychological construct on its own. Since there was no evidence of a change mechanism operating at the within-person level in the present study, it appears that the relations between the growth of stress and literacy achievement are more trait-based and stable among elementary students than state-based and fluid, at least across a short time span.

In sum, reciprocal effects between stress and literacy achievement were not found in the current study, at either level of analysis (i.e., between-person and within-person). These results stand in contrast to existing reciprocal effects studies, at both the between-person (e.g., subjective well-being and achievement; Ng et al., 2015) and within-person levels (e.g., stress management and distress; McClintock et al., 2019), in children and adults. Future research that uses LCM-SR modeling across many more timepoints and longer periods of time in between timepoints is needed to determine whether stress-literacy achievement relations map onto stress-appraisal theory (Lazarus & Folkman, 1984) and refer to processes that happen within an individual, or if existing stress studies are correct in their assumption that these variables operate at the between-person level and instead, occur across a group of individuals.

Limitations

The main limitation of this study is related to its short-term longitudinal design. There were only three timepoints in the study, and measures were administered with only about a month and a half in between timepoints. In the present study, the reverse effect of literacy

achievement on later stress was only found when previous stress was not a control. A longer-term longitudinal design may allow for reverse effects to be more firmly established with previous stress as a control. With respect to reciprocal effects testing, leading researchers suggest that five repeated measures be used to improve estimation in the LCM-SR, given that the model has increased complexity (Curran et al., 2014). The study design could therefore be strengthened by including five or more repeated measures and allowing a longer period of time between each timepoint. If these changes were made, it is possible that cross-lagged (i.e., reciprocal) relations between stress and literacy achievement would be found at the within-person level, and that stress-literacy achievement relations would, therefore, be state-based for students. Indeed, a longer-term longitudinal design would allow for larger growth trajectories in literacy achievement and stress across time. Future studies could use LCM-SR to tease apart within-person and between-person effects in the relations between stress and achievement over the entire span of elementary school, for example. A longitudinal design of this nature could allow future researchers to draw more valuable inferences about students' experience of distress, their coping abilities, and the literacy achievement of students.

Another significant limitation was related to the nature of the stress and literacy achievement measures. The coping factor of the PSS-10 only includes four items, so the conclusions that were drawn about the positive effects of (a) coping on literacy achievement, and (b) literacy achievement on coping are likely not all-encompassing. Future studies should incorporate the PSS-10 in conjunction with other, more comprehensive coping measures (e.g., Adolescent Coping Orientation for Problem Experiences; Patterson & McCubbin, 1987) to draw more generalizable conclusions about the differential role of coping on literacy achievement. In addition, the present study focused only on general life stress. While general hassles are thought

to be more relevant to the daily experience of stress in children and adolescents (e.g., Compas, 1987), it is possible that literacy achievement could have a greater impact on students' later academic stress. The present study did not find that literacy achievement impacted students' later stress (i.e., reverse effects) when previous stress was a control. Perhaps, effect sizes for these reverse effects would be greater for the impact of achievement on some domain-specific stress, such as academic stress. Future research should consider the possibility that literacy achievement might be more strongly related to stress about academics. Lastly, in the current study, the TOSREC was normed by grade and form, based on the test's administration guidelines. It is possible that this standardization process concealed growth in literacy achievement over the short period of three months. The TOSREC also provides Form O, which is normed by grade, but not by the point in the school year. Future studies could utilize this form in longitudinal research to allow for more variation across time, which is especially important for detecting between-person effects. Future studies should use literacy achievement measures that are not re-standardized by grade or form, to better detect growth trajectories in achievement across time.

Conclusions and Implications

The results of this study contribute to understanding how perceived stress and literacy achievement relate to one another among upper elementary students across time, at the between-person and within-person levels. The differential impact of coping on later literacy achievement was established. The present study was also the first to demonstrate reverse effects, or the impact of literacy achievement on both distress and coping, when previous stress was not a control. In contrast, no significant direct, reverse, or cross-lagged (i.e., reciprocal) relations between stress and literacy achievement were found when a latent curve model was used at the residual, within-person level. These results, rather the lack of significance at the within-person level, suggest that

there is consistency in individual growth in stress and literacy achievement over a short period of time, and in the relations between their growth patterns. Stress-literacy achievement relations may, therefore, be more trait-based, rather that state-based, for students, although longer-term studies are needed to determine whether this pattern is consistent over longer periods of time.

These findings hold important implications for school-based practices. School psychologists should advocate for practices that explicitly teach students coping skills, and for early literacy interventions. Given that perceived coping predicted later literacy achievement (i.e., the direct effect), educators could preventatively intervene upon stress by explicitly teaching students coping skills, which may lead to an increase in students' later literacy abilities. This type of intervention is imperative for students' general achievement, too, since upper elementary students are expected to use their foundational reading abilities to learn in all subject areas by the end of the third grade (Toste & Ciullo, 2017). Similarly, based on reverse effects evidenced in this study, educators may wish to promote students' literacy abilities, and in doing so, they may also be (a) supporting students' capacity to cope with stressors, and (b) reducing students' general sense of distress. Within-person results also hold important implications for the use of interventions in schools. Since stress-literacy achievement relations may be more "trait-like" and consistent for elementary students, at least across the short span of a few months, it may take interventions time to show a reduction in distress or increases in coping or literacy abilities. Educator may wish to implement preventative interventions to promote growth in these important areas, as a result. To improve researchers' understanding of potential bidirectional relations, and to draw firm conclusions about the state- versus trait-based nature of stress-literacy achievement relations, however, longer-term studies are required.

Appendices

Appendix A: Tables and Figures

Table 1

Adapted PSS-10 Items

	Original Items		Current Study Adapted Items
	The questions in this scale ask you about your feelings and thoughts during the last month. In each case, please indicate with a check how often you felt or thought a certain way.		These next questions are about how you felt and what you thought during the last week:
1.	In the last month, how often have you been upset because of something that happened unexpectedly?	1.	In the last week, how often did you get upset because something you did not expect happened?
2.	In the last month, how often have you felt that you were unable to control the important things in your life?	2.	In the last week, how often did you feel like you could not do anything to change the way things were going?
3.	In the last month, how often have you felt nervous and "stressed"?	3.	In the last week, how often did you feel nervous and “stressed”? [*in general when you’re in school*]
4.	In the last month, how often have you felt confident about your ability to handle your personal problems?	4.	In the last week, how often did you feel like you could make your problems better?
5.	In the last month, how often have you felt that things were going your way?	5.	How often did you feel like things were going right for you?
6.	In the last month, how often have you found that you could not cope with all the things that you had to do?	6.	How often were you too upset to do all the things you had to do?
7.	In the last month, how often have you been able to control irritations in your life?	7.	How often did you feel like you could deal with things that frustrated you? [*or do something to feel better or fix the frustrating problem?]*
8.	In the last month, how often have you felt that you were on top of things?	8.	How often did you think about your schoolwork and think, “I can do all of this!”?
9.	In the last month, how often have you been angered because of things that were outside of your control?	9.	Think about a time there were things you could not change. How often did you get mad about that?
10.	In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	10.	How often did you feel like there were so many hard things to do that you just could not do them all?

Table 2

Sample Demographics

	Full Sample	
Demographic Variables	*N*	%
Child Sex		
Female	223	56
Age at Time 1		
8 years	48	12
9 years	134	34
10 years	136	34
11 years	74	19
12 years	1	.3
School		
School 1	123	31
School 2	129	33
School 3	145	37
Grade Level		
3rd	125	30
4th	120	29
5th	144	35
Ethnicity		
Asian	24	6
Black	46	12
Latina/o	117	29
Multiracial	28	7
Not Reported	9	2
Other	2	.5
White	165	42
Language Status		
DLL	226	57

Note. Total n = 397. School 3 primarily serves children who are primarily low SES and are dual language learners (DLL). Children were coded as DLL) if the child spoke another language with at least one parent.

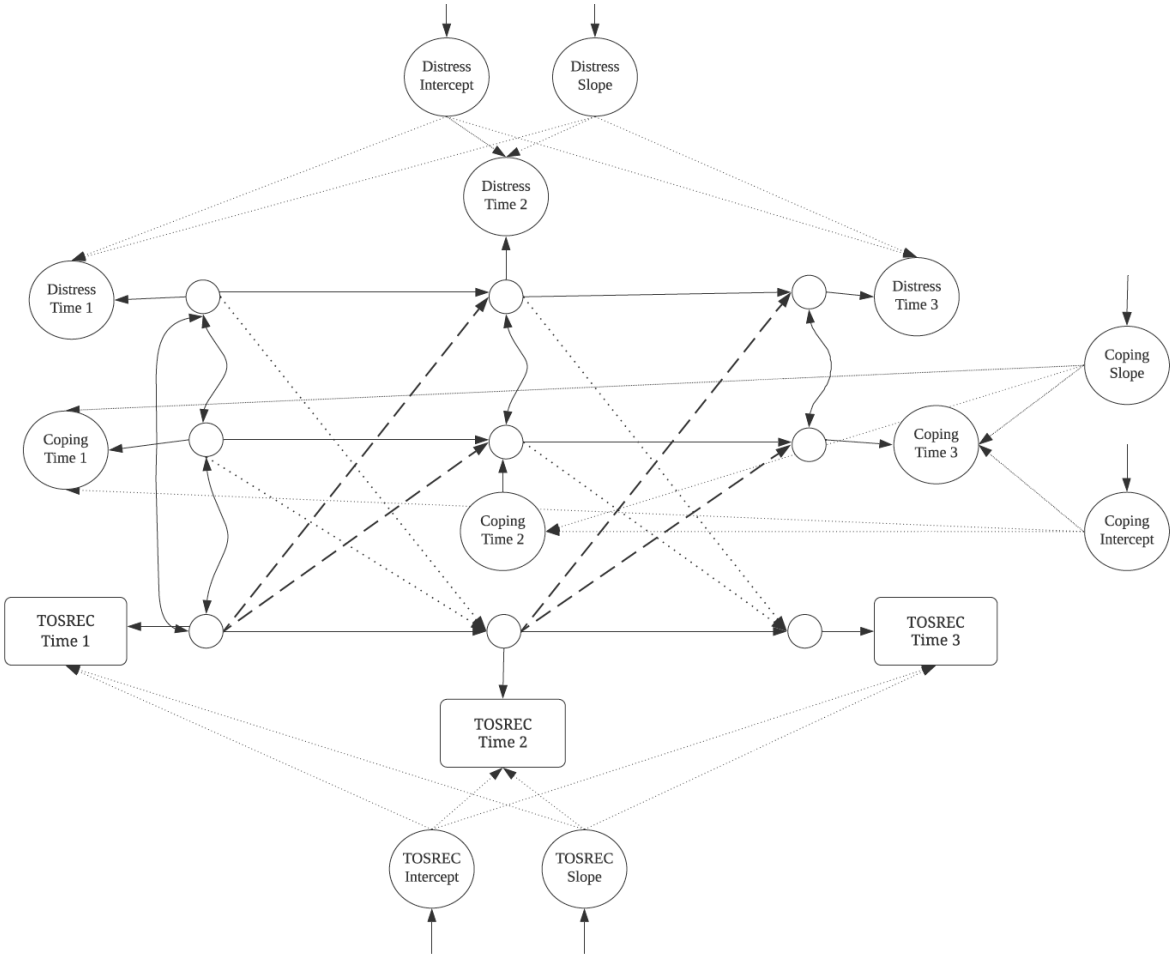

Figure 1. Latent curve model with structured residuals (Model A; dotted and dashed lines) with paths between the error terms of the stress subscales (perceived distress and perceived coping) and the error terms of the TOSREC, versus Direct Model (Model B1; dotted lines), and Reverse Model (Model B2; dashed lines). In this conceptual model, latent subscale factors for distress and coping will be derived from student-reported perceived stress items on the PSS-10. Six indicators (i.e., PSS items 1, 2, 3, 6, 9, and 10) comprise the distress factor while four indicators (i.e., PSS items 4, 5, 7, and 8) comprise the coping factor.

