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Reading-Related Causal Attributions for Success and Failure: Dynamic Links With Reading Skill

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Abstract

The present study investigated the relation among reading skills and attributions, naming speed, and phonological awareness across a wide range of reading skill. Participants were 1,105 school-age children and youths from two understudied populations: African Americans and Hispanic Americans. Individual assessments of children ranging in age from 8 to 15 years were conducted for reading outcomes, cognitive and linguistic predictors of reading, and attributions for success and failure in reading situations. Quantile regressions were formulated to estimate these relations across the full skill span of each outcome. Reading-related attributions predicted contextual word recognition, sight word and decoding fluency, and comprehension skills. Attributions to ability in success situations were positively related to each outcome across the full span. On three reading outcomes, this relation strengthened at higher skill levels. Attributions to effort in success situations were consistently and negatively related to all reading outcomes. The results provide evidence that the strength of the relation between reading and attributions varies according to reading skill levels, with the strongest evidence for ability-based attributions in situations of reading success.

The causal attributions that children make for experiences of success or failure while acquiring skills have been identified as one critical component of learning motivation (Weiner, 1972, 1986). Within organizing frameworks for motivation (e.g., Snow, Corno, & Jackson, 1996), the perceived causes (i.e., attributions) of success or failure function as a gatekeeping system for goal selection and precommitment to learning opportunities. For example, instrumental acts assigned as controllable causes are likely to be attempted in the future. The identification of noncontrollable causes in learning situations provides alerting to failure (i.e., aversive) experiences (Abramson, Seligman, & Teasdale, 1978). Both the emotional and the cognitive trace left by reaction and reflection after success or failure feed future motivational consequences, including goal selection and persistence; which in turn are associated with later achievement (Pintrich, 2000; Weiner, 2010).

Reading is a generative skill, the development of which has cascading effects on educational achievement and cognition (Stanovich, 1986). Much is currently known about the environmental (e.g., educational, familial, socioeconomic; see Thompson et al., 2015) and dispositional (e.g., individual differences, genetics, functional brain organization; see Olson, Keenan, Byrne, & Samuelsson, 2014; Ozernov-Palchik & Gaab, 2016) context of reading

development. Motivational aspects of learning such as attributions cut across these dynamics, providing an intraindividual context for differences in reading skill acquisition. The present study employed quantile regression with a large sample of children from two understudied populations across a wide range of skill to estimate the changing relations between multiple dimensions of attributions and several indicators of reading skill. Well-established correlates of reading skill—phonological awareness and rapid serial naming—were included as covariates for estimating associations with reading but were themselves also evaluated in the context of the quantile regression models.

Theories of attribution explain how perceived causes of an event are associated with emotions and perceptions that are indicative of future behavior (Weiner, 1986, 2010). In the context of reading achievement, attributions are described in relation to a set of three dimensions: stability, locus, and control. These dimensions categorize perceived causes by considering whether they are likely to change over time, whether they are internal or external to the individual, and whether the individual has control over them (Cox & Yang, 2012; Marsh, 1984; McAuley, Duncan, & Russell, 1992; McClure et al., 2011; Weiner, 2010). Attributing success to internal factors (e.g., ability) and failure to external factors (e.g., luck) is associated with positive achievement and motivation. However, the opposite holds true when attributing success to external causes (e.g., luck) and failure to internal causes (e.g., lack of ability; Wigfield, 1988). Attributing learning outcomes to causes that are both internal and controllable (i.e., effort) is considered to be more adaptive. Attributions to uncontrollable and more stable causes have been associated with poorer motivation and less persistence, particularly in the event of failure (Gibb & Alloy, 2006; McClure et al., 2011).

Previous work has suggested that children with learning disabilities demonstrate greater achievement gains when they attribute failures to either less stable or more controllable causes (Cox & Yang, 2012; Kistner, Osborne, & LeVerrier, 1988). Generally, the experiences of success or failure may influence achievement attributions and motivation to engage with text. For instance, children who experience consistent reading failure may become less motivated to read (Chan, 1994; Morgan, Fuchs, Compton, Cordray, & Fuchs, 2008; Wigfield, 1988). These experiences of repeated failure have been associated with a lack of control over future success, sometimes referred to as learned helplessness (Chan, 1994; Stanovich, 1986). In this manner, the learning experiences of individuals can influence their motivation to engage in further learning, making attributions and other motivational factors of particular interest among lower achieving children.

Attributions to ability, effort, and external causes in both situations of success and failure and how they correlate with reading achievement have been previously explored (e.g., Cox & Yang, 2012; Cuevas, Irving, & Russell, 2014; Marsh, 1984; Relich, 1983). A consistent finding has been a positive relation between achievement and attributing success outcomes to one's ability (Cuevas et al., 2014; Marsh, 1984). Children tend to attribute success to their own ability when they experience gains in achievement. Those with higher performance tend to demonstrate internal attributions for their successes (i.e., ability, effort), and notably in the case of failures, they are more likely to make attributions to internal causes that are less stable and more controllable (i.e., effort; Kistner et al., 1988). Although children with greater achievement have a greater tendency to attribute success to ability, they may also be

less likely to attribute their success to external causes (Cuevas et al., 2014). This was previously supported by Marsh, who found a negative relation between achievement and attributions to external causes in situations of success.

In situations of failure, a negative relation has also been found between achievement and ability attributions (Chan, 1994; Kurtz-Costes & Schneider, 1994). Such findings suggest that at higher skill levels, individuals may also be less likely to associate their failures to internal stable causes (e.g., lack of ability) or their successes to external factors (e.g., luck). Ability-oriented attributions tend to be most strongly associated with achievement (Marsh, 1984; McClure et al., 2011). Attributions for effort, however, have not demonstrated a similar level of consistency, with evidence of both positive and negative relations with reading skill in situations of success and those of failure (Cuevas et al., 2014; Kurtz-Costes & Schneider, 1994; Marsh, 1984; Nicholls, 1978). It has been hypothesized that effort attributions may be associated more with academic self-concept than with achievement (Marsh, 1984), suggesting that attributions for effort may vary according to a positive or negative sense of academic competency (Kurtz-Costes & Schneider, 1994).

Achievement attributions have been associated not only with absolute levels of reading skill but also with developmental differences in reading skill. Comparative and longitudinal studies have demonstrated differences in attributions between higher and lower achieving student populations. Kistner et al. (1988) found that in comparison to their typically developing peers, children with learning disabilities were less likely to attribute their failures to effort, a controllable cause. Children with greater reading skill have a tendency to perceive their ability more favorably (Cuevas et al., 2014); in contrast, those with poorer reading performance are less likely to attribute an event of success to their ability (Kurtz-Costes & Schneider, 1994). Greater accountability in situations of success compared with those with failure may act as a protective factor given fewer self-associations with negative outcomes. Children may be more likely to attribute successes to internal causes and attribute failure to external causes, adopting a self-serving bias pattern of attributions (Marsh, 1984; McClure et al., 2011). Although learned helplessness is not always associated with repeated failure (Kistner et al., 1988), the negative relation between achievement and ability attributions in failure situations may be especially strong among lower achieving populations that are more likely to associate failure with lack of skill (Chan, 1994; Kistner et al., 1988; Kurtz-Costes & Schneider, 1994).

It has been argued that there is a developmental progression in the capacity to distinguish ability from effort. Young children often perceive these constructs as the same, with differentiation developing throughout the childhood years (Chan, 1994; Nicholls, 1984; Wigfield, 1988). Longitudinal findings have suggested that individuals develop an increase in accountability for their learning outcomes over time and a decrease in attributions to external causes (Kistner et al., 1988). When comparing children's attributions at ages 8 and 10, Kurtz-Costes and Schneider (1994) found that there was limited consistency in attributions for failure at the younger age point; however, more distinct patterns emerged two years later at age 10. Older children have demonstrated an increased tendency to attribute both success and failure to effort (Kistner et al., 1988) and strategy use rather than external causes (Chan, 1994; Kurtz-Costes & Schneider, 1994). In addition, related work has also

found a decrease in motivation during adolescence (see Lazowski & Hulleman, 2016). Children's reasoning process about the occurrence of their learning outcomes may develop closer to early adolescence, resulting in a clearer pattern of achievement attributions around this time. This may also be associated with a greater number of learning experiences over time. However, investigations of adolescent reading motivation and attributions have been limited (Wolters, Denton, York, & Francis, 2014). The present work addressed associations between reading skill and related attributions across a wide age range that included both children and adolescents.

These studies have suggested that motivation for academic tasks and/or skills may have a changing role across the developmental emergence of a skill. There are problems with this inference based on the nature of existing studies. Many studies did not report effect sizes, limiting comparisons of motivation's effect across skill levels. The number of motivation measures and their varying psychometric quality preempt direct comparisons across developmental periods. In addition, although slowly changing with the availability of developmentally appropriate and psychometrically sound self-report measures, motivation measurement has often relied on teacher or parent reporting (Fulmer & Frijters, 2009). These measures, including those related to attributions, rely on short self-descriptive statements and, as a result, often lack validity with respect to the referential content of the motivation statement (Fulmer & Frijters, 2009). With respect to outcomes, the reading measures employed in these studies vary according to the developmental levels targeted, with few studies that incorporated attributions also using direct assessments of reading skill that are commensurate (i.e., in the measurement sense) across the entire childhood reading skill span. In the present study, a behavioral vignette self-report measure of motivation was used, along with direct assessment of reading skill, using measures that are commensurate across the entire range of reading skill.