Table 3

Descriptive Statistics

			Time 1		**Time 2**		**Time 3**	
	Number of Items	***Total Possible Range***	***M(SD)***	***α***	***M(SD)***	***α***	***M(SD)***	***α***
PSS-10	10	1-5	2.47(.60)	**.76**	2.56(.61)	**.78**	2.49(.60)	**.78**
Distress	6	1-5	2.66(.71)	**.71**	2.77(.73)	**.76**	2.73(.71)	**.76**
Coping	4	1-5	2.18(.67)	.61	2.23(.69)	.63	2.14(.71)	**.69**
TOSREC Scores	--	0-146	101.66(21.41)	--	104.8(23.49)	--	103.10(21.62)	--

Note. Alpha coefficients in bold meet an acceptable internal reliability level of .65 or higher (DeVellis, 2003). PSS-10 = 10-item Perceived Stress Scale (Cohen & Williamson, 1988). TOSREC = Test of Silent Reading Efficiency and Comprehension (Wagner, Torgesen, Rashotte, & Pearson, 2010). TOSREC scores are standardized index scores (mean of 100 and SD of 15). Listwise n = 271.

Table 4

Correlations

Measure	1	2	3	4	5	6	7	8	9
1. Distress T1	--	.46**	.51**	.38**	.50**	.37**	-.08	-.16**	-.09
2. Coping T1	.46**	--	.29**	.54**	.28**	.58**	.14**	.20**	.22**
3. Distress T2	.51**	.29**	--	.47**	.53**	.34**	-.20**	-.23**	-.18**
4. Coping T2	.38**	.54**	.47**	--	.32**	.60**	.20**	.23**	.20**
5. Distress T3	.50**	.28**	.53**	.32**	--	.39**	-.16**	-.19**	-.17**
6. Coping T3	.37**	.58**	.34**	.60**	.39**	--	.13*	.14*	.13*
7. TOSREC Score T1	-.08	.14**	-.20**	.20**	-.16**	.13*	--	.88**	.89**
8. TOSREC Score T2	-.16**	.20**	-.23**	.23**	-.19**	.14*	.88**	--	.91*
9. TOSREC Score T3	-.09	.22**	-.18**	.20**	-.17*	.13*	.89**	.91*	--

Note:

** = significant at the .01 level
* = significant at the .05 level

Table 5

Fit Statistics for Stress Confirmatory Factor Analyses (CFA)

Model Fit Statistics					
CFA Model	χ^2	*RMSEA*	*SRMR*	*CFI*	AIC Index
Time 1	42.64	**.03**	**.04**	**.98**	10901.53
Time 2	59.74**	**.05**	**.04**	**.95**	9293.78
Time 3	58.83**	**.05**	**.05**	**.95**	9124.48
All timepoints	459.28***	**.03**	**.05**	**.95**	28637.02

RMSEA = root mean square error of approximation. SRMR = standardized root mean square residual. CFI = comparative fit index.

Table 6

Temporal Measurement Invariance Testing

	Model Fit Statistics				
Model	χ^2	*RMSEA*	*SRM*	*CFI*	AIC Index
Configural	459.28***	.03	.05	.95	28637.02
Metric	472.80***	.03	.05	.96	28617.06
Scalar	499.78***	.03	.05	.95	28604.82

***$p < .001$

Table 7

Path Model: Direct Effects of Latent Distress and Coping on Literacy Achievement

Predictors	**T2 Literacy Achievement**				**T3 Literacy Achievement**			
	Unstand. Estimate (SE)	Standardized Estimate (SE)	*p*-value	CI	Unstand. Estimate (SE)	Standardized Estimate (SE)	*p*-value	CI
T1 Distress	-1.83(1.71)	.06(.04)	.28	(-5.18, 1.53)	2.34(1.63)	-0.04(.04)	.15	(-.86, 5.54)
T1 Coping	-2.25(1.78)	-.09(.04)	.21	(-5.72, 1.23)	**-3.28(1.62)**	**-.06(.04)**	**.04**	**(-6.45, -.11)**

Note: The *p*-values and confidence intervals of the unstandardized model results are reported in the table. Bolded rows are significant.

Table 8

Path Model: Reverse Effects of Literacy Achievement on Latent Distress

Predictor	**Time 2 Distress**				**Time 3 Distress**			
	Unstand. Estimate (SE)	Standardized Estimate (SE)	*p*-value	CI	Unstand. Estimate (SE)	Standardized Estimate (SE)	*p*-value	CI
T1 TOSREC Model 1	-.002(.003)	-.08(.09)	.37	(-.007, .003)	.00(.003)	-0.01(.11)	.91	(-.007, .006)
T1 TOSREC Model 2	**-.007(.003)**	**-.23(.09)**	**.01**	**(-.013, -.002)**	-.005(.003)	-.17(.11)	.14	(-.012, .002)

Note: The *p*-values and confidence intervals of the unstandardized model results are reported in the table. Bolded rows are significant. Model 1 controls for previous distress at Time 1 and Time 2. Model 2 does not control for previous distress at Time 1 and Time 2.

Table 9

Path Model: Reverse Effects of Literacy Achievement on Latent Coping

Predictor	**T2 Coping**				**T3 Coping**			
	Unstand. Estimate (SE)	Standardized Estimate (SE)	*p*-value	CI	Unstand. Estimate (SE)	Standardized Estimate (SE)	*p*-value	CI
T1 TOSREC Model 1	-.001(.003)	-.06(.11)	.61	(-.007, .004)	.00(.003)	-.01(.01)	.90	(-.005, .005)
T1 TOSREC Model 2	**-.006(.002)**	**-.23(.10)**	**.01**	**(-.01, -.001)**	-.005(.004)	-.20(.12)	.13	(-.013, .002)

Note: The *p*-values and confidence intervals of the unstandardized model results are reported in the table. Bolded rows are significant. Model 1 controls for previous coping at Time 1 and Time 2. Model 2 does not control for previous coping at Time 1 and Time 2.

Table 10

LCM-SR: Stress-Achievement Relations at the Residual Level[1]

Effect		Path	Unstandardized Estimate (SE)	Standardized Estimate (SE)	*p*-value	CI
Within-Person Effects	*Cross-Lagged (Direct) Effects*	T2 TOSREC on T1 Distress	.82(7.21)	.01(.13)	.91	(-13.31, 14.95)
		T2 TOSREC on T1 Coping	-3.67(5.60)	.08(.26)	.51	(-14.65, 7.3)
		T3 TOSREC on T2 Distress	.82(7.21)	-.10(.28)	.91	(-13.31, 14.95)
		T3 TOSREC on T2 Coping	-3.67(5.60)	-.06(.29)	.51	(-4.65, 7.3)
	Cross-Lagged (Reverse) Effects	T2 Distress on T1 TOSREC	.01(.04)	.15(.77)	.74	(-.07, .10)
		T3 Distress on T2 TOSREC	.01(.04)	.07(.27)	.74	(-.07, .10)
		T2 Coping on T1 TOSREC	.004(.03)	.28(3.57)	.89	(-.05, .06)
		T3 Coping on T1 TOSREC	.004(.03)	.20(1.97)	.89	(-.05, .06)
Between-Person Effects	*Means of Slopes*	Distress	.03(.02)	*n/a*	.14	(-.01, .08)
		Coping	-.03(.03)	*n/a*	.27	(-.09, .02)
		TOSREC	.61(.37)	*n/a*	.09	(-.10, 1.33)
	Variances of Slopes	Distress	-2.36(13.18)	*n/a*	.86	(-28.20, 23.47)
		Coping	-.01(.21)	*n/a*	.98	(-.87, .47)
		TOSREC	35.81(268.37)	*n/a*	.93	(-561.82, 490.19)
	Slope Correlations	Distress/TOSREC	-1.78(15.48)	*n/a*	.91	(-32.13, 28.56)
		Coping/TOSREC	-.17(3.60)	*n/a*	.96	(-7.21, 6.88)

Note: The *p*-values and confidence intervals of the unstandardized model results are reported. Bolded rows are significant. [1]In the LCM-SR, the cross-lagged regressions were estimated at the residual level, which isolates within-person variability from between-person variability in stress-literacy achievement relations. Residuals, also known as error terms, can be conceptualized as "time-specific" fluctuations within individuals from their own predicted mean-level scores (i.e., their own growth trajectory; Curran et al., 2014)

Appendix B: Comprehensive Introduction and Literature Review

Reading provides the basis for success in school and opportunities in life, yet the literacy achievement gap continues to be a pervasive problem in the US education system. Literacy is especially important in upper elementary school because, by that time, reading becomes fundamental to the process of learning (Hernandez, 2011; Toste & Ciullo, 2017). Children who have not mastered reading by the end of third grade face obstacles to success in later grades and are at-risk for other negative outcomes throughout the lifespan, such as high school drop-out and unemployment (Hernandez, 2011). This proposed study focuses on the perceived stress of children during the pivotal period in upper elementary school when students make the shift from *learning to read* to *reading to learn* (Hernandez, 2011; Toste & Ciullo, 2017). Perceived stress is operationalized as an individual's appraisal of how uncontrollable, emotionally upsetting, or overwhelming situations in their life are (Cohen et al., 1997).

The majority of the literature on stress and achievement has utilized biological (e.g., cortisol) or environmental indicators of stress (e.g., poverty), rather than conceptualizing stress from a psychological perspective. Only three studies of stress and achievement in primary or secondary school-age children (O'Neal, 2018; Schmeelk-Cone & Zimmerman, 2003; Suldo et al., 2008) conceptualize stress from a psychological framework, as in this proposed dissertation. Although limited, these studies have demonstrated that children (O'Neal, 2018) and adolescents (Schmeelk-Cone & Zimmerman, 2003; Suldo et al., 2008) who report high levels of perceived stress are at increased risk for negative outcomes, such as academic

underachievement. Stress has significant implications for students later in life, too, such as being less likely to graduate from high school or college, earning lower salaries, and increased risk of incarceration (McKinsey, 2009).

Despite its negative relation with achievement, stress is an understudied contributor to the academic opportunity gap (Levy et al., 2016). The perceived stress literature is largely cross-sectional and does not analyze the negative effects of stress over time. Only two longitudinal studies, described in further detail in the literature review below, examine the relation between perceived, general life stress and achievement (O'Neal, 2018; Schmeelk-Cone & Zimmerman, 2003). Moreover, the majority of existing stress research does not explore the relations between stress and achievement among elementary aged children, when the achievement gap begins to widen (Burchinal et al., 2011). In addition, both cross-sectional and longitudinal studies often explore the relationship between stress and broad measures of achievement, such as GPA in core academic subjects or standardized test scores. More narrow measures of achievement, such as the Test of Silent Reading Efficiency and Comprehension (TOSREC), may better assess students' level of literacy achievement, which is important for success in many subject areas in elementary school. In sum, longitudinal studies that link perceived stress and literacy achievement in samples of elementary students are needed to better understand the effect of stress on the future literacy achievement of students.

Studies have begun to establish the direct effects of stress on achievement (e.g., O'Neal, 2018; Schmeelk-Cone & Zimmerman, 2003), but it is unclear whether the reverse holds true -- literacy affects stress. This dissertation examines these

reverse effects, in addition to the direct and cross-lagged (i.e., reciprocal) effects between stress and literacy using longitudinal data. The consideration of reverse effects (i.e., the impact of literacy on perceived stress) is especially important, given that students in upper elementary school are, typically, no longer being taught to read, but are expected to read to learn (e.g., Hernandez, 2011; Toste & Ciullo, 2017). It is possible that students experiencing difficulty with reading during this critical time may, therefore, appraise situations in their lives as more stressful. It is also possible that literacy problems could result in generalized stress, both at school and in other environments, since reading does not only occur in school.

According to the psychological framework, stress is perceived when an event or experience causes distress in an individual that exceeds their ability to negate, or cope with, its harmful effects (Suldo et al., 2008). The stress response may manifest, as an internal experience of stress-related feelings (e.g., anxiety, anger, hopelessness, overwhelm) in reaction to distressing life experiences (Suldo et al., 2018). The present study relies on the Perceived Stress Scale (PSS; Cohen & Williamson, 1988), which is a widely disseminated method of assessing the perception of psychological stress, typically among adolescent youth or adults. The PSS conceptualizes stress as an individual's appraisal of (a) their experience of distress and (b) their coping resources. By breaking down the PSS into its distress and coping subscales, stress can be thought of as a social-emotional skill, particularly when considering one's appraisal of their ability to cope with stress.

The PSS is based on stress-appraisal theory, which posits that stress is experienced through a two-step cognitive, appraisal process that is triggered by

exposure to an event or stressor (Lazarus & Folkman, 1984). First, the individual subjectively evaluates whether the event is a threat to their well-being (i.e., primary appraisal). When an event is appraised as a threat, an individual then evaluates their available resources and ability to handle, or cope with, the situation (i.e., secondary appraisal; Lazarus & Folkman, 1984). According to Lazarus and Folkman's (1984) model, a stress response will only occur if one perceives that coping resources are not adequately available to them. This framework allows for individual differences and contextual factors to inform what is considered stressful to an individual. Moreover, the resulting PSS-10 has a global (i.e., general or widely applicable) focus, which is particularly important for research with children, who may not recognize the exact source of their stress. In the present study, perceived, general life stress is operationalized as the degree to which situations in one's life are judged as uncontrollable, emotionally upsetting, or overwhelming (Cohen et al., 1997).

A reciprocal model between the social-emotional factor of stress and literacy may be more suitable than focusing solely on the direct (i.e., stress impacting literacy) or reverse (i.e., literacy impacting stress) effects. Indeed, research suggests that social-emotional processes increase achievement, and that achievement may also increase social-emotional skills (Marsh et al., 2017). These cross-lagged models, which are informally called "reciprocal effects", suggest that social-emotional and academic development co-occur mutually over time (e.g., Marsh et al., 2017). Although no studies, to my knowledge, have examined reciprocal relations between stress and literacy, recent research has begun to examine cross-lagged models between achievement and other social-emotional variables that are similar to stress.

For example, Ng et al. (2015) found cross-lagged effects between life satisfaction and achievement (i.e., achievement had a positive relation with later life satisfaction, and life satisfaction had a positive relation with later achievement). There may be similar, but negative, reciprocal effects between stress and achievement. Cross-lagged relations have also been found in the relation between achievement and many other social-emotional constructs, such as effortful control (Hughes et al., 2008), grit (Boyars, 2019; O'Neal et al., 2018), and subjective well-being (Quinn & Duckworth, 2007). This dissertation builds on these studies, and contributes to a gap in the literature, by examining reciprocal relations between the social-emotional factor of stress and literacy, over time.

Overall, the present study aims to longitudinally examine how stress and literacy relate to one another among upper elementary students. Using a sample of third to fifth grade students across three schools, this proposed dissertation will examine (a) how stress affects later literacy achievement; (b) how literacy achievement affects later stress; and (c) the cross-lagged (i.e., reciprocal) relations between stress and literacy over time. The present study also aims to address challenges in teasing apart within- and between-person effects in developmental processes that co-occur (Curran & Hancock, *in press*) by implementing a latent curve model with structured residuals (LCM-SR) to examine stress-literacy relations. By exploring the distinct role of between- and within-person effects, this study may contribute to our understanding of state- versus trait-based differences in relations between stress and literacy, over time.

Literature Review

Stress Frameworks

Stress research has developed from multiple disciplines, resulting in varying approaches to the conceptualization and measurement of stress. Across these disciplines (e.g., psychology, epidemiology, sociology, biology, anthropology), three broad stress frameworks have emerged: biological, environmental, and psychological stress (Suldo et al., 2008). In the biological model, stress is one's physiological response to an external event or experience that gives rise to a state of distress (Suldo et al., 2008). The psychological response can be measured using biological indicators that increase the arousal of an organism, including elevated blood pressure, increased heart rate, and the presence of hormones and neurotransmitters such as cortisol, adrenaline, or norepinephrine (Cohen et al. 1997; McEwen, 2000; Selye, 1993). A heightened state of arousal is considered adaptive in the biological model of stress, to a certain degree, because it prepares the individual to effectively adjust to stress. Long-term, overstimulation of the stress-response system, however, has been associated with a variety of negative outcomes in adults, such as decreased life satisfaction (Evans et al., 1998) and a decline in immune function (Stein & Miller, 1993). Fewer stress studies focus on child populations; however, biological stress has been associated with impaired executive functioning (Wagner et al., 2016), lower academic achievement (Berry et al., 2012) and aggression (O'Neal, 2010) in young children.

The environmental perspective defines stress as an external event or experience that is typically associated with increased adaptive demands (Compass, 1987). This can include immediate threats of harm or unpleasant environmental

conditions (Suldo et al., 2008). Environmental, or external stress, is often measured using stress inventories. These inventories are checklists of events that are believed to be arduous for an individual, such as living in a home with too many people, having difficulty making friends, or experiencing communication problems with parents (e.g., Hispanic Children's Stress Inventory; Padilla et al., 1988). A drawback of these types of measures is that they make the assumption that "stressful events" are equally stressful across individuals, whereas in reality, individual differences and contextual factors influence whether an individual will experience a stress response after an event or experience occurs (Lazarus & Folkman, 1984). Nonetheless, environmental stress has been associated with a wide range of negative outcomes, including psychopathology (Jaser et al., 2005) academic underachievement (Alva & de Los Reyes, 1999), and decreased life satisfaction (McKnight et al., 2002). Though biological and environmental stress have both been associated with similar outcomes in children and adolescents (e.g., academic underachievement, psychopathology), these frameworks do not explain why some children experience negative outcomes in the face of stress, while other children do not.

Psychological frameworks focus on perceived stress, or an individual's subjective evaluation of their ability to manage demands that result from aversive events or experiences in their lives (Cohen et al., 1997). Lazarus and Folkman (1984) refer to this model as a "transactional perspective of stress," given its focus on the interaction between an environmental precipitant (i.e., external stress) and physiological bodily reactions (i.e., distress). An individual may display cognitive, emotional, or behavioral responses to the interaction between external stress and

distress. Most importantly, stress is perceived when an event or experience causes distress in an individual that exceeds their ability to negate its harmful effects (Suldo et al., 2008). A psychological conceptualization of perceived stress, therefore, allows for consideration that one might possess resources, like coping, that allow them to experience stress in the environment without compromised functioning (Suldo et al., 2008). This type of conceptualization helps to explain why some children experience the negative outcomes that stress has been associated with, while other children do not. Psychological stress, due to its consideration of coping, has become one of the most widely accepted conceptualizations of stress in the last 20 years (Suldo et al., 2008). Psychological stress also yields similar, negative outcomes as environmental and biological stress in children and adolescents. Indeed, children and adolescents who report high levels of perceived stress are at risk for negative outcomes later in life, such as academic underachievement (Schmeelk-Cone & Zimmerman, 2003), decreased life satisfaction (Mayberry & Graham, 2001), and psychopathology (Martin et al., 1995).

Perceived Stress

The present study conceptualizes stress in line with the psychological framework, as the degree to which situations in one's life are judged as uncontrollable, emotionally upsetting, or overwhelming (Cohen et al., 1997). Stress, as conceptualized in this dissertation, may manifest as the perceived, internal experience of stress-related feelings (e.g., anxiety, anger, hopelessness, overwhelm) in reaction to distressing life experiences (Suldo et al., 2008). The focus on perceived, general life stress, rather than an event-specific perspective, removes the assumption

that an increase in the number of stressful life events leads to increased levels of perceived stress. A distinct aspect of the psychological model, compared to environmental and biological perspectives, is that it places emphasis on an individual's subjective evaluation of threat that may result from environmental demands. Stress occurs when an individual perceives that environmental demands have exceeded their available coping resources (Lazarus & Folkman, 1984). An individual may experience a stressful event, but due to their coping resources, their functioning will not be negatively affected by the event or experience. Another individual may experience the same event and have a negative reaction that compromises their functioning, due to the absence of available coping resources (Cohen et al., 1997; Cohen & Williamson, 1988; Lazarus & Folkman, 1984). The present study takes individual differences into consideration by conceptualizing stress from a psychological model, and measuring perceived stress in children.

Theoretical Framework

This study relies on Lazarus and Folkman's (1984) stress-appraisal framework. Lazarus and Folkman (1984) posit that the impact of stressful events on an individual's functioning is determined by an individual's perception of the event's stressfulness. The Perceived Stress Scale (PSS) was developed, using Lazarus and Folkman's (1984) framework, out of need for a measure that captures this subjective process, also known as the appraisal element of stress (i.e., the cognitive process by which individuals evaluate the potential threat of a stressor and then determine their ability to cope with it).

Stress appraisal. Lazarus and Folkman's (1984) framework posits that stress is experienced through appraisal, which is a cognitive process that is triggered by exposure to a specific event or stressor. There are two types of appraisal: primary and secondary appraisal (Lazarus & Folkman, 1984). Primary appraisal is an individual's subjective evaluation of an event as a threat to their well-being. When an event is appraised as a threat, the cognitive process of secondary appraisal occurs, through which an individual evaluates their available resources and ability to handle, or cope with, the situation. Coping has been defined as the process of eliminating or lessening the negative effects of the stressful event. It can involve changing the threatening environment (e.g., fight or flight response), or evoking thoughts or actions to relieve the emotional stress response (Lazarus & Folkman, 1984). The stress-appraisal model postulates that no stress response will occur if one perceives that coping resources are adequately available to them. In this situation, coping acts as a buffer in the face of distress, such that one's exposure to a stressor does not compromise their functioning. Alternatively, a state of stress is experienced when one is uncertain of their ability to cope with a situation that has been appraised as harmful or threatening. If an individual has problems with coping, the stress response will materialize and affect their functioning. This appraisal process occurs both at the onset and through the duration of the stressful event, such that an individual is consistently reevaluating and reappraising threat and their potential state of stress (Lazarus & Folkman, 1984).

The stress-appraisal framework posits that an event, regardless of its importance or intensity, may or may not be perceived as stressful by an individual. By focusing on stress-appraisal, Lazarus and Folkman's (1984) theory allows for

personal differences and context to inform what is considered stressful to an individual. Other perspectives assume that certain life events (e.g., job loss, marriage) will be perceived as stressful across all individuals. Historically, life events checklists have been largely used in the stress literature, even though these types of measures do not consider one's perception of stress in response to these events. Life events checklists, which take an environmental approach to stress, also do not capture the effect of daily hassles on stress, despite research suggesting that daily hassles may be more relevant to the experience of stress in children and adolescents (Compas, 1987). In addition, there may also be greater individual differences among the stress experience in children (Ryan, 1988), such that the child's interpretation of the stressful event is an especially important mediator in whether, or to what degree, they will experience stress (Smith & Carlson, 1997). Thus, a stress framework that focuses on whether an event is appraised as a threat, and subsequently whether there are coping resources available, is more suited for use in children.