Additionally, much research into the attribution-achievement relation has focused on samples of convenience, which are predominantly European American/Caucasian and of middle to high socioeconomic status. In studies that have not explicitly recruited children identified as European American, the majority/minority or ethnic status has not been fully described. With increasing numbers of children of minority backgrounds being educated in the U.S. school system, limited or underspecified sampling is increasingly unjustified (for rare counterexamples, see Cox & Yang, 2012; Swinton, Kurtz-Costes, Rowley, & Okeke-Adenju, 2011). According to data from the U.S. Census, 55% of elementary and secondary students were from non-Hispanic European American backgrounds, whereas 23% were Hispanic and 14% were African American (U.S. Census Bureau, 2015; see also National Center for Education Statistics, 2012).

The sampling bias is important to address when considering attributional dynamics, because there may be inter- and intracultural differences in motivation structures and their role in skill development (e.g., Choi, Nisbett, & Norenzayan, 1999). For instance, Cox and Yang (2012) found that collectivism was associated with stability attributions (i.e., ability) among Hispanic children. Collectivist cultures have been associated with beliefs that individuals are motivated, interdependent members with shared group values. Cox and Yang's findings demonstrated that although collectivism was initially related to stability attributions in

situations of failure, there was little increase in attributions to stable causes over time. In addition, Swinton et al. (2011) explored attributions of African American students and found significant sex differences across various subject domains. With a large presence of European American samples among attribution and reading motivation literature, there is a need to explore how such factors are related to reading skill among other races and ethnic groups. This work examined relations between reading skill and attributions for success and failure among African American and Hispanic youths.

Any investigation of the motivation–reading relation must account for the substantial evidence base that already exists for the development of reading skill itself. Phonological processing, and more specifically phonological awareness, is one of the best studied cognitive-linguistic skills that is predictive of reading. This skill is both a developmental precursor for (e.g., Wagner, 1988; Wagner & Torgesen, 1987) and an outcome of (e.g., Wimmer, Landerl, Linortner, & Hummer, 1991; Ziegler & Goswami, 2005) the acquisition of reading skill. In prospective longitudinal studies, phonological awareness has an influence on the early development of reading skill (e.g., Lervåg, Bråten, & Hulme, 2009; Schatschneider, Fletcher, Francis, Carlson, & Foorman, 2004) and continues to be important through the entire course of reading acquisition, but it fades in importance (see, e.g., Kirby, Parrila, & Pfeiffer, 2003; Wagner et al., 1997) as the child builds a corpus of sight words and reading becomes more dependent on the development of cognitive factors (e.g., Hulslander, Olson, Willcutt, & Wadsworth, 2010) and other elements, such as the quality of semantic representations (e.g., Frost, Madsbjerg, Niedersøe, Olofsson, & Sørensen, 2005).

Rapid automatized naming (Wolf, Bowers, & Biddle, 2000) is a second cognitive-linguistic skill that has clearly established developmental relations with reading. The relation between rapid naming and reading is separable from the phonological awareness and reading relation (e.g., Byrne et al., 2007; Norton & Wolf, 2012), at least with respect to the environmental as opposed to genetic variance in reading (Petrill, Deater-Deckard, Thompson, DeThorne, & Schatschneider, 2006). The influence of rapid naming from early to skilled reading has been relatively well studied. Of the four rapid automatized naming tasks widely used in the literature, alphanumeric serial naming (i.e., letters, numbers) has the strongest theoretical and empirical relation with reading. Correlations between color or object naming and reading decrease in size past the pre- to early reading stages (Wolf, 1984). Color and object naming also show more variable developmental associations with reading as skill develops (van den Bos, Zijlstra, & Jutje Spelberg, 2002). Past research has shown that rapid automatized naming becomes an increasingly more important predictor of decoding, single-word identification, and passage comprehension from grade 1 to grade 5, especially after grade 3 (Kirby et al., 2003). Although well studied to date, most extant studies have used age category as a proxy for reading skill, collapsing children who vary in reading skill within one- or two-year wide age bands. These bands in turn contain a wide range of reading skill, preempting the accurate estimation of naming speed, phonology, or reading motivation as continuous processes.

The present study investigated the relations between motivation and reading skill across a wide range of reading skill, addressing several of the problems in the extant literature. Studies of the motivation–reading relation have included many motivation constructs (see

Wolters et al., 2014), but the attributional approach to motivation has been employed much less frequently. The models reported in the present study also control for the two most consistent cognitive-linguistic predictors of the measured reading outcomes across this skill range: phonological awareness and rapid automatized naming. In contrast to many cross-sectional studies of reading skill, children were not divided into arbitrary age or grade-defined groupings. Within the context of correlational designs, this practice confounds skill development with chronological age, obscuring cross-age variability, while simultaneously restricting variance within each age category. In the present study, quantile regression was used to examine reading skill across the full skill range from 8 to 15 years. Quantile regression provided a unique opportunity to reliably estimate correlations and associated changes in these relations over varying levels of the outcome (Petscher & Logan, 2014). Previously demonstrated predictors of reading skill—phonological awareness and rapid automatized naming—were also included in a multiple quantile regression framework so the relation with reading-related causal attributions could be evaluated, controlling for these known determinants of reading skill.

Based on past empirical findings and the theoretical role that attributions play in mediating task engagement, we anticipated that attributions for success to ability would be positively related to reading outcomes. These correlations were anticipated to be moderately strong. Conversely, we anticipated attributions to effort and external causal, along with all attributions for failure, to be negatively related to reading skill. Within the quantile framework, we expected that correlations between success/ability attributions and reading skills would increase in strength with increasing levels of reading skill. This reflects the theoretical dynamics involved in attribution formation: the reinforcing role that awareness of success has within the context of skill acquisition. Consistent with the past substantial literature, we anticipated that naming speed and phonological awareness would demonstrate positive relations with reading. For decontextualized reading outcomes, this relation would weaken as reading skill increases, reflecting the automatization of lower level reading processes.

Method

Participants

The sample for the present study was part of the larger, multisite Genes, Reading and Dyslexia Study, which was designed to investigate the molecular genetics of normal reading and reading disabilities in understudied minority populations. To date, molecular genetic studies of reading ability and disability have focused exclusively on nonminority children. The larger study recruited children ages 8–15 years of primarily African American and Hispanic/Latino heritages at seven sites across the United States, Canada, and Puerto Rico. To ensure representation across the developmental spectrum of reading ability, oversampling of the lower end of the distribution was employed. Additional participants who had a history of poor reading skills (as documented by prior school or clinical testing), a report of skills falling below expected level for age or grade, and/or a provision of special services in reading were recruited.

Telephone screening with the primary caregiver was completed to determine eligibility prior to obtaining consent for participation. Exclusion criteria were as follows: age outside the target age range; nonminority ethnic or racial group membership; foster care placement; preterm birth (defined as <36 weeks' gestation); prolonged stay (i.e., greater than five days) in the neonatal intensive care unit after birth; history of diagnosed or suspected significant cognitive delays, significant behavioral problems, or frequent school absences; history of serious emotional/psychiatric disturbances (i.e., major depression, psychotic or pervasive developmental disorder, autism) or chronic neurologic condition (i.e., seizure disorder, developmental neurological conditions, Tourette's syndrome or other tic disorder, acquired brain injuries); and documented hearing or uncorrected vision impairment.

Table 1 provides a description of the sample, including age, reading ability relative to age expectations (i.e., standardized scores), and sample means on all study variables. Although recruitment specifically targeted children behind developmental expectations for reading ability and normally developing children, the overall distributions of reading skills reflected the full developmental range for the study ages (i.e., Test of Word Reading Efficiency [TOWRE] composite standard score mean [M] = 92.9, standard deviation [SD] = 16.8, interquartile range = 23; Torgesen, Wagner, & Rashotte, 1999). The sample comprised 1,105 children (52.5% male) between the ages of 8 and 15 years (age M = 11.6 years, SD = 2.1 years). All children were of minority racial and/or ethnic backgrounds. Via a demographic and family questionnaire, Hispanic American ethnicity was endorsed 68.9% of the time (n = 762), and African American background was endorsed 29.9% of the time (n = 330). Of the latter, 5.2% (n = 58) also endorsed Hispanic ethnicity. A small number endorsed non-European American other as their children's racial or ethnic background (n = 13; 1.2%). When a parent endorsed Spanish for his or her child's primary language, the child was administered the Test de Vocabulario en Imagenes Peabody. Valid administration and scoring of this test identified 260 (34.1% of the Hispanic children) as bilingual. As subsequently described, all participants were also assessed on the fourth edition of the Peabody Picture Vocabulary Test (English-monolingual participants M = 96.8, SD = 15.1; bilingual participants M = 87.9, SD = 14.8). All participants were only considered for inclusion with valid completion of all English-language assessments and a minimum of three years of formal schooling in English.

Mother's education was available for much of the sample (78.2%): 18.9% of mothers did not complete high school, 34.6% had earned a high school diploma or GED, 20.6% had completed some college coursework beyond high school, and 27.6% had completed college or held an additional graduate degree. The sample is generally comparable to the educational background of women (i.e., not divided by race or ethnicity) in the United States, according to 2012 U.S. Census data, which reported that 11.3% of women did not complete high school, 29.4% were high school graduates, 27.8% had completed some college coursework beyond high school, and 31.4% had completed college or held an additional graduate degree (U.S. Census Bureau, 2016). Furthermore, just over one third of the present sample was receiving financial assistance for food (34.3%; Temporary Assistance for Needy Families, Food Stamps, or Women, Infants, and Children) or other areas of need (38.1%; Medicaid/HUSKY or Section 8/government assistance with housing).

Measures

Participants completed a large battery of one-on-one directly administered cognitive and educational testing. The present study focuses on four reading outcomes, causal attributions for success and failure, and related cognitive-linguistic skills that have strong developmental links with reading. For measures of reading skill, tests have been normed on large, representative samples for the full age range of children in the present study. Because the study was conducted on a continuous intake model, assessments occurred throughout the year, with care taken to avoid problematic timing (e.g., end or start of the school year).

Reading Outcomes—Reading comprehension and contextual word-reading accuracy at the paragraph level were assessed using the second edition of the Standardized Reading Inventory (SRI-2; Newcomer, 1999). Ten graded passages of increasing difficulty were presented to the children. A contextual reading accuracy score was formed from the number of words in the passage minus oral reading errors (e.g., omissions, insertions, substitutions). Correctly answered comprehension questions formed the basis for a text comprehension score. The SRI-2 has been nationally normed, with internal consistency coefficients that are acceptable across the developmental span of the current sample, ranging from .88 to .97. Test-retest reliability coefficients range from .83 to .92 across ages and across text comprehension and word identification subscores.

Noncontextual reading fluency was assessed with the Sight Word Efficiency and Phonemic Decoding Efficiency subtests of the TOWRE. The child was presented with a list of either real words (Sight Word Efficiency) or pseudowords (Phonemic Decoding Efficiency), with the number of words read correctly within 45 seconds constituting the total score. Words within each task are ordered according to difficulty. The TOWRE has been extensively validated, with previously demonstrated high reliabilities for the current age range (alternate form .88 and .91 for each subtest, respectively).

Attributions—The Sydney Attribution Scale (SAS) is a well-validated self-report measure of causal attributions to success and failure in the context of reading experiences (Marsh, 1984; Marsh, Cairns, Relich, Barnes, & Debus, 1984). Participants were presented with 13 brief behavioral vignettes that described either success or failure while engaged in common reading experiences (e.g., “Suppose your teacher chose you to be in the top reading group in your class...”). Each behavioral vignette was followed with three self-report items, scored on a Likert-style response scale with five degrees of endorsement. For each vignette, the three response scales assessed ability, effort, and external causal attributions to the success or failure experience (e.g., respectively, “You are good at reading” vs. “You are a poor reader”; “You really work hard at reading” vs. “You were careless about reading the story”; “The teacher made a mistake” vs. “The story was too hard for everyone”). In total, six attribution scales for reading are available from the SAS, each with six items: success to ability, success to effort, success to external causes, failure to ability, failure to effort, and failure to external causes. This is a direct self-report scale, but because a high proportion of the sample had been identified as struggling readers, items on this task were read to participants when necessary (e.g., children younger than 10, those who struggled with

reading tasks in earlier assessments). Marsh et al. reported both high subscale reliabilities (.80–.90) and excellent factor validation of the SAS structure.

Reading-Related Skills—Phonological awareness was assessed with the Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen, & Rashotte, 1999) Blending Words subtest. This task assesses the ability to combine orally presented individual speech sounds into words. Internal consistency reliability reported by the test authors over a large and developmentally representative sample exceeds .89. The Rapid Automatized Naming Test (RAN; Wolf & Denckla, 2005) is a measure of serial naming speed. During the RAN letters task, a child is presented with five lowercase letters, in random sequence, across five rows of 10 items each. Children are asked to name the stimuli as quickly as possible without making mistakes, with time to complete the set as the test score. As per the standardized administration rules, repeated stimuli and self-corrects were not counted as errors, whereas omissions and substitutions were. The task was readministered after a delay for participants making more than four errors. In these cases, the second valid administration was scored and used in the data analysis. For analytic purposes, time to complete the array was transformed to a rate score (i.e., number of items per second) to correct marked positive skew manifested when data were in speed form (before: skewness = 1.70, kurtosis = 4.67; after: skewness = 0.27, kurtosis = 0.01). As a result of this transformation, higher scores in the following analysis represent more items per second and, thus, better serial naming speed.

Results

An insignificant amount of missing data was present, consisting of 22 data points distributed evenly across the 17 analytic variables (0.12% missing data rate). Because Little's (1988) test for data missing completely at random did not support systematic associations between missingness and the analytic variables ($\chi^2[84] = 75.53, p = .73$), and the amount of missing data was minimal, the expectation maximization algorithm was used to complete the data set via a single imputation. Analyses comparing this approach with listwise deletion generated substantively equivalent results in the quantile regressions subsequently reported.

Reliability Analysis

A reliability analysis using the greatest lower bound was conducted on the previously published subscales of the SAS. Cronbach's coefficient α , although widely implemented, has serious limitations as an index of reliability (Sijtsma, 2009). Although alternatives to α are not universally agreed upon, in the presence of sufficient sample size (i.e., >1,000; Ten Berge & So an, 2004), the greatest lower bound reliability provides an estimate that does not systematically under- or overestimate reliability for large samples but is interpreted on the same scale as other reliability coefficients (Sijtsma, 2009; see also Revelle & Zinbarg, 2009). The greatest lower bound algebraic procedure from the Psych library (Revelle, 2014) for the R statistical system was used to estimate the greatest lower bound for each SAS subscale. Because the sample contained 260 participants who were identified as coming from a bilingual home, SAS subscale reliability was also estimated separately for these participants.

Reliability coefficients were as follows (bilingual coefficients are in parentheses): success to ability = .90 (.89), success to effort = .82 (.78), success to external causes = .76 (.78), failure to ability = .83 (.82), failure to effort = .71 (.69), and failure to external causes = .59 (.53). All but the final subscale demonstrated acceptable to good reliabilities for both the overall sample and participants identified as bilingual. Two items on the subscale concerned with attributions of failure to external causes (e.g., "...the teacher doesn't like you"; "...the story is boring") demonstrated a low correlation with the attribution of failure to external causes total scale. All quantile regression analyses reported in the next subsection were conducted with and without this subscale included, although no substantive differences across these two sets of analyses were observed.

Quantile Regression Analysis

Originally developed and extensively used with econometrics (Koenker & Bassett, 1978), quantile regression is an extension of linear regression. Petscher and Logan (2014) described how quantile regression has several characteristics that intersect with the analytic needs of developmental studies. Rather than estimating a single regression coefficient for the prediction of an outcome, multiple coefficients are estimated along the full range of the outcome. All data points are used to estimate the slope at each selected quantile but are weighted by residual errors based on the distance of each data point from the quantile itself. In developmental studies, estimation of the relation with a predictor might be applied across the full range of a skill, such as reading ability (for an application example, see Tighe & Schatschneider, 2016; for an introductory overview of the analytic process, see Petscher, Logan, & Zhou, 2013).

In the present study, reading ability was assessed across four constructs: contextual word reading (SRI-2 word recognition accuracy), comprehension (SRI-2 passage comprehension), word-reading fluency (TOWRE Sight Word Efficiency), and decoding fluency (TOWRE Phonemic Decoding Efficiency). Initial exploratory analyses indicated that there was pronounced heterogeneity in the relation between reading outcomes and several predictors (e.g., attributions, phonological awareness, rapid automatized naming, chronological age). This circumstance harms the validity of linear regression because the variance in the dependent variable differs along levels of the independent variable; however, quantile regression was developed for these circumstances.

Table 2 presents correlations and descriptive statistics for the 12 variables involved in the quantile regression analyses. Four quantile regression models were formed by regressing raw scores for each reading outcome (e.g., contextual word reading, comprehension, word-reading fluency, decoding fluency) onto the following predictors: six dimensions of motivational attributions (SAS subscales), phonological awareness (CTOPP Blending Words), rapid automatized naming (RAN letters), and age. No problematic multicollinearity among predictors was present. Regression equations were estimated at 19 quantiles, starting with the fifth, in increments of five to the 19th. Although power calculations for quantile regression are not readily accessible, two features of the analysis give us confidence in the validity of the quantile models subsequently described. Data density was relatively homogeneous across skill levels, with each skill level represented by an equivalent number

of participants. In addition, as will be seen in graphs portraying the quantile functions, standard errors across quantiles were similar.

Quantile regression models were conducted on *z*-score standardized data to allow the relative strength of regression coefficients to be easily estimated. Quantile plots were generated for visual examination of changing correlations between the abovementioned variables and outcomes across skill levels. For tabular presentation of results and for post hoc comparisons across quantiles, the 20th, 50th, and 80th quantiles were isolated in Tables 3–6, representing low, medium, and high reading skill. Post hoc contrasts among quantiles were conducted via the *quantreg* procedure (Koenker, 2013) in the R statistical system. To control type I error resulting from multiple quantile comparisons (Petscher & Logan, 2014), only the following three quantile contrasts were conducted and only when the global test for equal coefficients across quantiles attained significance: 20th versus 50th, 80th versus 50th, and 80th versus 20th. Note that all models reported estimate the conditional relation between each predictor and reading skill, accounting for the influence of the other predictors. For example, estimates of the attribution–reading relation at different quantiles of reading skill also account for the effects of phonological awareness, rapid automatized naming, and age on reading skill.