Perceived Stress Scale

The PSS (Table 1) is one of the most widely disseminated methods of assessing the perception of psychological stress, typically among adolescent youth or adults. The PSS was developed to address limitations in the assessment of general life stress, as it generates a global stress score based on experiences and feelings in daily life, rather than focusing on stress appraisal of specific life events (e.g., divorce, job loss). As a result, the PSS may capture stress from ongoing stressful life circumstances, such as chronic illness or poverty. It may also capture the stress that an individual feels in reaction to adverse events occurring in the lives of close friends

and family. The general nature of the items query for the experience of stress, rather than the cause of it. This removes the risk that an individual may be misattributing the source of their stress, like on event-specific scales. Rather, the PSS' global focus captures the experience of stress in any domain of an individual's life (Cohen & Williamson, 1988). This is particularly important for research with children, given that children may not recognize the exact source of their stress. In sum, the PSS has a clear advantage over event-specific scales that approach stress measurement from an environmental perspective.

PSS in Research with Children. The present study relies on the PSS, in part, due to its focus on stress and achievement in upper elementary students. Items in event-specific scales are often tailored towards adults, with the inclusion of major life events or stressors that are not relevant to children, such as divorce, being fired from work, or experiencing trouble with a boss (e.g., Life Events Questionnaire, 1990; Holmes-Rahe Stress Inventory, 2017). Adaptations of these event-specific scales exist (e.g., Student Stress Scale), but they are geared towards stressors that older adolescents or college-aged students may experience (e.g., pregnancy, change of academic major). Even if researchers adapted these questionnaires to be more relevant to children, event-specific measures may not accurately capture the experience of stress and coping in children and youth. Indeed, research suggests that youth are more likely to report stress from daily hassles whereas adults are more likely to report stress resulting from major life events (Compas, 1987). A number of other studies have also demonstrated that daily hassles, or everyday minor stressors, can be experienced as stressful for youth (Booth & Anthony, 2015; de Anda et al.,

2000; Kanner et al., 1981; Lohman & Jarvis, 2000). A framework that focuses on the perception of events as stressful is, therefore, more appropriate for research in children than an event-specific perspective. Due to its general nature, the PSS-10 captures individuals' perceptions of the stress of daily hassles, as well as a variety of stressful life events or situations that one might experience. In sum, the PSS uses the stress-appraisal framework and is broader compared to narrow event-specific scales, so it is therefore more suited for use with children.

Factor Structure. Some researchers have considered the factor structure of the PSS-10 to be controversial, due to conflicting interpretations of the two-factor structure that has been demonstrated in the literature. Studies have continuously identified that the PSS-10 has a two-factor structure (e.g., Baik et al., 2019; Barbosa-Keiker et al., 2013; Cohen, 1988; Lu et al., 2017; Taylor, 2015) with the distinction in factors corresponding to the direction of the items (i.e., positively phrased versus negatively phrased items), but researchers hold different beliefs about the distinction. Cohen (1988) originally postulated that the distinction between the factors is irrelevant because it relates only to the direction in the phrasing of the items. According to Cohen (1988), therefore, the PSS-10 assesses a single stress construct. More recently, researchers have argued that the distinct factors reflect two separate elements of the stress experience (i.e., distress and coping), thus measuring two factors (Barbosa-Leiker et al., 2013; Golden-Kreutz et al., 2004; Roberti et al., 2006). These researchers have labeled the negatively phrased items (e.g., "How often have you felt that you were unable to control the important things in your life?") as *Perceived Distress* or *Perceived Helplessness*, and the positively phrased items (e.g.,

"How often have you felt confident about your ability to handle your personal problems?") as *Perceived Coping* or *Perceived Self-efficacy* (Barbosa-Leiker et al., 2013; Golden-Kreutz et al., 2004; Roberti et al., 2006). Thus, coping refers to how an individual sees themself as efficacious at handling stress, which is distinct from the actual experience of distress. The two subscales will henceforth be referred to as perceived distress and perceived coping. Overall, this distinction is important because the stress-appraisal theory (Lazarus & Folkman, 1984) posits that no stress response will occur if one perceives that coping resources are adequately available to them. Based on stress-appraisal theory (Lazarus & Folkman, 1984) and consensus among most psychometric researchers that the two factors of the PSS-10 refer to the distinct elements of distress and coping (e.g., Baik et al., 2019; Barbosa-Keiker et al., 2013; Lu et al., 2017; Taylor, 2015), it is expected that the PSS-10 will have a two-factor structure in the present study. Additionally, a recent thesis from our lab also found that the PSS-10 had a two-factor structure with a distress and coping factor, using the same sample as in this dissertation (Meyering, 2020).

Stress and Achievement

Stress has a negative effect on academic performance (e.g., LePine et al., 2004) and is an understudied contributor to the academic opportunity gap (Levy et al., 2016). The stress and achievement literature is limited in that it focuses mainly on the effect of academic stress on achievement, often in samples of college students (e.g., Lui & Lu, 2010), and does not explore the relation between stress and achievement among elementary aged children, when the achievement gap begins to widen (Burchinal et al., 2011). By focusing primarily on academic stress, the literature does

not capture the overall experience of stress for students across their lives. Rather, there is a need for achievement research to move beyond the focus on academic-related stressors to reflect the overall impact of stress on student achievement. Elementary-aged children spend a considerable amount of their time at school, and as a result, stress from all sources and areas of a child's life may impact their academic performance.

Only three studies (O'Neal, 2018; Schmeelk-Cone & Zimmerman, 2003; Suldo et al., 2008) examine the relationship between perceived, psychological stress and achievement in children and adolescents. Across these studies, stress had a negative impact on overall grades (Schmeelk-Cone & Zimmerman, 2003) and reading achievement (O'Neal, 2018), or when it did not impact achievement negatively, stress coexisted with deficits in mental health and coping strategies (Suldo et al., 2008). Due to the limited research on perceived stress and achievement, studies that measured environmental (Alva & de Los Reyes, 1999; Cunningham et al., 2008; Gillock & Reyes, 1999) and biological stress (Berry et al., 2012) in children and adolescents will also be reviewed, given that stress has been linked to lower achievement across biological, environmental, and psychological perspectives.

Psychological stress. Few studies have examined patterns of perceived, general life stress over time. In one study, researchers used the PSS to measure perceived stress in a large sample of at-risk African American students (i.e., initial GPAs of 3.0 or lower in the 9th grade) throughout their high school experience. Schmeelk-Cone and Zimmerman (2003) found that adolescents with high levels of perceived stress received lower grades and were less likely to graduate from high

school than those with lower stress levels over time. The researchers were predominantly interested in psychosocial outcomes of stress (e.g., anxiety, depression, antisocial behavior), though the study did establish links between perceived stress and lower achievement in youth, over time. The present study aims to extend this work to the elementary-age population, with a distinct focus on achievement as an outcome of perceived stress. More recently, a short-term longitudinal study found that stress, measured using the PSS, had a negative impact on the literacy achievement of largely Latinx, dual-language learner (DLL) elementary students (O'Neal, 2018). Results indicated that stress negatively influenced literacy achievement by impacting the mediator of emotional engagement among third through fifth grade students in the sample (O'Neal, 2018). Stress' impact on later literacy achievement was not mediated by grit. O'Neal (2018) established stress' impact on later literacy, via the mediator of emotional engagement, in one of the three schools used in the present dissertation. However, the study was primarily focused on the social-emotional mediators (e.g., engagement, grit). The present study builds on this work by examining reciprocal relations between stress and literacy, and by incorporating additional schools into the dataset to better generalize results to the elementary-age population, overall.

Despite the benefits of longitudinal research, the impact of stress on achievement has predominantly been examined in cross-sectional studies. In one study that adopted a psychological perspective, the PSS-15 was used to compare the perceived stress of academically advanced high school students in an International Baccalaureate (IB) program to general education students at the same school (Suldo

et al., 2008). Results indicated that students in the IB program had higher levels of stress than students in general education, but IB students also had higher achievement, as measured through their GPA (Suldo et al., 2008). This finding stands in contrast to the majority of stress studies that have demonstrated a negative relation between stress and achievement; however, it is important to note that students in IB programs are typically higher performing, and it is unlikely that the higher stress they experienced caused higher academic performance. Despite superior achievement, higher perceived stress among the students in the IB program co-occurred with compromised mental health and coping strategies (Suldo et al., 2008). In addition, the sample consisted primarily of White students at one school, demonstrating the need for studies that focus on perceived stress in diverse samples of students, and with younger students.

Environmental Stress. A small number of cross-sectional studies have linked life stress to lower achievement by measuring exposure to stressful life events in youth (Alva & de Los Reyes, 1999; Cunningham et al., 2008; Gillock & Reyes, 1999). Alva & de Los Reyes (1999) found that exposure to stressful life events predicted lower achievement, as measured through GPA, in a sample of 9th grade students attending a predominantly Hispanic, public high school. Similarly, stressful life events were negatively correlated with academic achievement in a cross-sectional study of urban, low-income, Latinx students in 10th grade (Gillock & Reyes, 1999). In essence, students who reported frequent experiences of personal stressors tended to have lower academic achievement, as measured through their cumulative GPAs (Gillock & Reyes, 1999). In another study, Cunningham et al. (2002) examined the

role of stressful life events in a sample of African American students attending an urban high school. Results indicated that stress, as measured through a cumulative index of negative life events on the Life Events Questionnaire (LEQ), was negatively correlated with GPA. Although cross-sectional and limited in diversity (by sampling only either Latinx or African American students), these studies indicate that stressful life events have a negative effect on the achievement of students. Other environmental indicators of stress, such as poverty, neighborhood stress, and family transitions are often studied in elementary-aged children (e.g., Morales & Guerra, 2016). However, like event-specific studies, these studies do not consider the degree to which children possess coping resources, which may prevent them from being negatively affected by stressors in their environment (Suldo et al., 2008).

Although environmental indicators of stress, such as poverty, neighborhood stress, and family transitions are often studied in elementary-aged children (e.g., Morales & Guerra, 2006), the only research that takes a psychological approach in studying the effects of perceived life stress on the achievement of elementary students has been done by our lab. The main benefit of this type of approach is that it allows for the consideration of coping, such that children may possess coping resources that help prevent their compromised functioning in times of external stress (Suldo et al., 2008). The present study builds on the existing literature by examining the relation between psychological, perceived stress and literacy achievement in a different sample.

Biological Stress. Stress studies that adopt a biological framework are largely outside of the scope of the present study, since they tend to associate stress with

negative health outcomes in adulthood (e.g., Stein & Miller, 1993). When biological stress has been measured in children, studies have largely focused on stress' relation with later psychopathology (e.g., O'Neal, 2010), or its negative impact on executive functioning (e.g., Wagner et al., 2016), rather than achievement. However, one longitudinal study on biological stress and achievement found that higher salivary cortisol levels were predictive of lower academic achievement for preschoolers with concurrently moderate to high levels of salivary alpha-amylase (Berry et al., 2012). Achievement was measured using W scores from three subtests of the Woodcock-Johnson Test of Achievement-III (WJ-III). Biological stress, therefore, had a negative impact on later achievement in the sample of low-income children (Berry et al., 2012). Although scarce, biological stress studies are consistent with environmental and psychological approaches in their findings that stress has a negative impact on children's functioning, and often, on achievement outcomes.

In sum, research consistently shows that stress has a negative impact on achievement, regardless of whether stress was defined and measured through psychological (i.e., perceived stress), environmental (i.e., stressful event inventories), or biological (i.e., presence of hormones and neurotransmitters such as cortisol) perspectives. As detailed above, studies that focus on the effects of perceived stress (O'Neal, 2018; Schmeelk-Cone & Zimmerman, 2003) and stressful life experiences (Alva & de Los Reyes, 1999) are largely consistent in their findings that stress has a negative impact on children's achievement. Similarly, one study on biological stress and achievement found biological stress had a negative impact on the later achievement of the young children in the sample, who were largely from low-income

backgrounds (Berry et al., 2012). Other studies of biological stress largely focus on stress' negative impact on executive functioning (e.g., Wagner et al., 2016) or its relationship with later psychopathology in children (e.g., O'Neal et al., 2010), rather than achievement. These biological stress studies focused primarily on early childhood or preschool-aged children, but were consistent with environmental and psychological approaches in their findings that stress (often measured through cortisol responses) has a negative impact on children's functioning.