Attributions to ability in situations of reading success (i.e., “You are good at reading”) demonstrated significant positive relations to each reading outcome at all skill levels, controlling for the other five attribution dimensions, phonological awareness, rapid automatized naming, and age. As presented in Tables 3–6, these correlations ranged from .14 to .31. For three of the four outcomes, this relationship increased in strength as reading skill increased. For example, Figure 1 illustrates that for TOWRE Phonemic Decoding scores, attributions to ability weakly predicted low reading skill levels ($b_{20th} = .17, p < .001$) but almost doubled at high skill levels ($b_{80th} = .31, p < .001$). The *x*-axis in this figure indicates quantiles of skill on the TOWRE Phonemic Decoding subtest, from low to high skill. The *y*-axis indicates the correlation between success attributions to ability and Phonemic Decoding scores at each quantile.

The overall test of quantile equality was significant ($\chi^2[18] = 32.16, p = .02$), indicating that there were significant differences in the attribution–reading relation along the full range of 19 quantiles that were evaluated. A similar pattern was observed for SRI–2 passage comprehension, with very low levels of skill demonstrating no association between ability attributions for success. This association rose to .17 in the middle of the skill range and was sustained at higher levels of skill. Significant variation in ability attributions in situations of success were demonstrated for three of the four reading outcomes—SRI–2 passage comprehension ($\chi^2[18] = 35.97, p = .007$), TOWRE Sight Word Efficiency ($\chi^2[18] = 44.00, p < .001$), and TOWRE Phonemic Decoding Efficiency ($\chi^2[18] = 32.16, p = .02$)—but not SRI–2 word recognition accuracy. Attributions to effort in situations of reading success (i.e., “You really work hard at reading”) demonstrated small significant negative relations with reading skill across all reading outcomes and across the full range of reading skill. These correlations ranged from $-.07$ to $-.15$ and varied by reading skill for SRI–2 passage comprehension ($\chi^2[18] = 29.21, p = .04$). Post hoc comparisons did not indicate significant differences between quantiles. Attributions to external causes for reading success (i.e., “You

were lucky”) also demonstrated a small negative but statistically significant relation with reading skill on all outcomes (range = $-.05$ to $-.14$) but did not vary over skill levels.

In situations of reading failure, ability attributions demonstrated two small but significant negative effects at the 20th and 50th quantiles of reading skill. Overall tests of quantile equality demonstrated significant differences across reading levels for two of the four outcomes: SRI–2 word recognition accuracy ($\chi^2[18] = 31.65, p = .02$) and TOWRE Phonemic Decoding Efficiency ($\chi^2[18] = 29.81, p = .04$). Post hoc comparisons further indicated that correlational differences from the 50th to the 80th quantiles ($F = 6.02, p = .01$) and from the 20th to the 80th quantiles ($F = 7.20, p = .007$) were significant for TOWRE Phonemic Decoding. Correlations showed a change in association from negative to positive at the higher reading levels. Attributions to effort demonstrated two small but significant effects. A positive association was found at lower skill levels for SRI–2 word recognition accuracy, whereas a negative effect was found at higher skill levels for TOWRE Sight Word Efficiency. Attributions to external causes in situations of reading failure were not significantly associated with any reading outcomes (see Tables 3–6). Overall tests of equality did not show significant differences between quantiles for attributions of either effort or external causes in situations of failure.

On all of the reading outcomes, CTOPP Blending Words demonstrated a significant and moderately strong positive relation across the full skill range of reading skill (range = $.10$ to $.35$). There was a clear trend toward stronger relations at higher skill levels for SRI–2 word recognition accuracy, with significant variation across skill levels ($\chi^2[18] = 72.91, p < .001$). Post hoc quantile contrasts supported this trend, indicating significant differences for all quantile comparisons: 20th versus 50th ($F = 14.36, p < .001$), 50th versus 80th ($F = 10.88, p < .001$), and 20th versus 80th ($F = 29.65, p < .001$; see Table 7). The relation between phonological awareness and comprehension almost doubled from low to high skill levels. A different pattern of variation across quantiles was observed for the TOWRE Phonemic Decoding Efficiency outcome ($\chi^2[18] = 35.96, p = .007$). As illustrated in Figure 2, moderate relations (range = $.20$ to $.25$) were observed at low skill levels, but at higher levels of decoding skill, the size of this relation decreased. Post hoc comparisons showed that the increase in correlation from the 20th to the 50th quantile ($F = 4.40, p = .04$) and the decrease from the 50th to the 80th quantile ($F = 10.71, p = .001$) were significant.

Rapid automatized naming was also a consistently positive predictor of reading skill, with faster naming speeds associated with greater reading ability at each skill level and on every outcome (range = $.19$ to $.56$). On the three word-level outcomes (TOWRE Phonemic Decoding Efficiency, Sight Word Efficiency, and SRI–2 word recognition accuracy), faster naming was more strongly associated with reading at low skill levels. Naming speed was a markedly stronger predictor of both word-reading outcomes (i.e., TOWRE Sight Word Efficiency and SRI–2 word recognition accuracy) at low skill levels but still strongly predictive at high ability levels. Figure 3 illustrates these relations for TOWRE Sight Word Efficiency. Post hoc quantile contrasts demonstrated significant differences between low and high skill levels at the 20th versus 80th quantiles across three outcomes: SRI–2 word recognition accuracy ($F = 5.55, p = .02$), TOWRE Sight Word Efficiency ($F = 18.03, p < .001$), and TOWRE Phonemic Decoding ($F = 5.08, p = .02$).

Similarly, age was positively associated with all reading outcomes across the full range of reading skill (range = .09 to .37). A consistent increase in the strength of these relations was observed from low to high reading skill across all outcomes. Overall tests of quantile equality showed significant variation in age for SRI-2 word recognition accuracy ($\chi^2[18] = 39.58, p = .002$) and SRI-2 passage comprehension ($\chi^2[18] = 48.42, p < .001$). Increases in correlation from low to high skill were significant, as indicated by post hoc quantile contrasts for SRI-2 word recognition accuracy ($F = 7.57, p = .006$) and SRI-2 passage comprehension ($F = 10.41, p = .001$). Significant variation in age across reading skill was not observed for the remaining two outcomes.

A series of sensitivity analyses were conducted post hoc to ensure that the models, as formulated, were robust to language status and/or race. Two variables were formed: parent-declared African American heritage versus not and bilingual status (as described in the Methods section) versus not. Quantile models were evaluated with and without these two predictors. In all cases, the relations between cognitive, linguistic, and attributional predictors with reading outcomes were identical across the two model sets. For the sake of parsimony in the choice of predictors, both variables were dropped from the final models.

Discussion

The present study demonstrated that three classes of predictors vary in their effects on reading outcomes across levels of reading skill: causal attributions for success and failure, phonological awareness, and rapid automatized naming. Results demonstrating a positive relation for attributions to ability in success situations across all levels of reading achievement are consistent with previous research investigating the motivation–reading relation (Cuevas et al., 2014; Marsh, 1984). Greater exposure to reading success as skill increases is expected to be associated with an increased sense of competency. The size of this relation was small to moderate, although it is important to note that these effects were estimated, controlling for two cognitive-linguistic skills with the strongest and most robustly demonstrated relation with reading skill. In the case of the phonemic decoding (pseudoword) fluency outcome, the relation between attributions of success to ability increased to moderate strength as skill increased; for phonological awareness, this pattern was reversed, with decreasing strength from moderate at low levels of skill to small at high decoding skill.

Attributions to both effort and external causes demonstrated small negative relations with reading skill that were consistent over the full range of reading skill. Related investigations have revealed mixed results for attributions to both effort and external causes. In some cases, effort attributions were not as strongly correlated with reading achievement when compared with attributions for ability (Marsh, 1984). Consistent with the present findings, Marsh found in situations of success that attributions for external causes were negatively correlated with reading achievement. The disability literature has suggested an association between low reading skill and repeated failure, with a greater tendency to attribute successes to external causes such as luck (Chan, 1994; Pintrich, Anderman & Klobucar, 1994). At low levels of reading skill, children who experience repeated failure may be more likely to attribute an event of success to external causes due to lower frequencies of positive experiences with reading. These findings in addition to a small negative relation for effort attributions may

have developmental implications, considering the age range of the present sample. Stipek (1993) suggested that greater effort was associated with low skill among older students, whereas less effort was associated with higher skill. Accordingly, older students among the low reading skill group are more likely to have experienced consecutive failures and may lack positive competency beliefs, resulting in attributions to external factors (Berkeley, Mastropieri & Scruggs, 2011).

Collectively, such findings reinforce the criticality of developing strategies that assist children in attributing their reading success to internal and controllable factors such as ability or effort. Psychological approaches to intervention that highlight a motivational approach to achievement (see, e.g., Blackwell, Trzesniewski, & Dweck, 2007; Paunesku et al., 2015; Toland & Boyle, 2008) have shown evidence of relations between ability beliefs and achievement outcomes. For instance, viewing intelligence as stable or unchangeable has been associated with less persistence (Blackwell et al., 2007; Dweck, 2000). Relating success to internal and controllable factors is associated with positive motivation and self-efficacy beliefs, which in turn are indicative of greater persistence contributing to achievement gains (Berkeley et al., 2011; Weiner, 1986, 2010).

One unique contribution of the present study was to show that these relations are not static across the full range of reading achievement but vary across reading skill levels. Had the relation between attributions and reading outcomes been modeled with linear regression, the small and sometimes nonsignificant relation at low skill levels would have been overestimated, and the increased importance of this relation at higher skill levels would have been profoundly underestimated, relative to the strength of the relation at median skill levels.

These cross-sectional results stand in contrast to the longitudinally derived finding that earlier attributions to stable causes (e.g., ability, capacity) are associated with reduced performance later (Cox & Yang, 2012). Two explanations can be offered for these contrasting but not contradictory results. First, these studies examined situations of earlier poor performance or failure and later success, whereas the current study examined the cross-sectional effects of ability attributions in success situations. Second, the developmental resolution of the present study was much greater. Across this full skill span, children likely come to appreciate that skill increases over time. In addition, as conceptualizations of attributions become more sophisticated, ability and effort are seen as separate internal constructs that differ in their controllability (Chan, 1994; Wigfield, 1988). This interpretation has been supported by the following findings: (a) Only ability attributions in success situations demonstrated relations with reading (Cuevas et al., 2014); (b) those relations were weakest, and half as strong in one case, at the lowest reading skill levels, where children would not have had equal opportunities to see changes in achievement relative to ability; and (c) there was an increasingly strong relation between ability attributions and reading as skill levels increased, with more opportunities for a child to observe changes in achievement.

Evidence of the validity for the quantile regression approach and its application to the attribution–reading relation can be found in the pattern of results for phonological awareness and rapid automatized naming. The results for these established predictors of reading

replicated previously demonstrated relations with reading across four reading outcomes. Greater phonological awareness skill and faster naming speed were both positively related to reading skill. In addition, variation in the strength of these relations over the full range of reading skill was consistent with theory and past longitudinal findings.

The finding that the ability to blend sounds increased in importance as a predictor of reading comprehension and contextual word reading at higher skill levels is a unique finding. There are two possible explanations for this. First, phonemic blending as a measure of phonological awareness may be more valid for emergent and early skill levels but may index different skills as orthographic representations become more robust (i.e., spelling, reading). Second, this finding may derive from the specific measure of reading comprehension. The SRI-2 texts are reading-level graded passages, and the test designers may have increased passage difficulty by incrementally adding lower frequency but orthographically regular words. In contrast, on the measure of phonemic decoding fluency, phonological processing decreased in importance as decoding skill increased (see Figure 2). This dynamic is consistent with the increased automaticity and efficiency of orthographic processing that occurs with extensive reading experience and the resulting higher quality representations developing from that experience (Bowers & Wolf, 1993; O'Brien, Wolf, Miller, Lovett, & Morris, 2011).

Also consistent with past findings, rapid automatized naming demonstrated strong positive relations with every reading outcome (Kirby, Georgiou, Martinussen, & Parrila, 2010). On contextual word reading, sight word fluency, and decoding fluency, this relation was dramatically stronger at low skill levels, decreasing with higher skill levels. Based on their review of reading-rapid automatized naming studies, Kirby et al. suggested that the relation between reading skill and rapid automatized naming may be curvilinear across levels of reading skill. The present results go some distance at detailing the shape of this relation across the full reading skill range found from childhood to early adolescence. The replication of previous developmental findings involving phonological awareness and rapid automatized naming supports the overall validity of the quantile regression approach adopted in the present study, suggesting its validity as a method to explore the changing relations of these predictors across a wide span of reading ability development.

One major strength of the present study is that it provided descriptive information about attributions on a sample of children who were diverse socioeconomically and of varied language and non-European American racial and ethnic backgrounds. The mean attribution levels and correlations with reading skill provided in Table 1 provide important descriptive information from a sample of 1,105 African American and Hispanic children. Because children identified as European American were not included in the sample, direct comparisons with less racially or ethnically diverse samples cannot be made within the present study. This design issue limits cross-cultural comparisons because similar studies within other populations may not use equivalent measures of attribution or reading ability.

Several of our findings that diverge from past research may be due to the unique motivational dynamics of skill acquisition within another cultural context; however, very few studies are available for comparison. For example, although providing a detailed

longitudinal view of changes in levels of attributions, Swinton et al. (2011) did not relate attributions to directly assessed reading skill. In their study, attributions of failure to math ability in grade 8 was negatively related to classroom engagement. Cox and Yang (2012) specifically investigated attributions in response to an initial failure, in contrast to the present study's focus on attributions and skill acquisition measured together cross-sectionally. Cox and Yang, however, investigated sociocultural dynamics in that collectivism was positively correlated with increased attributions to stable causes, but this relation did not increase over time. These findings suggest potential intracultural and/or intraindividual variation in the degree to which ability attributions may become more important as skill is acquired. In the context of this sparse research literature, the present study at minimum indicates that the relations between attributions and achievement previously demonstrated seem to hold in minority populations, despite cultural or ethnic attributional differences that might exist in general.

Quantile regression provided a detailed nonlinear look at the relation between motivation and reading skill, lending significant strength to the present study as well. This allowed for the demonstration of clearly varying relations between cognitive reading precursors and reading skill and between attributions and reading skill. This strength of the quantile regression framework comes at a cost. Although the analysis was able to evaluate the present suite of independent variables conditional on each other, no accommodation was made for the latent structure among attribution constructs. Past research into the factor structure of the SAS has demonstrated support for separable factors along the subscales (e.g., Marsh, 1984); however, whether this factor structure is invariant across low- versus high-achieving children and/or racial or ethnic groups has not been evaluated.

There is the possibility that children's language ability may have affected their response to the attribution scale because it was a language-based measure. Despite some of the sample being bilingual, English-language competence was required for participation in the study. In addition, the language demands of the attribution measure are not high, with simple grammar and vocabulary used for individual items. Evidence that language ability had minimal impact can be found in the high to excellent reliability demonstrated by three SAS subscales (success to ability, success to effort, and failure to ability) that were the focus of our findings. In addition, reliability calculated for participants from self-identified Spanish-speaking homes was very close to the overall sample reliability, which suggests consistency within bilingual children's responses.

The assumed causal flow of reading skill predicting reading-related causal attributions, rather than vice versa, paints a simplistic version of the relations between these two constructs. It is quite possible that reading-related causal attributions may drive reading skill acquisition. This approach has been taken in past work, albeit with equivalently correlational designs like the current study (e.g., Chan, 1994; Kistner et al., 1988). Causal psychological consequences (e.g., self-esteem, expectancy) of attributions are especially important for determining future behaviors such as the likelihood to engage in or avoid reading tasks (Weiner, 2010), which in turn would be predictive of later reading performance. Lazowski and Hulleman's (2016) meta-analysis of educational interventions that contain motivation-related treatment components provided one possibility for how the causal role of motivation

might be investigated. Their review stated the importance of testing theories of motivation, such as attribution theory, within the contexts of interventions and randomized experimental research designs as a way of exploring theory-driven program effects.

The major finding of the present study—that attributions to ability in the context of success experiences increase from low to high skill levels—has implications for the development of reading skill, instruction, and reading disabilities. For typically developing children, higher skill levels occur at older ages, which themselves are associated with greater language abilities and the developmental emergence of the frontal lobe processes for insight and metacognition. Thinking about how one learns and being able to verbally label what affects success or failure are likely to be executive in nature and mediated by frontal structures, which are late to develop. Low correlations with ability attributions at low reading skill levels would suggest that incorporating attributional elements to instruction would be superfluous for either beginning readers or children experiencing significant difficulties with acquiring normal reading skill.

Alternatively, it may be that attributional elements in instruction must be linked to instances of success that are observable by the child, which may occur with direct teaching or modeling of a skill or reading strategy. Struggling learners who tend to attribute failures to ability, as a stable and uncontrollable cause, can benefit from instructional efforts that make explicit connections between experiences of success, effortful learning, and in turn, later achievement gains. Such elements must be carefully crafted for both beginning readers and children experiencing significant reading difficulties. At these early and lower levels of reading skill, it would be important to assign children tasks within their range of ability. A task should be neither too challenging nor too simple to ensure that children put forth effort on a task that they can achieve so they are left feeling competent and successful in their learning (Pintrich, 2003). To replicate the experience of success that older or more skilled readers experience, such remedial elements could be tied to discrete occurrences of successful skill acquisition to enhance future engagement. Motivation-compatible reading instruction incorporates reciprocal teaching models, combined with mastery practice elements and developmentally scaffolded content.

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References

- Abramson LY, Seligman ME, Teasdale JD. Learned helplessness in humans: Critique and reformulation. *Journal of Abnormal Psychology*. 1978; 87(1):49–74. DOI: 10.1037/0021-843X.87.1.49 [PubMed: 649856]
- Berkeley S, Mastropieri MA, Scruggs TE. Reading comprehension strategy instruction and attribution retraining for secondary students with learning and other mild disabilities. *Journal of Learning Disabilities*. 2011; 44(1):18–32. DOI: 10.1177/0022219410371677 [PubMed: 21335506]