Literacy Achievement. Across perspectives, research has consistently shown that children and adolescents who experience higher stress levels are at-risk for academic underachievement. Yet, the majority of these studies examine achievement using broad outcomes, such as general achievement test scores (e.g., WJ-III) or cumulative GPA (e.g., Alva & de Los Reyes, 1999; Berry et al., 2012; Cunningham et al., 2008; Gillock & Reyes, 1999; Schmeelk-Cone & Zimmerman, 2003; Suldo et al., 2008). When examining stress-achievement relations in elementary populations, it is worth narrowing in on literacy achievement, given that reading strongly influences later opportunities for students in school and in their occupations (Hernandez, 2011). Literacy ability is particularly important during upper elementary-school years, while GPA is often not as important. In fact, researchers have established the importance of mastering reading by the end of third grade (e.g., Hernandez, 2011; Toste & Ciullo, 2017), when the shift from *learning to read* to *reading to learn* occurs. Students who have not mastered reading by this pivotal point face barriers to success in later grades, as reading becomes fundamental to the process of learning in all subject areas. Students who fail to reach this milestone are also at-risk for other negative outcomes

throughout the lifespan, such as high school drop-out and unemployment (Hernandez, 2011). In one longitudinal study, children who were not reading proficiently in third grade, as indicated by the reading recognition subtest of the Peabody Individual Achievement Test (PIAT), were four times more likely to drop out of high school (Hernandez, 2011). Despite the importance of literacy achievement for upper elementary students, only one perceived stress study (O'Neal, 2018) focuses on the relation between stress and literacy achievement in children. By building on this study, and utilizing the TOSREC, the present study will contribute the gap in the literature on stress and literacy achievement.

In sum, the present study focuses on literacy achievement because reading is a crucial skill that underlies achievement in other content areas. Reading also predicts future achievement and is widely a precursor to success in Western society (Hernandez, 2011). It is therefore necessary to identify key social-emotional factors, like perceived stress, that may impede students' reading abilities at the critical time when students are expected to read difficult material to obtain grade-level content knowledge (Toste & Ciullo, 2017). In examining stress as a social-emotional factor, largely due to its coping component, research can move towards reducing the academic opportunity gap, which is impacted by a gap in literacy achievement that disproportionately affects certain minority groups, including African American students and DLL students (Murphy, 2014), and has lifelong, negative implications (Hernandez, 2011).

Direction of Relations between Stress and Achievement

Stress studies are often designed to understand the direct effects of stress on achievement, rather the reverse effects of achievement on stress. Perhaps, for upper elementary students experiencing difficulty with reading, their lower literacy achievement leads to stress. The transition from *learning to read* to *reading to learn* occurs in upper elementary school, during the third to fourth grades (Hernandez, 2011; Toste & Ciullo, 2017). It is intuitive to assume that students struggling with reading at this crucial period, when they are no longer being taught to read but are expected to read to learn, may appraise situations in their lives as more stressful, especially since school is such a big part of children's lives. The possibility that unidirectional relations between stress and achievement could also occur in the reverse is, therefore, worth exploring to determine whether achievement impacts perceived stress. It is also important to focus on the effect of literacy achievement on general stress, rather than academic stress, because reading is a crucial skill that is necessary for success across many different environments (Hernandez, 2011). Moreover, reading does not only occur in school, so it is likely that literacy problems could result in generalized stress, both at school and in other environments.

Stress as a Social-Emotional Factor. Although much of the research suggests that stress impacts achievement, it is also possible that achievement impacts the social-emotional factor of stress. I refer to stress as a social-emotional factor because stress on the PSS is operationalized as not only the experience of distress, but also the degree to which one believes that they are efficacious at handling stress. The measure is based on stress-appraisal theory, which posits that stress only affects an individual's well-being or functioning negatively when they (a) perceive a situation

as a threat, loss, or challenge and (b) perceive that their coping resources are not adequate to handle the situation (Lazarus & Folkman, 1984). The coping subscale of the PSS, in particular, includes positive perceptions of stress and is also referred to in the literature as perceived self-efficacy (e.g., Barbosa-Leiker et al., 2013; Golden-Kreutz et al., 2004; Roberti et al., 2006). In breaking down stress on the PSS into its distress and coping subscales, stress can be thought of as a social-emotional skill, particularly when considering stress management or coping with stress. Indeed, one's perceived efficacy at handling stress fits with CASEL's (2020) inclusion of self-management (i.e., the abilities to manage oneself effectively to achieve goals, including stress management) in their social-emotional learning framework. In the proposed study, perceived stress will be broken down into the distress and coping subscales in all analyses.

Reciprocal Effects. A reciprocal model between stress and achievement might be more suitable than focusing solely on direct or reverse effects, described above. Social-emotional skills (e.g., coping) and achievement are constructs that mutually develop over time (Marsh et al., 2017), and reciprocal models may be better able to capture the effects of "co-developmental" processes (Curran & Hancock, *in press*). No studies, to my knowledge, have examined cross-lagged models with stress and achievement.

Most stress research is unidirectional (e.g., stress impacts achievement), but recent research has begun to examine cross-lagged models with achievement and other social-emotional variables. For example, cross-lagged relations have been found between effortful engagement and reading achievement (Hughes et al., 2008). Cross-

lagged relations between grit and literacy achievement have also been found in a short-term longitudinal study from my lab (O'Neal et al., 2018) as well as in a recent dissertation (Boyars, 2019). This dissertation will build on the work that our lab has done on grit-literacy relations by extending reciprocal modeling to stress and literacy achievement. Other recent research has begun to examine reciprocal relations between literacy achievement and social-emotional variables that are similar to stress (i.e., life satisfaction).

The construct of life satisfaction, which is similar to the global (i.e., general or widely applicable) coping component of stress, has been studied via cross-lagged modeling. One short-term longitudinal study examined the reciprocal relation between subjective life satisfaction and achievement (cumulative GPA in English, Math, and Science) in a sample of diverse middle school students (Ng et al., 2015). Students indicated the extent to which they agree with statements about life such as "My life is going well" and "My life is better than most kids," which may be similar to endorsing low levels of perceived stress, due to the global nature of both scales and the consideration of general coping on the PSS. Ng et al. (2015) found cross-lagged effects between life satisfaction and achievement. Achievement had a positive relation with later life satisfaction, and life satisfaction had a positive relation with subsequent achievement, even after controlling for demographic variables and baseline levels of GPA (Ng et al., 2015). Further, the relations between students' life satisfaction and achievement were not moderated by negative or positive affective experiences in school. Similarly, Quinn and Duckworth (2007) found that subjective well-being positively predicted later academic performance, and that earning better

grades also predicted later subjective well-being, in a sample of fifth grade students. There may be similar, but negative, reciprocal effects between stress and achievement.

Between-person versus within-person effects. Researchers in education and psychology tend to model the between-person effects of constructs (Pekrun, 2021), even though the psychological theories underlying such constructs often describe within-person processes (Curran & Bauer, 2011). These within-person processes are state-based and are thought to fluctuate within an individual, over time. For example, when an individual engages in coping successfully, it is thought to eliminate the effects of stress (e.g., Roth & Cohen, 1986). Psychological theories also explain other within-person processes, including ways that an individual might regulate their positive and negative affect, as another example. When an individual engages in exercise, for instance, it is expected that their positive affect will subsequently increase (e.g., Pendedo & Dahn, 2005). When an individual experiences negative affect, however, they may be more likely to engage in substance use to regulate their emotions (e.g., Kassel et al., 2010). These psychological theories, and the majority of others, explain processes that happen within an individual, rather than across a group of individuals (Curran & Bauer, 2011). There is growing consensus among researchers that statistical models must explicitly examine within-person effects to draw more accurate conclusions among constructs that are based on within-person, psychological theories (e.g., Curran & Hancock, *in press*; *Pekrun*, 2021). This can be accomplished by using repeated measures to examine changes within a given individual, also known as focusing on "intraindividual processes" (Curran & Bauer,

2011). A latent curve model with structured residuals (LCM-SR) can be used to examine stress-literacy relations without confounding between- and within-person effects (Curran & Hancock, *in press*). In fact, the LCM-SR procedure provides estimates of both between- and within-person effects of change over time in "co-developmental processes" (Curran & Hancock, *in press*). Overall, this dissertation makes a novel contribution to the literature by using an LCM-SR to examine reciprocal relations between stress and literacy achievement.

Challenges to Statistical Modeling. Despite this consensus among researchers, it is difficult to separate between- and within-person effects when modeling psychological constructs that are mutually developing over time (Curran & Hancock, *in press*), as in this dissertation with perceived stress and literacy achievement. Many traditional models, including the autoregressive cross-lagged models described in the literature above, tend to conflate within- and between-person effects (Curran & Hancock, *in press*). As described above, a within-person effect is a measure of how much an individual in the sample varies over time, relative to themselves (Curran & Hancock, *in press*). Between-person effects, on the other hand, focus on the stable "trait-like differences" between separate individuals in the sample. It is possible to examine stress at the between-person level, and stress may have a trait-based component for some individuals. Based on stress-appraisal theory, however, the present study seeks to measure within-person effects when model testing on the direct, reverse, and cross-lagged (i.e., reciprocal) relations between stress and literacy achievement over time. The rationale for the within-subject

conceptualization to perceived stress is detailed below and is based on the recommendations made by Curran and Hancock (*in press*).

Within-person effects. This dissertation focuses on state-like differences in stress-literacy relations, thus examining within-person effects, or the variability in distress and coping for an individual in the sample relative to themselves, over time. This is due, in part, to the item phrasing of the PSS-10. The modified version of the PSS-10, which was adapted for use with children, is phrased to capture distress and coping within the last week. Specifically, the modified PSS-10 asks respondents to think about how they felt, and what they thought, during the last week. An individual's stress item responses could differ depending on when the PSS-10 is administered. Thus, at each timepoint, the PSS-10 captures participants' stress and coping relative to themselves.

Stress-appraisal theory (Lazarus & Folkman, 1984) also proposes stress-literacy achievement relations at the level of within-person processes. Lazarus and Folkman (1984) posit that regardless of the specific stressor, an individual will only reach a state of stress if they (a) appraise an event as a threat, and (b) perceive that coping resources are not adequately available to them. Stress is further conceptualized as a transaction, or relation, between an individual and their constantly changing, complex environment (i.e., state-based approach; Lazarus and Folkman, 1984). This state-based transaction, as well as the cognitive stress appraisal process following exposure to an event, suggests that stress occurs at the within-person level, rather than at the between-person level. Stress measurement should capture fluctuations in stress that one experiences relative to themselves (i.e., within-person effects), since an

individual may differ in their appraisal of a situation as a threat and their coping resources, based on their changing environment.

Within-person effects may also be more appropriate in capturing children's perception and appraisal of stress. Children's social-emotional functioning at young ages can often be a temporary state that may depend on short term frustrations with peers, or the school environment (e.g., Dodge, 1991). As a result, children may be more likely to respond to stress measures at the within-person level, and trait-based differences in constructs (i.e., between-person effects) may be more likely to be firmly established with age. The focus on within-person effects has also been recommended to better understand temporal relations between processes that are jointly unfolding and growing across development (e.g., Curran & Bauer, 2011; Curren et al., 2014; Curran & Hancock, *in press*; Long et al., 2019; Pekrun, 2021), like social-emotional competencies (e.g., coping) and literacy abilities often are for elementary children. This developmental perspective, as well as stress theory and the nature of the PSS-10 item wording, provide rationale for the within-person measurement of stress-literacy relations over time.