- Blackwell LS, Trzesniewski KH, Dweck CS. Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention. *Child Development*. 2007; 78(1):246–263. DOI: 10.1111/j.1467-8624.2007.00995.x [PubMed: 17328703]
- Bowers PG, Wolf M. Theoretical links among naming speed, precise timing mechanisms and orthographic skill in dyslexia. *Reading and Writing*. 1993; 5(1):69–85. DOI: 10.1007/BF01026919
- Byrne B, Samuelsson S, Wadsworth S, Hulslander J, Corley R, DeFries JC, ... Olson RK. Longitudinal twin study of early literacy development: Preschool through grade 1. *Reading and Writing*. 2007; 20(1/2):77–102. DOI: 10.1007/s11145-006-9019-9
- Chan LK. Relationship of motivation, strategic learning, and reading achievement in grades 5, 7, and 9. *Journal of Experimental Education*. 1994; 62(4):319–339. DOI: 10.1080/00220973.1994.9944138
- Choi I, Nisbett RE, Norenzayan A. Causal attribution across cultures: Variation and universality. *Psychological Bulletin*. 1999; 125(1):47–63. 0033-2909/99/\$3.00.
- Cox CB, Yang Y. Getting off on the wrong foot: Longitudinal effects of Hispanic students' stability attributions following poor initial test performance. *Learning and Individual Differences*. 2012; 22(1):123–127. DOI: 10.1016/j.lindif.2011.09.008
- Cuevas JA, Irving MA, Russell LR. Applied cognition: Testing the effects of independent silent reading on secondary students' achievement and attribution. *Reading Psychology*. 2014; 35(2):127–159. DOI: 10.1080/02702711.2012.675419
- Dweck, CS. *Self-theories: Their role in motivation, personality, and development*. Philadelphia, PA: Psychology; 2000.
- Frost J, Madsbjerg S, Niersdøe J, Olofsson Å, Sørensen PM. Semantic and phonological skills in predicting reading development: From 3–16 years of age. *Dyslexia*. 2005; 11(2):79–92. DOI: 10.1002/dys.292 [PubMed: 15918368]
- Fulmer SM, Frijters JC. A review of self-report and alternative approaches in the measurement of student motivation. *Educational Psychology Review*. 2009; 21(3):219–246. DOI: 10.1007/s10648-009-9107-x
- Gibb BE, Alloy LB. A prospective test of the hopelessness theory of depression in children. *Journal of Clinical Child and Adolescent Psychology*. 2006; 35(2):264–274. DOI: 10.1207/s15374424jccp3502_10 [PubMed: 16597222]
- Hulslander J, Olson RK, Willcutt EG, Wadsworth SJ. Longitudinal stability of reading-related skills and their prediction of reading development. *Scientific Studies of Reading*. 2010; 14(2):111–136. DOI: 10.1080/10888431003604058 [PubMed: 20563241]
- Kirby JR, Georgiou GK, Martinussen R, Parrila R. Naming speed and reading: From prediction to instruction. *Reading Research Quarterly*. 2010; 45(3):341–362. DOI: 10.1598/RRQ.45.3.4
- Kirby JR, Parrila RK, Pfeiffer SL. Naming speed and phonological awareness as predictors of reading development. *Journal of Educational Psychology*. 2003; 95(3):453–464. DOI: 10.1037/0022-0663.95.3.453
- Kistner JA, Osborne M, LeVerrier L. Causal attributions of learning-disabled children: Developmental patterns and relation to academic progress. *Journal of Educational Psychology*. 1988; 80(1):82–89. DOI: 10.1037/0022-0663.80.1.82
- Koenker, R. *Quantreg: Quantile regression (Version 5.29)*. 2016. Available at <https://cran.r-project.org/web/packages/quantreg/index.html>
- Koenker R, Bassett G Jr. Regression quantiles. *Econometrica*. 1978; 46(1):33–50. DOI: 10.2307/1913643
- Kurtz-Costes BE, Schneider W. Self-concept, attributional beliefs, and school achievement: A longitudinal analysis. *Contemporary Educational Psychology*. 1994; 19(2):199–216. DOI: 10.1006/ceps.1994.1017
- Lazowski RA, Hulleman CS. Motivation interventions in education: A meta-analytic review. *Review of Educational Research*. 2016; 86(2):602–640. DOI: 10.3102/0034654315617832
- Lervåg A, Bråten I, Hulme C. The cognitive and linguistic foundations of early reading development: A Norwegian latent variable longitudinal study. *Developmental Psychology*. 2009; 45(3):764–781. DOI: 10.1037/a0014132 [PubMed: 19413430]
- Little RJA. A test of missing completely at random for multivariate data with missing values. *Journal of the American Statistical Association*. 1988; 83(404):1198–1202.

- Marsh HW. Relationships among dimensions of self-attribution, dimensions of self-concept and academic achievements. *Journal of Educational Psychology*. 1984; 76(6):1291–1308. DOI: 10.1037/0022-0663.76.6.1291
- Marsh HW, Cairns L, Relich J, Barnes J, Debus RL. The relationship between dimensions of self-attribution and dimensions of self-concept. *Journal of Educational Psychology*. 1984; 76(1):3–32. DOI: 10.1037/0022-0663.76.1.3
- McAuley E, Duncan TE, Russell DW. Measuring causal attributions: The revised Causal Dimension Scale (CDSII). *Personality and Social Psychology Bulletin*. 1992; 18(5):566–573. DOI: 10.1177/0146167292185006
- McClure J, Meyer LH, Garisch J, Fischer R, Weir KF, Walkey FH. Students' attributions for their best and worst marks: Do they relate to achievement? *Contemporary Educational Psychology*. 2011; 36(2):71–81. DOI: 10.1016/j.cedpsych.2010.11.001
- Morgan PL, Fuchs D, Compton DL, Cordray DS, Fuchs LS. Does early reading failure decrease children's reading motivation? *Journal of Learning Disabilities*. 2008; 41(5):387–404. DOI: 10.1177/0022219408321112 [PubMed: 18768772]
- National Center for Education Statistics. Enrollment and percentage distribution of enrollment in public elementary and secondary schools, by race/ethnicity and region: Selected years, fall 1995 through fall 2021 [Table]. Washington, DC: National Center for Education Statistics, U.S. Department of Education; 2012. Retrieved from https://nces.ed.gov/programs/digest/d12/tables/dt12_044.asp
- Newcomer, PL. Standardized Reading Inventory. 2. Austin, TX: PRO-ED; 1999.
- Nicholls JG. The development of the concepts of effort and ability, perception of academic attainment, and the understanding that difficult tasks require more ability. *Child Development*. 1978; 49(3): 800–814. DOI: 10.2307/1128250
- Nicholls JG. Achievement motivation: Conceptions of ability, subjective experience, task choice, and performance. *Psychological Review*. 1984; 91(3):328–346. DOI: 10.1037/0033-295X.91.3.328
- Norton ES, Wolf M. Rapid automatized naming (RAN) and reading fluency: Implications for understanding and treatment of reading disabilities. *Annual Review of Psychology*. 2012; 63:427–452. DOI: 10.1146/annurev-psych-120710-100431
- O'Brien BA, Wolf M, Miller LT, Lovett MW, Morris R. Orthographic processing efficiency in developmental dyslexia: An investigation of age and treatment factors at the sublexical level. *Annals of Dyslexia*. 2011; 61(1):111–135. DOI: 10.1007/s11881-010-0050-9 [PubMed: 21213077]
- Olson RK, Keenan JM, Byrne B, Samuelsson S. Why do children differ in their development of reading and related skills? *Scientific Studies of Reading*. 2014; 18(1):38–54. DOI: 10.1080/10888438.2013.800521 [PubMed: 25104901]
- Ozernov-Palchik O, Gaab N. Tackling the 'dyslexia paradox': Reading brain and behavior for early markers of developmental dyslexia. *WIREs: Cognitive Science*. 2016; 7(2):156–176. DOI: 10.1002/wcs.1383 [PubMed: 26836227]
- Paunesku D, Walton GM, Romero C, Smith EN, Yeager DS, Dweck CS. Mind-set interventions are a scalable treatment for academic underachievement. *Psychological Science*. 2015; 26(6):784–793. DOI: 10.1177/0956797615571017 [PubMed: 25862544]
- Petrill SA, Deater-Deckard K, Thompson LA, DeThorne LS, Schatschneider C. Genetic and environmental effects of serial naming and phonological awareness on early reading outcomes. *Journal of Educational Psychology*. 2006; 98(1):112–121. DOI: 10.1037/0022-0663.98.1.112 [PubMed: 19444324]
- Petscher Y, Logan JA. Quantile regression in the study of developmental sciences. *Child Development*. 2014; 85(3):861–881. DOI: 10.1111/cdev.12190 [PubMed: 24329596]
- Petscher, Y., Logan, JA., Zhou, C. Extending conditional means modeling: An introduction to quantile regression. In: Petscher, Y., Schatschneider, C., Compton, DL., editors. *Applied quantitative analysis in education and the social sciences*. New York, NY: Routledge; 2013. p. 3-33.
- Pintrich, P. The role of goal orientation in self-regulated learning. In: Boekaerts, M., Pintrich, P.R., Zeidner, M., editors. *Handbook of self-regulation*. New York, NY: Academic; 2000. p. 451-502.