Research Questions and Hypotheses

1. Does a correlated two-factor perceived stress model fit the data, with stress-coping and stress-distress as the two factors?
    a. *Hypothesis:* Confirmatory factor analysis will confirm that the data fits a correlated two-factor model, with coping and distress as the two factors at Time 1, Time 2, and Time 3.
2. Does perceived stress predict students' later literacy achievement?

   a. *Hypothesis:* Time 1 latent distress will have a negative relation with Time 2 and Time 3 observed literacy achievement among students. Time 1 latent coping will have a positive relation with Time 2 and Time 3 observed literacy achievement among students.

3. Does literacy achievement predict students' later perceived stress?
   a. *Hypothesis:* Time 1 observed literacy achievement will have a positive relation with Time 2 and Time 3 latent coping, and a negative relation with Time 2 and Time 3 latent distress among students.

4. Are there cross-lagged (i.e., reciprocal) effects between stress and literacy achievement over time?
   a. *Hypothesis:* There will be cross-lagged (i.e., reciprocal) effects over time between latent stress and literacy achievement.
   b. *Exploratory:* Is there a differential role of between- and within-person effects in the cross-lagged model between latent stress and literacy achievement, reflecting state- versus trait-based differences in the relations between constructs over time?

Appendix C: Comprehensive Methods

The present study utilizes existing data from two cohorts of a short-term longitudinal dataset. The two cohorts were collected from January to June 2014, and March to June 2015, respectively. The data was initially collected as part of a larger study, which included other social-emotional variables (e.g., grit, peer and teacher support, anger regulation) that were not used in the present study. At each time point, students completed a self-report measure for stress in addition to a literacy achievement performance task. The longitudinal analyses examined stress and literacy data from Time 1, Time 2, and Time 3 while controlling for demographic variables including sex, ethnic minority status (White vs. non-White), DLL status, school placement, gifted center participation, and interview format (individual vs. group interview administration). Further details about the study design are provided below.

Participants

Three hundred and ninety-six students participated in the study (M_{age} = 9.62, 56% female; 57% dual language learners; 12% Black, 6% Asian, 30% Latinx, 7% Multiracial; 43% White; see Table 2). Students were identified as DLL if they or their parents reported that a parent spoke a language other than English at home (Child Trends, 2014). In cases where the child- and parent-reported ethnicity and/or DLL status differed, researchers used the parent report as the correct indicator of ethnicity and/or DLL status. Thirty percent of the sample was in third grade, 29% were in fourth grade, and 35% were in fifth grade. Fifty-five percent of the students from School 1 and 36% of the students from Schools 2 and 3 agreed to participate in the

study. The recruitment rate per class in School 1 ranged from 33% to 70% per class, with most classes near 55% to 60% recruitment per class. In Schools 2 and 3, the recruitment rate ranged from 12% to 67% per class. It is possible that some teachers may have provided more reminders to students to return consent forms, depending on their level of interest in the study. Analysis therefore controlled for potential class cluster effects on model testing. In all three schools, participating students' demographics were proportional to that of the schools' total student body.

The school district did not permit researchers to ask students or parents about their socioeconomic or immigrant generational status. However, school-level estimates of free and reduced meal status provide a suggestion of socioeconomic status of the population of each school, and the estimates indicated differences between the schools. One of the schools was a Title 1 elementary school in which 95% of the students received free or reduced meals. The school served primarily low-income, dual-language families. Additionally, all the participants from this school identified as ethnic minority students. The other two schools were comparable on demographics, with about 14% of students receiving free or reduced meals in each school. These schools were located in a more affluent area, with less than 5% of White students, 6% of Latinx students, and 7% of Black students eligible for free and reduced meals. This suggests that only a small number of the White and ethnic minority groups from the second and third schools came from low-income families.

Demographic variables, such as DLL and ethnic minority status, may affect students perceived stress levels and achievement. Ethnic minority children are disproportionally exposed to stressful life conditions (e.g., family poverty, diminished

community resources, racial discrimination) and are regarded as at higher risk for mental health problems compared to their White peers (e.g., Gonzalez & Kim, 1997). Similarly, DLL students face a significant amount of stress and may be at elevated academic risk throughout elementary school (National Academy of Sciences, Engineering, and Medicine, 2017). The rationale for controlling for DLL status and ethnic minority status was that these demographic variables may affect stress-literacy relations, and over half the sample is comprised by each group, with 56% of participants identifying as ethnic minority students and 57% of students categorized as DLLs. In addition, about 13% of the students in the sample were enrolled at a gifted center, where they took advanced coursework. The gifted center was located at the second school. Note that students who were not enrolled at the gifted center were also included in the sample from that school. Since participation in more advanced courses might also affect perceived stress and literacy achievement, the present study controlled for gifted center participation in all analyses.

Procedure

This short-term longitudinal study used data from Time 1, Time 2, and Time 3 of a larger study over three months. Data from the first school was collected from January to June 2014, while data from the second and third schools were collected from March to June 2015. The research was approved by the University of Maryland IRB and the participating schools' district Office of Shared Accountability. Researchers recruited participants by visiting with teachers during team meetings to discuss participation in the study, along with visiting students' classrooms to explain the study. Parent consent and student assent were obtained. Demographic data were

collected on consent forms, including participants' age, race/ethnicity, sex, and language spoken at home.

There was approximately one month between students' interviews at each timepoint, on average. At Time 1, which occurred during a single designated school day, students completed a self-report measure of perceived stress as well as a three-minute English reading performance task. First, students completed a self-report measure of perceived stress. Researchers read the perceived stress measure aloud and one-on-one to each participant, and answer options were presented on a printed scale so that the participant could read along. Students had the opportunity to point out their answer on the printed sheet, if desired. At the first school, students with limited or no English language skills ($N = 6$) were interviewed by Spanish- and French-speaking researchers. Due to time constraints, 14% of students' Time 1 data from all three schools were collected in a small group setting. As a result, analyses will control for interview format to ensure that one-on-one versus group data collection does not influence stress-literacy relations. The same procedures were conducted with participants at Time 2 and Time 3. Similarly, 1.5% of students' Time 2 data and 3% percent of students' Time 3 data were collected in a small group setting due to time constraints.

Measures

Perceived stress. Perceived stress was assessed using a modified version of the 10-item Perceived Stress Scale (PSS-10; Cohen & Williamson, 1988). Students rated how often their lives felt uncontrollable, emotionally upsetting, or overwhelming within the last week (1= Never, 5 = Very Often). Questions focused on

general, perceived life stress (e.g., “How often did you feel like you could not do anything to change the way things were going?”). Positively stated items (items 4, 5, 7 and 8) were reverse coded. For these reverse coded items (i.e., the coping subscale), the results of analyses will be inversely interpreted (e.g., a negative relationship should be interpreted positively).

Minor adaptations in item phrasing were made to the scale to make it more accessible to the sample of elementary students, given that the original PSS-10 was designed for individuals with a junior high school education or above (Table 1). During this process, the PSS-10 was also piloted in School 1 to improve item phrasing to make it more accessible for DLL students. In addition, the modified version of the PSS-10 asked students to reflect on stressful experiences over the past week rather than the past month. This change was made because the researchers expected it would be easier for younger students to accurately reflect on their stressful experiences in a shorter time frame.

Researchers have conducted factor analysis on the PSS-10 among different populations and the scale has consistently demonstrated a two-factor structure (Lee, 2012). In addition, a recent thesis supported a two-factor structure of the PSS-10 in a sample of upper elementary children across the three schools (Meyering, 2016). Another recent study conducted a CFA of the stress variable using data from School 1, as a preliminary step before mediation model testing, and found support for a one-factor structure of the PSS-10 when one item was removed (O’Neal, 2018). However, O’Neal (2018) did not compare the results of the one-factor model to a two-factor model, and it is, therefore, possible that a two-factor structure could have had a better

model fit. The PSS-10 has repeatedly demonstrated adequate internal consistency reliability with a Cronbach's alpha of .74 - .91 (Lee, 2012). Test-retest reliability of the PSS-10 has been conducted in multiple studies and has been found to be adequate (r = .74 - .77; Lee, 2012). These studies considered an alpha value of .70 as the minimum measure of adequate internal consistency (Lee, 2012; Nunnally & Bernstein, 1994). At the same time, the PSS was used as a latent factor in model testing in the present study, which makes lower alpha coefficients less of a concern (Hancock, 2018).

Literacy achievement. Literacy achievement was assessed through the Test of Silent Reading Efficiency and Comprehension (TOSREC; Wagner et al., 2010). The TOSREC is a standardized reading performance task designed to test students' silent reading decoding (accuracy), fluency (speed), and comprehension. Each participant took the TOSREC at Time 1, Time 2, and Time 3.

The TOSREC consists of logical and illogical sentences that get longer and more difficult to read as the student proceeds through the test. Students had three minutes to read as many sentences as they could to themselves and mark whether each sentence was true or false (e.g., "An apple is blue."). On each response booklet, there were sample items (to explain the task to students), practice items, and 60 test items. Raw scores were calculated by summing the correct items, and then subtracting the number of incorrect items from the total. Then, raw scores were converted to standard index scores (M = 100, SD = 15). Standardized index scores were used for data analysis, which is consistent with other studies that have used the TOSREC (e.g., Durwin et al., 2018; Kim et al., 2011; Johnson et al., 2011;).

TOSREC response booklets were normed by grade (e.g., Grade 3) and form, which corresponded to the point in the school year (e.g., Form B was administered during the second third of the school year, December through February). In other words, the TOSREC forms provide more specific norming beyond the grade-level of the student, such that a raw score on the TOSREC in the first third of the school year would be a different number than in the second, and last, third of the school year. The present study did not control for participants' age, as a result of the fine-grained norming by grade and form on the TOSREC. This is consistent with other studies that have used different forms on the TOSREC, depending on the point in the school year, and subsequently did not control for participant age (e.g., Kim et al., 2011; Durwin et al., 2018). The decision to use separate forms was also based upon the test's administration guidelines.

Although there was a short time span of about a month and a half in between each timepoint in the present study, it was expected that there would still be change in standardized scores on the TOSREC across time, due to the nature of the sample; over half of the sample was comprised of DLL students (56% DLL). It is likely that the literacy achievement of DLL students, who are relatively new to the English language, would vary over a short period of time (National Academies of Sciences, Engineering, and Medicine, 2017). Standardized assessments of DLLs provide evidence of their learning, and experts recommend the use of assessments at multiple time points at the elementary level to identify children's reading development, progress monitor, and improve the effectiveness of strategies to support their learning (National Academies of Sciences, Engineering, and Medicine, 2017). For these

reasons, in the current study, the literacy achievement of students may show growth over time, even though there is only about a month and a half in between each time point.

The TOSREC has strong reliability and convergent validity with other measures of literacy achievement, such as the Woodcock-Johnson Tests of Academic Achievement, 3rd ed. (WJ-III; Wagner et al., 2010). The TOSREC also has strong correlations with the Dynamic Indicators of Basic Early Literacy Skills (DIEBLS) Oral Reading Fluency (ORF; r = 0.81; Kim et al., 2010). Previous studies have found that reliability coefficients exceed .85 across third through fifth grades (Wagner et al., 2010).

Analytic Approach

First, the data was reviewed in IBM SPSS Statistics version 27 (SPSS Inc., 2021). Cases that had missing data at all timepoints were removed from analysis (*n* =13). These cases reflect students whose parents returned consent forms to researchers, but the students did not end up participating in the study. After these cases were removed, it appeared that the remaining missing data was largely from the first school and specifically, from participants who were interviewed in a group format for their responses to the PSS-10. Note that at this school, there were time constraints that led the researchers to interview about 39% of the participants in a group format, rather than individually (*n* = 50). The participants who were interviewed in a group format reflect 12.4% of the sample, overall. Given that the missing data appears to be related to the school placement and interview format, the data is in theory, missing at random (MAR). Previous studies using this data have

controlled for school placement and group format to manage this missing data mechanism (e.g., Boyars, 2019; Meyering, 2016). Other missing data appeared to be missing completely at random (MCAR) in that it did not seem to have any patterns and can be explained by attrition or students who were absent from school on one of the data collection days (n = 24). In Mplus, a restricted maximum likelihood robust standard error estimation approach (i.e., MLR) was used to manage missing and potential non-normal data (Muthen & Muthen, 2020).