- Pintrich P. A motivational science perspective on the role of student motivation in learning and teaching contexts. *Journal of Educational Psychology*. 2003; 95(4):667–686. DOI: 10.1037/0022-0663.95.4.667
- Pintrich P, Anderman EM, Klobucar C. Intraindividual differences in motivation and cognition in students with and without disabilities. *Journal of Learning Disabilities*. 1994; 27(6):360–370. DOI: 10.1177/002221949402700603 [PubMed: 8051509]
- Relich, J. Unpublished doctoral dissertation. The University of Sydney; NSW, Australia: 1983. Attribution, affect variables and achievement in arithmetic.
- Revelle, W. Psych: Procedures for personality and psychological research (Version 00). 2016. Available at <https://CRAN.R-project.org/package=psych> Version = 1.6.9
- Revelle W, Zinbarg RE. Coefficients alpha, beta, omega, and the glb: Comments on Sijsma. *Psychometrika*. 2009; 74(1):145–154. DOI: 10.1007/s11336-008-9102-z
- Schatschneider D, Fletcher JM, Francis DJ, Carlson CD, Foorman BR. Kindergarten prediction of reading skills: A longitudinal comparative analysis. *Journal of Educational Psychology*. 2004; 96(2):265–282. DOI: 10.1037/0022-0663.96.2.265
- Sijsma K. On the use, the misuse, and the very limited usefulness of Cronbach's alpha. *Psychometrika*. 2009; 74(1):107–120. DOI: 10.1007/s11336-008-9101-0 [PubMed: 20037639]
- Snow, RE., Corno, L., Jackson, DN. Individual differences in affective and conative functions. In: Berliner, DC., Calfee, RC., editors. *Handbook of educational psychology*. New York, NY: Macmillan; 1996. p. 243–310.
- Stanovich KE. Matthew effects in reading: Some consequences of individual differences in the acquisition of literacy. *Reading Research Quarterly*. 1986; 21(4):360–407. DOI: 10.1598/RRQ.21.4.1
- Stipek, DJ. *Motivation to learn: From theory to practice*. 2. Boston, MA: Allyn & Bacon; 1993.
- Swinton AD, Kurtz-Costes B, Rowley SJ, Okeke-Adeyanju N. A longitudinal examination of African American adolescents' attributions about achievement outcomes. *Child Development*. 2011; 82(5):1486–1500. DOI: 10.1111/j.1467-8624.2011.01623.x [PubMed: 21793818]
- Ten Berge JMF, So an G. The greatest lower bound to the reliability of a test and the hypothesis of unidimensionality. *Psychometrika*. 2004; 69(4):613–625. DOI: 10.1007/BF02289858
- Thompson PA, Hulme C, Nash HM, Gooch D, Hayiou-Thomas E, Snowling MJ. Developmental dyslexia: Predicting individual risk. *The Journal of Child Psychology and Psychiatry*. 2015; 56(9):976–987. DOI: 10.1111/jcpp.12412 [PubMed: 25832320]
- Tighe EL, Schatschneider C. A quantile regression approach to understanding the relations among morphological awareness, vocabulary, and reading comprehension in adult basic education students. *Journal of Learning Disabilities*. 2016; 49(4):424–436. DOI: 10.1177/0022219414556771 [PubMed: 25351773]
- Toland J, Boyle C. Applying cognitive behavioural methods to retrain children's attributions for success and failure in learning. *School Psychology International*. 2008; 29(3):286–302. DOI: 10.1177/0143034308093674
- Torgesen, JK., Wagner, RK., Rashotte, CA. *Test of Word Reading Efficiency*. Austin, TX: PRO-ED; 1999.
- U.S. Census Bureau. *School enrollment in the United States: 2015*. Washington, DC: Author; 2015. Retrieved from <https://www.census.gov/hhes/school/>
- U.S. Census Bureau. *Educational attainment in the United States: 2012*. Washington, DC: Author; 2016. (Rev. ed.) Retrieved from <https://www.census.gov/data/tables/2012/demo/educational-attainment/cps-detailed-tables.html>
- van den Bos KP, Zijlstra BJH, Iutje Spelberg HC. Life-span data on continuous-naming speeds of numbers, letters, colors, and pictured objects, and word-reading speed. *Scientific Studies of Reading*. 2002; 6(1):25–49. DOI: 10.1207/S1532799XSSR0601_02
- Wagner RK. Causal relations between the development of phonological processing abilities and the acquisition of reading skills: A meta-analysis. *Merrill-Palmer Quarterly*. 1988; 34(3):261–279.
- Wagner RK, Torgesen JK. The nature of phonological processing and its causal role in the acquisition of reading skills. *Psychological Bulletin*. 1987; 101(2):192–212. DOI: 10.1037/0033-2909.101.2.192

- Wagner, R.K., Torgesen, J.K., Rashotte, C.A. Comprehensive Test of Phonological Processing (CTOPP). Austin, TX: PRO-ED; 1999.
- Wagner R.K., Torgesen J.K., Rashotte C.A., Hecht S.A., Barker T.A., Burgess S.R., ... Garon T. Changing relations between phonological processing abilities and word-level reading as children develop from beginning to skilled readers: A 5-year longitudinal study. *Developmental Psychology*. 1997; 33(3):468–479. DOI: 10.1037/0012-1649.33.3.468 [PubMed: 9149925]
- Weiner B. Attribution theory, achievement motivation, and the educational process. *Review of Educational Research*. 1972; 42(2):203–215.
- Weiner, B. An attributional theory of motivation and emotion. New York, NY: Springer-Verlag; 1986.
- Weiner B. The development of an attribution-based theory of motivation: A history of ideas. *Educational Psychologist*. 2010; 45(1):28–36. DOI: 10.1080/00461520903433596
- Wigfield A. Children's attributions for success and failure: Effects of age and attentional focus. *Journal of Educational Psychology*. 1988; 80(1):76–81. DOI: 10.1037/0022-0663.80.1.76
- Wimmer H, Landerl K, Linortner R, Hummer P. The relationship of phonemic awareness to reading acquisition: More consequence than precondition but still important. *Cognition*. 1991; 40(3):219–249. DOI: 10.1016/0010-0277(91)90026-Z [PubMed: 1786676]
- Wolf M. Naming, reading, and the dyslexias: A longitudinal overview. *Annals of Dyslexia*. 1984; 34(1):87–115. DOI: 10.1007/BF02663615 [PubMed: 24243296]
- Wolf M, Bowers P.G., Biddle K. Naming-speed processes, timing, and reading: A conceptual review. *Journal of Learning Disabilities*. 2000; 33(4):387–407. DOI: 10.1177/002221940003300409 [PubMed: 15493099]
- Wolf, M., Denckla, M.B. Rapid Automatized Naming & Rapid Alternating Stimulus Tests. Austin, TX: PRO-ED; 2005.
- Wolters C.A., Denton C.A., York M.J., Francis D.J. Adolescents' motivation for reading: Group differences and relation to standardized achievement. *Reading and Writing*. 2014; 27(3):503–533. DOI: 10.1007/s11145-013-9454-3
- Ziegler J.C., Goswami U. Reading acquisition, developmental dyslexia, and skilled reading across languages: A psycholinguistic grain size theory. *Psychological Bulletin*. 2005; 131(1):3–29. DOI: 10.1037/0033-2909.131.1.3 [PubMed: 15631549]

FIGURE 1.

Relation Between Attributions to Ability for Success and Nonword Decoding Ability (TOWRE Phonemic Decoding), Controlling for Other Attributions, Phonological Awareness, Rapid Automatized Naming, and Age

Note. TOWRE = Test of Word Reading Efficiency. The error bars represent 95% confidence intervals.

FIGURE 2.

Relation Between Phonological Blending (Comprehensive Test of Phonological Processing Blending Words) and Nonword Decoding Ability (TOWRE Phonemic Decoding Efficiency), Controlling for Attributions, Rapid Automatized Naming, and Age

Note. TOWRE = Test of Word Reading Efficiency. The error bars represent 95% confidence intervals.

FIGURE 3.

Relation Between Rapid Automatized Naming (Letters) and Single-Word Identification Fluency (TOWRE Sight Word Efficiency), Controlling for Attributions, Phonological Blending, and Age

Note. TOWRE = Test of Word Reading Efficiency. The error bars represent 95% confidence intervals.

TABLE 1

Description of the Sample

Characteristic/measure	<i>M</i>	<i>SD</i>
Age	11.6	2.1
<i>Test of Word Reading Efficiency</i>		
• Sight Word Efficiency standard score ^a	94.7	13.3
• Phonemic Decoding Efficiency standard score ^a	93.7	15.2
<i>Standardized Reading Inventory, second edition</i>		
• Comprehension standard score ^b	7.6	4.0
• Word recognition accuracy standard score ^b	7.1	4.1
• Reading quotient standard score ^a	83.9	22.7
Male (proportion)	.525	
Hispanic (proportion)	.699	
African American (proportion)	.335	

^aStandard score normed to $M = 100$, $SD = 15$.

^bStandard score normed to $M = 10$, $SD = 00$.

TABLE 2

Descriptive Statistics and Correlations Among Study Variables ($N = 1,105$)

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. TOWRE Sight Word Efficiency	—												
2. TOWRE Phonemic Decoding Efficiency	.83**	—											
3. SRI-2 word recognition accuracy	.78**	.83**	—										
4. SRI-2 passage comprehension	.69**	.65**	.79**	—									
5. Comprehensive Test of Phonological Processing Blending Words	.42**	.42**	.46**	.50**	—								
6. Rapid Automatized Naming Test letters	.73**	.61**	.60**	.52**	.32**	—							
7. SAS success to ability	.27**	.30**	.27**	.22**	.10**	.20*	—						
8. SAS success to effort	-.09**	-.09**	-.11**	-.11**	-.10**	-.06*	.45**	—					
9. SAS success to external causes	-.32**	-.28**	-.30**	-.30**	-.20**	-.23**	-.20**	-.08**	—				
10. SAS failure to ability	-.18**	-.19**	-.15**	-.13**	-.06*	-.13**	-.54**	-.20**	.24**	—			
11. SAS failure to effort	.03	.03	.06*	.07*	.04	.07*	-.17**	-.17**	.17**	.46**	—		
12. SAS failure to external causes	-.12**	-.07*	-.08**	-.07*	-.03	-.12**	-.01	-.04	.31**	.17**	.14**	—	
13. Age	.54**	.41**	.50**	.50**	.26**	.51**	-.06*	-.23**	-.16**	.17**	.27**	-.04	—
<i>M</i>	64.98	30.93	26.77	46.64	13.03	26.25	3.75	4.09	2.63	2.22	2.77	2.71	11.63
<i>SD</i>	16.78	14.58	13.42	23.08	3.82	8.42	0.91	0.70	0.82	0.88	0.79	0.69	2.12

Note. SAS = Sydney Attribution Scale; SRI-2 = Standardized Reading Inventory, second edition; TOWRE = Test of Word Reading Efficiency. All descriptive statistics are based on raw scores, except Rapid Automatized Naming Test letters, which is time in seconds to complete the task.