Prior to model testing in Mplus, preliminary descriptive statistics and psychometric analysis (i.e., alpha coefficients, means, ranges, standard deviations) of perceived stress and its subscales were assessed using SPSS to determine if the data was agreeable with previous research. Alpha coefficients of .65 or higher were considered to meet an acceptable internal reliability level (DeVellis, 2003).

Subsequent analysis was conducted using Mplus version 8.6 (Muthén & Muthén, 2021). Analyses controlled for ethnic minority status (White vs. non-White), DLL status, sex, school placement, gifted center participation, and interview format (individual vs. group interview administration). Analyses used a design-based approach (Hancock, 2018) to adjust for cluster sampling between classrooms. In all models, fit indices were examined to evaluate model fit, including Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), and Standardized Root Mean Squared Residual (SRMR). Model fit was assessed with cutoffs used in previous studies that have considered RMSEA values of less than 0.06, SRMR values of less than 0.08, and CFI values of greater than 0.95 as evidence of good model-data fit (e.g., Hu & Bentler, 1999; Sass, 2011).

Hypothesis 1. A confirmatory factor analysis (CFA) was conducted to determine if the PSS-10 data fit the expected factor structure. Model fit of the Time 1, Time 2, and Time 3 factor structures was compared using AIC Indices, with lower AIC indices indicating better model fit (Wagenmakers & Farrell, 2004). As a two-correlated factor model was supported, two latent perceived stress subscale factors (distress and coping) were used in all subsequent analyses. A CFA was also completed at Time 2 and Time 3 to cross-validate the results. Lastly, a temporal measurement invariance process was conducted to assess the stability of the factor structure over time, which was important because change in time can only be tested if the latent variables in the model are conceptualized in the same way across time (Putnik & Bornstein, 2016). Specifically, a baseline "configural" model was compared to a "metric" model in which the factor loadings were constrained to be equivalent across time (Putnik & Bornstein, 2016). Scalar invariance was then tested by constraining item intercepts to be equivalent across time and comparing the "scalar" model to the "metric" model (Putnik & Bornstein, 2016).

Hypothesis 2 and 3. Path analyses were conducted to examine hypothesis two (i.e., the relation between perceived stress and later literacy achievement) and hypothesis three (i.e., the relation between literacy achievement and later perceived stress). First, latent variable path analyses (LVPA) were run with Time 1 latent scores of the PSS-10 subscales (distress and coping) predicting observed Time 2 and Time 3 TOSREC scores, while controlling for previous literacy, using Time 1 and Time 2 TOSREC scores. To determine reverse-effects, another LVPA was run with Time 1 TOSREC scores predicting Time 2 and Time 3 latent scores of the PSS-10 subscales

(distress and coping), while controlling for previous latent stress factors at Time 1 and Time 2. Note that these path analyses are not necessary as a precursor to examining cross-lagged effects between stress and literacy achievement (hypothesis four); however, I conducted these preliminary analyses, as I am also interested in the direct and reverse effects of distress and coping on literacy achievement among students.

Hypothesis 4. An LCM-SR model was run with the direct, reverse, and cross-lagged relations between latent perceived coping, latent perceived distress, and observed literacy achievement residuals. One challenge of the LCM-SR is that repeated measures may be needed to improve estimation, given the increased complexity of the model (Curran and Hancock, *in press*). I used three timepoints to help combat this challenge associated with the LCM-SR. The model integrated relations among the repeated perceived stress and literacy achievement measures at three time points, simultaneously (see Figure 1). The LCM-SR builds on the commonly used autoregressive cross-lagged (ARCL) panel model, but the key difference is its use of a residual structure and isolation of between-person and within-person effects. The residuals (i.e., error terms) represent "time-specific deviations" from the growth trajectories of individuals (Bainter & Howard, 2016). Within-person variability is captured by the structured residuals that are associated with the repeated measures, while between-person variability is captured by the latent curve factors (Curran et al., 2014). It is possible to include autoregressive and cross-lagged regressions in the within-person portion of the model, without affecting the underlying latent growth curve, or the between-person variability (Hawes et al., 2015). The autoregressive and cross-lagged paths, therefore, represent within-person

change, or state-like "fluctuations within individuals from their own predicted average-level scores across time" (Long et al., 2019). The random intercepts correspond to "trait-like," between-person differences in initial levels of stress and literacy achievement, while the random slopes represent between-person "trajectories of change" in each variable (Long et al., 2019). Finally, the correlation between the random slopes indicates the degree to which between-person differences in stress are linked with between-person differences in literacy achievement. (Long et al., 2019) In sum, the autoregressive cross-lagged regressions were estimated between the residuals (i.e., individuals' deviations from their mean at specific points in time) of the variables in the LCM-SR, which allowed for the separation of between-person and within-person variability in stress-literacy achievement relations over time (Curran & Hancock, *in press*).

The LCM-SR model-building strategy followed the recommendations of Curran et al. (2014) and was conducted in a series of steps. First, growth models including intercepts and slopes were run with distress, coping, and TOSREC, separately. Distress and coping were run as second order growth models, since stress was a latent variable. In contrast, TOSREC was run as a first order growth model, since literacy achievement was an observed variable. Once the univariate models were established, the separate models were combined into a single growth model that included distress, coping, and TOSREC. Then, a separate intercept-only model (slope factor loadings set to 0) was run to determine whether there was between-person variability in the overall levels of distress, coping, and literacy achievement (Curran et al., 2014). We then ran a growth model that included latent factors for the residuals

of distress, coping, and TOSREC. Lastly, we added autoregressive and cross-lagged regressions to the residual structure that was defined in the previous step. In the final model, we allowed the residuals to covary at T1, but not at T2 or T3, to fix an initial convergence problem. The autoregressive and cross-lagged effects in the final model correspond to within-person change in stress-literacy achievement relations over time; however, the LCM-SR also parses apart between-person effects. As a result, the slopes of distress, coping, and TOSREC, as well as their means and variances, were assessed in the LCM-SR model results to determine whether the relations between stress and literacy achievement were also operating at the between-person level.

References

Abe, J. A. A., & Izard, C. E. (1999). The developmental functions of emotions: An analysis in terms of differential emotions theory. *Cognition and Emotion*, *13*(5), 523–549.

Alva, S. A., & de Los Reyes, R. (1999). Psychosocial stress, internalized symptoms, and the academic achievement of Hispanic adolescents. *Journal of Adolescent Research, 14*, 343–358.

Baik, S. H., Fox, R. S., Mills, S. D., Roesch, S. C., Sadler, G. R., Klonoff, E. A., et al. (2019). Reliability and validity of the perceived stress scale-10 in Hispanic Americans with English or Spanish language preference. J. Health Psychol. 24, 628–639. Doi: 10.1177/1359105316684938

Bainter, S.A., & Howard, A.L. (2016). Comparing within-person effects from multivariate longitudinal models. *Developmental Psychology, 52*(12), 1955-1968. Doi:10.1037/dev0000215

Barbosa-Leiker, C., Kostick, M., Lei, M., McPherson, S., Roper, V., Hoekstra, T., & Wright, B. (2013). Measurement invariance of the perceived stress scale and latent mean differences across gender and time. *Stress and Health*, *29*(3), 253–260.

Berry, D., Blair, C., Willoughby, M., & Granger, D.A. (2012). Salivary alpha-amylase and cortisol in infancy and toddlerhood: Direct and indirect relations with executive functioning and academic ability in childhood. *Psychoneuroendocrinology,* 37(10), 1700-1711. https://doi.org/10.1016/j.psycneuen.2012.03.002

Bollen, K.A., (2002). Latent variables in psychology and the social sciences. *Annual Review of Psychology, 53*, 605-634.

Booth, J. M, & Anthony, E. K. (2015). Examining the interaction of daily hassles across ecological domains on substance use and delinquency among low-income adolescents of color. *Journal of Human Behavior in the Social Environment, 25*(8), 810-821.

Boyars, M. (2019). The chick or the egg? Muti-group, short-term longitudinal relations between grit and literacy achievement. [Unpublished dissertation]. University of Maryland, College Park, MD.

Burchinal, M., McCartney, K., Steinberg, L., Crosnoe, R., Friedman, S. L, McLoyd, V., & Pianta, R. (2011). Examining the Black-White Achievement Gap Among Low-Income Children Using the NICHD Study of Early Child Care and Youth Development. *Child Development, 82*(5), 1404-1420.

Cohen, S., Kessler, R., & Underwood G, L. (1997). Strategies for measuring stress in studies of psychiatric and physical disorders. In *Measuring Stress: A Guide for Health and Social Scientists* (1st ed., pp. 3–26). New York: Oxford University Press.

Cohen, S., & Williamson, G. (1988). Perceived stress in a probability sample of the United States. In Shirlynn Spacapan & Stuart Oskamp (Eds.), *The Social Psychology of Health: The Claremont Symposium on Applied Social Psychology* (pp. 31–67). Thousand Oaks, CA, US: Sage Publications, Inc.

Collaborative for Academic, Social, and Emotional Learning (CASEL). (2020). SEL: What are the core competence areas and where are they promoted? https://casel.org/sel-framework/

Compas, B. E. (1987). Stress and life events during childhood and adolescence. *Clinical Psychological Review*, *7*, 275–302.

Curran, P. J., & Bauer, D. J. (2011). The disaggregation of within-person and between-person effects in longitudinal models of change. *Annual Review of Psychology*, *62*, 583–619. https://doi.org/10.1146/annurev.psych.093008.100356

Curran, P. J., Howard, A. L., Bainter, S. A., Lane, S. T., & McGinley, J. S. (2014). The separation of between-person and within-person components of individual change over time: a latent curve model with structured residuals. Journal of Consulting and Clinical Psychology, 82, 879–894.

Curran, P.J., & Hancock, G., (in press). Modeling co-developmental processes. *Developmental Psychology.*

Cunningham, M., Hurley, M., Foney, D., Hayes, D. (2002). Influence of Perceived Contextual Stress on Self-Esteem and Academic Outcomes in African American Adolescents. *Journal of Black Psychology*, *28*(3), 215-233. doi:10.1177/0095798402028003003

de Anda, D., Baroni, S., Boskin, L., Buchwald, L., Morgan, J., Ow, J., Siegal Gold, J., Weiss, R. (2000). Stress, stressors and coping among high school students. *Children and Youth Services Review, 22*(6), 441-463.

DeVellis, R. F. (2003). Factor analysis: Scale development, theory and applications. In *Applied Social Research Methods* (Vol. 26, pp. 10–137). Dörnyei, Z., & Taguchi, T. (2009). *Questionnaires in second language research: Construction, administration, and processing*. Routledge.

Durwin, C.C., Moore, D., & Caroll, D.A. (2018). Evaluating the TOSREC as a brief RTI screen for early struggling readings in urban schools. *NERA Conference Proceedings*, 1-7.

Evans, G.W., Bullinger, M., & Hygge, S. (1998). Chronic noise exposure and physiological response: A prospective study of children living under environmental stress. *Psychological Science, 9,* 75-77.

Gillock, K. L., & Reyes, O. (1999). Stress, Support, and Academic Performance of Urban, Low-Income, Mexican American Adolescents. *Journal of Youth and Adolescence, 28*, 259–282. https://doi.org/10.1023/A:1021657516275

Golden-Kreutz, D. M., Browne, M. W., Frierson, G. M., & Andersen, B. L. (2004). Assessing stress in cancer patients: a second-order factor analysis model for the perceived stress scale. Assessment 11, 216–223. Doi: 10.1177/107319110426 7398

Gonzalez, N.A., & Kim L.S. (1997). Stress and coping in an ethnic minority context. In: Wolchik S.A., Sandler I.N. (eds) Handbook of Children's Coping. Issues in Clinical Child Psychology. Springer, Boston, MA. https://doi.org/10.1997/978-1-4757-2677-0_17

Hawes, S.W., Crane, C.A., Henderson, C.E., Mulvey, E.P., Schubert, C.A., & Pardini, D.A. (2015). Codevelopment of psychopathic features and alcohol use during emerging adulthood: Disaggregating between- and within-person change. *Journal of Abnormal Psychology,* 124(3), 729-730.

Hernandez, D. J. (2011). *Double jeopardy: How third-grade reading skills and poverty influence high school graduation*. The Annie E. Casey Foundation: Washington, DC.

Hu, L.-t., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Hughes, J. N., Luo, W., Kwok, O.M., & Loyd, L. K. (2008). Teacher-student support, effortful engagement, and achievement: A 3-year longitudinal study. *Journal of Educational Psychology*, *100*(1), 1.

Jaser, S.S., Langrock, A.M., Keller, G., Merchant, M.J., Benson, M.A., Reeslund, K., et al. (2005). Coping with the stress of parental depression II: Adolescent and parent reports of coping and adjustment. *Journal of Clinical Child and Adolescent Psychology, 34,* 193-205.

Johnson, E.S., Pool, J.L., & Carter, D.R. (2011). Validity evidence for the Test of Silent Reading Efficiency and Comprehension (TOSREC). *Assessment for Effective Intervention*, 1-8. Doi: 10.117/1534508410395556

Kassel, D.J., Hussong, A.M., Wardle, M.C, Veilleux, J.C., Heinz, A. et al. (2010). Affective influences in drug use etiology. In: *Handbook of Drug Use Etiology: Theory, Methods and Empirical Findings.* Washington, D.C.

Kanner, A. D., Feldman, S. S., Weinberger, D. A., & Ford, M. E. (1987). Uplifts, hassles and adaptational outcomes in early adolescence. *J. Early Adolesc. 7*, 371-384.

Kim, Y., Wagner, R. K., Foster, E. (2011). Relations among oral reading fluency, silent reading fluency, and reading comprehension: A latent variable study of first-grade readers. *Scientific Studies of Reading, 15*(4), 338-362.

Landry, S. (2008). Effective early childhood programs: Turning knowledge into action. In: Tarlov, A.R., Debbink, M.P. (eds) *Investing in Early Childhood Development.* New York: Palgrave Macmillan. Doi: 10.1057/9780230610415_4

Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping*. New York: Springer Publishing Company, Inc.

Lee, E. H. (2012). Review of the psychometric evidence of the perceived stress scale. *Asian Nursing Research*, *6*(4), 121–127.

LePine, J. A., LePine, M. A., & Jackson, C. L. (2004). Challenge and Hindrance Stress: Relationships with Exhaustion, Motivation to Learn, and Learning Performance. *Journal of Applied Psychology, 89*(5), 883-891.

Levy, D. J, Heissel, J. A, Richeson, J. A., Adam, E. K. (2016). Psychological and Biological Responses to Race-Based Social Stress as Pathways to Disparities in Educational Outcomes. *American Psychologist, 71*(6), 455-473.

Lohman, B. J., Jarvis, P. A. Adolescent Stressors, Coping Strategies, and Psychological Health Studied in the Family Context. *Journal of Youth and Adolescence* 29, 15–43 (2000). https://doi.org/10.1023/A:1005117020812

Long, E.E., Young, J.F., & Hankin, B.F. (2019). Separating within-person from between-person effects in longitudinal co-occurrence of depression and different anxiety syndromes in youth. *Journal of Research in Personality, 81,* 158-167

Lu, W., Bian, Q., Wang, W., Wu, X., Wang, Z., and Zhao, M. (2017). Chinese version of the Perceived Stress Scale-10: a psychometric study in Chinese university students. PLoS One 12:e0189543. doi:10.1371/journal.pone.0189543

Lui, Y., & Lu, Z. (2010). The Chinese High School Student's Stress in the School and Academic Achievement. *Educational Psychology: An International Journal of Experimental Educational Psychology, 31*(1), 27-35.

Marsh, H. W., Martin, A. J., Yeung, A. S., & Craven, R. (2017). Competence Self-Perceptions. *Handbook of Competence and Motivation: Theory and Application*, 85–115.

Martin, R.A., Kazarian, S.S., & Breiter, H.J. (1995). Perceived stress, life events, dysfunctional attitudes, and depression in adolescent psychiatric inpatients. *Journal of Psychopathology and Behavioral Assessment, 17,* 81-95.

Mayberry, D.J., & Graham, D. (2001). Hassles and uplifts: Including interpersonal event. *Stress and Health, 17,* 91-104.

McClintock, A.S., Brown, R., Coe, C.L., Zgierska, A., & Barret, B. (2019). Mindfulness practice and stress following mindfulness-based stress reduction: Examining within-person and between-person associations with latent curve modeling. *Mindfulness, 10*, 1905-1914. Doi:10.1007/s12671-019-01159-x

McKnight, C.G., Huebner, E.S., & Suldo, S. (2002). Relationships among stressful life events, temperament, problem behavior, and global life satisfaction in adolescents. *Psychology in the Schools, 39*, 677-687.

McNeish, D.M., & Harring, J.R. (2017). Clustered data with small sample sizes: Comparing the performance of model-based and design-based approaches. *Communications in Statistics – Simulation and Computation, 46*(2), 855-869. Doi:10.1080/03610918.2014.983648.

Morales, J., & Guerra, N. G. (2006). Effects of multiple context and cumulative stress on urban children's adjustment in elementary school. *Child Development, 77*(4), 907-23. Doi:10.1111/j.1467-8624.2006.00910.x

Meyering, K. (2020). Assessment of perceived stress among school-age children: Relations with emotional engagement and literacy achievement. [Unpublished thesis]. University of Maryland, College Park, MD. https://doi.org/10.13016/ww7d-lhgw

McEwen, B. S. (2000). Allostasis and allostatic load: Implications for neuropsychopharmacology. *Neuropsychopharmacology*, *22*(2), 108–124.

Murphey, D. (2014, December). The academic achievement of English language learners: Data for the U.S. and each of the states (Issue Brief No. 2014-62).

Muthén, L. K., & Muthén, B. O. (1998-2020). *Mplus User's Guide*. Seventh Edition. Los Angeles, CA: Muthén & Muthén

National Academies of Sciences, Engineering, and Medicine. (2017). *Promoting the Educational Successes of Children and Youth Learning English: Promising Futures.* Washington, DC: The National Academies Press. https://doi.org/10.17226/24677.

Ng, Z. J., Huebner, S. E., & Hills, K. J. (2015). Life satisfaction and academic performance in early adolescents: Evidence for reciprocal association. *Journal of School Psychology*, *53*, 479-491.

Noone, P. A. (2017). The Holmes-Rahe stress inventory, *Occupational Medicine, 67*(7), 581-582.

Nunally, J. & Bernstein, I. (1994). Psychometric theory (3rd ed). New York: McGraw-Hill.

O'Neal, C. R. (2018). The impact of stress on later literacy achievement via grit and engagement among dual language elementary school students. *School Psychology International,* 1-18. Doi: 10.1177/0143034317752519

O'Neal, C.R., Brotman, L.M., Huang, K., Gouley, K.K., Kamboukos, D., Calzada, E.J., & Pine, D.S. (2010). Understanding relations among early family environment, cortisol response, and child aggression via a prevention experiment. *Child Development,* 81(1), 290-305. Doi: 10.1111/j.1467-8624.2009.01395.x

Padilla, A. M., Cervantes, R. C., Maldonado, M., & Garcia, R. E. (1988). Coping responses to psychosocial stressors among Mexican and Central American immigrants. *Journal of Community Psychology, 16*(4), 418-427.

Reinhard, P. (2021). Emotions in reading and learning from texts: Progress and open problems. *Discourse Processes,* Doi: 10.1080/0163853X.2021.1938878

Pekrun, R. (2021). Emotions in reading and learning from texts: Progress and open problems. *Discourse Processes.* Advance online publication. Doi:10.1080/0163853X.2021.1938878

Penedo, F.J., Dahn, J.R. (2005). Exercise and well-being: A review of mental and physical health benefits associated with physical activity. *Curr. Opin. Psychiatry, 18,* 189-193.

Putnik, D.L. & Bornstein, M.H. (2016). Measurement invariance conventions and reporting: The state of the art and future directions for psychological research. *Developmental Review,* 41, 71-90.

Quinn, P. D., & Duckworth, A. (2006). Happiness and academic achievement: Evidence for reciprocal causality. *The Annual Meeting of the American Psychological Society,* 24-27.

Roberti, J. W., Harrington, L. N., and Storch, E. A. (2006). Further psychometric support for the 10−item version of the perceived stress scale. *J. Coll. Couns*. 9, 135–147. Doi: 10.1002/j.2161-1882.2006.tb00100.x

Roth, S. & Cohen, L.J (1986). Approach, avoidance, and coping with stress. *Am. Psychol., 41*, 813-819.

Ruble, D. N., Eisenberg, R., & Higgins, E. T. (2014). Developmental changes in achievement evaluation: Motivational implications of self-other differences. *Child Development*, *65*(4), 1095–1110.

Sass, D.A. (2011). Testing measurement invariance and comparing latent factor means within a confirmatory factor analysis framework. *Journal of Psychoeducational Assessment, 29*, 347-363.

Schmeelk-Cone, K.H., & Zimmerman, M.A. (2003). A longitudinal analysis of stress in African American youth: Predictors and outcomes of stress trajectories. *Journal of Youth and Adolescence, 32*(6), 419-430.

Schmader, T., Johns, M., & Forbes, C. (2008). An integrated process model of 77 stereotype threat effects on performance. Psychol. Rev. 115, 336-356.

Selye, H. (1993). *History of the stress concept.* In L. Goldberger & S. Breznitz (Eds.), *Handbook of stress: Theoretical and clinical aspects* (p. 7–17). Free Press.

Skinner, E. A., & Saxton, E. A. (2019). The development of academic coping in children and youth: A comprehensive review and critique. *Developmental Review*, *53*, 1-55.

Stein, M. & Miller, A.H. (1993). Stress, the immune system, and health and illness. In L. Goldberger & S. Breznitz (Eds.), Handbook of stress: Theoretical and clinical aspects New York: Free Press

Suldo, S. M., Shaunessy, E., & Hardesty, R. (2008). Relationships among stress, coping, and mental health in high-achieving high school students. *Psychology in the Schools, 45*(4), 273-290.

Taylor, J. M. (2015). Psychometric analysis of the ten-item Perceived Stress Scale. Psychol. Assess. 27, 90–101. Doi: 10.1037/a0038100

Toste J. R., & Ciullo, S. (2017). Reading and writing instruction in the upper elementary grades. *Intervention in School and Clinic, 52*, 259–261.

Wagenmakers, E. J., & Farrell, S. (2004). AIC model selection using Akaike weights. *Psychonomic Bulletin & Review* 11, 192–196. https://doi.org/10.3758/BF03206482

Wagner, S.L., Cepeda, I., Krieger, D., Maggi, S., D'Angiulli, A., Weinberg, J., & Grunau, R.E. (2016). Higher cortisol is associated with poorer executive functioning in preschool children: The role of parenting stress, parent coping and quality of daycare. *Child Neuropsychology,* 22:7, 853-869. DOI: 10.1080/09297049.2015.1080232

Wagner, R. K., Torgesen, J. K., Rashotte, C. A., & Pearson, N. A. (2010). *Test of silent reading efficiency and comprehension*. Pro-Ed.