* $p < .05$.

** $p < .01$.

TABLE 3
Standardized Regression Coefficients for Standardized Reading Inventory (Second Edition) Word Recognition Accuracy

Quantile	Correlation	SE	Lower	Upper	t(1)	Equal coefficients across quantiles: $\chi^2(18)$
Success to ability						
20th	.16	.028	.11	.22	5.89***	20.02
50th	.20	.030	.15	.26	6.83***	
80th	.21	.034	.14	.27	5.98***	
Success to effort						
20th	-.08	.028	-.14	-.03	-3.01**	15.35
50th	-.14	.028	-.19	-.08	-4.98***	
80th	-.10	.024	-.15	-.05	-4.21***	
Success to external causes						
20th	-.13	.024	-.18	-.08	-5.35***	23.98
50th	-.10	.026	-.15	-.05	-3.83***	
80th	-.05	.031	-.12	.01	-1.71	
Failure to ability						
20th	-.05	.030	-.11	.01	-1.75	31.65*
50th	-.04	.031	-.11	.02	-1.43	
80th	-.02	.041	-.10	.06	-0.51	
Failure to effort						
20th	.05	.026	.00	.11	2.07*	17.66
50th	.02	.027	-.04	.07	0.67	
80th	-.04	.036	-.11	.03	-1.11	
Failure to external causes						
20th	.03	.024	-.01	.08	1.42	20.27
50th	-.02	.025	-.07	.03	-0.87	
80th	.02	.033	-.04	.09	0.76	
Rapid automatized naming						
						36.93***

Quantile	Correlation	SE	Lower	Upper	t(1)	Equal coefficients across quantiles: $\chi^2(18)$
20th	.39	.030	.33	.45	13.16***	
50th	.34	.030	.28	.40	11.28***	
80th	.30	.035	.23	.37	8.66***	
Phonological awareness						72.91***
20th	.16	.026	.11	.21	6.11***	
50th	.25	.025	.20	.30	10.00***	
80th	.35	.032	.29	.41	10.95***	
Age						39.58**
20th	.19	.030	.13	.24	6.17***	
50th	.25	.031	.19	.31	8.29***	
80th	.30	.038	.23	.37	7.98***	

* $p < .05$.
** $p < .01$.
*** $p < .001$.

TABLE 4
Standardized Regression Coefficients for Standardized Reading Inventory (Second Edition) Passage Comprehension

Quantile	Correlation	SE	Lower	Upper	t(1)	Equal coefficients across quantiles: $\chi^2(18)$
Success to ability						35.97**
20th	.14	.042	.06	.22	3.32***	
50th	.20	.035	.13	.27	5.66***	
80th	.15	.036	.08	.23	4.24***	
Success to effort						29.21*
20th	-.14	.038	-.21	-.06	-3.62***	
50th	-.10	.027	-.16	-.05	-3.88***	
80th	-.08	.026	-.13	-.02	-2.87**	
Success to external causes						10.93
20th	-.10	.032	-.16	-.04	-3.10**	
50th	-.13	.029	-.19	-.08	-4.57***	
80th	-.12	.030	-.17	-.06	-3.84***	
Failure to ability						10.79
20th	-.05	.044	-.14	.03	-1.22	
50th	-.04	.038	-.11	.04	-1.01	
80th	-.03	.038	-.11	.04	-0.82	
Failure to effort						14.61
20th	-.01	.037	-.08	.06	-0.27	
50th	.04	.032	-.02	.11	1.28	
80th	.01	.032	-.05	.07	0.30	
Failure to external causes						25.08
20th	.01	.031	-.05	.07	0.43	
50th	-.02	.029	-.08	.04	-0.77	
80th	-.01	.028	-.06	.05	-0.23	
Rapid automatized naming						20.91

Quantile	Correlation	SE	Lower	Upper	t(1)	Equal coefficients across quantiles: $\chi^2(18)$
20th	.19	.040	.12	.27	4.86***	
50th	.24	.035	.17	.31	6.82***	
80th	.22	.034	.15	.29	6.38***	
Phonological awareness						13.12
20th	.29	.035	.22	.36	8.40***	
50th	.31	.030	.25	.37	10.56***	
80th	.35	.030	.29	.41	11.61***	
Age						48.42***
20th	.22	.040	.14	.30	5.54***	
50th	.30	.035	.23	.37	8.48***	
80th	.37	.036	.30	.44	10.49***	

* $p < .05$.
** $p < .01$.
*** $p < .001$.

TABLE 5
Standardized Regression Coefficients for Test of Word Reading Efficiency Sight Word Efficiency

Quantile	Correlation	SE	Lower	Upper	t(1)	Equal coefficients across quantiles: $\chi^2(18)$
Success to ability						44.00***
20th	.17	.048	.08	.26	3.53***	
50th	.17	.023	.13	.22	7.70***	
80th	.15	.023	.11	.20	6.81***	
Success to effort						23.51
20th	-.08	.040	-.16	-.00	-2.04*	
50th	-.09	.018	-.13	-.06	-5.08***	
80th	-.07	.017	-.10	-.04	-4.19***	
Success to external causes						25.89
20th	-.14	.038	-.21	-.07	-3.68***	
50th	-.11	.021	-.15	-.07	-5.13***	
80th	-.05	.018	-.08	-.01	-2.67**	
Failure to ability						22.16
20th	-.06	.048	-.16	.03	-1.35	
50th	-.05	.016	-.08	-.02	-3.36***	
80th	-.04	.020	-.08	.00	-1.84	
Failure to effort						11.81
20th	.01	.041	-.07	.09	0.32	
50th	-.01	.018	-.05	.02	-0.65	
80th	.04	.018	-.08	-.01	-2.48*	
Failure to external causes						18.37
20th	.03	.037	-.05	.10	0.72	
50th	-.02	.017	-.05	.01	-1.18	
80th	-.03	.016	-.06	.00	-1.82	

Quantile	Correlation	SE	Lower	Upper	t(1)	Equal coefficients across quantiles: $\chi^2(18)$
Rapid automatized naming						
20th	.56	.041	.48	.64	13.49***	84.54***
50th	.45	.017	.42	.49	26.37***	
80th	.38	.018	.35	.42	21.76***	
Phonological awareness						
20th	.19	.036	.12	.26	5.22***	22.63
50th	.15	.019	.11	.18	7.70***	
80th	.10	.017	.07	.13	5.93***	
Age						
20th	.19	.044	.11	.28	4.43***	19.46
50th	.22	.019	.18	.25	11.28***	
80th	.26	.019	.22	.29	13.21***	

* $p < .05$.
** $p < .01$.
*** $p < .001$.

TABLE 6
Standardized Regression Coefficients for Test of Word Reading Efficiency Phonemic Decoding Efficiency

Quantile	Correlation	SE	Lower	Upper	t(1)	Equal coefficients across quantiles: $\chi^2(18)$
Success to ability						32.16 *
.20	.17	.028	.11	.23	6.02 ***	
.50	.24	.035	.17	.31	6.74 ***	
.80	.31	.026	.26	.36	11.84 ***	
Success to effort						10.18
.20	-.11	.029	-.16	-.05	-3.64 ***	
.50	-.12	.030	-.18	-.06	-3.88 ***	
.80	-.15	.020	-.19	-.11	-7.32 ***	
Success to external causes						20.79
.20	-.07	.026	-.12	-.02	-2.79 **	
.50	-.08	.031	-.14	-.02	-2.57 *	
.80	-.06	.026	-.11	-.01	-2.23 *	
Failure to ability						29.81 *
.20	-.07	.025	-.12	-.02	-2.83 **	
.50	-.06	.036	-.13	.01	-1.56	
.80	.03	.029	-.03	.08	0.88	
Failure to effort						23.61
.20	.03	.021	-.01	.07	1.47	
.50	.05	.032	-.02	.11	1.46	
.80	-.00	.022	-.05	.04	-0.15	
Failure to external causes						16.14
.20	.04	.026	-.01	.09	1.68	
.50	.01	.029	-.05	.07	0.34	
.80	.00	.019	-.04	.04	0.12	

Quantile	Correlation	SE	Lower	Upper	t(1)	Equal coefficients across quantiles: $\chi^2(18)$
Rapid automatized naming						
.20	.47	.027	.41	.52	17.21***	49.78***
.50	.46	.032	.39	.52	14.30***	
.80	.39	.024	.34	.43	16.03***	
Phonological awareness						
.20	.20	.024	.15	.25	8.47***	35.96**
.50	.26	.029	.20	.32	8.96***	
.80	.17	.024	.12	.22	6.98***	
Age						
.20	.09	.030	.04	.15	3.22**	14.15
.50	.13	.033	.06	.19	3.80***	
.80	.17	.024	.12	.22	6.98***	

* $p < .05$.
** $p < .01$.
*** $p < .001$.

TABLE 7

Post Hoc Quantile Comparisons

Quantile	SRI-2 Word Recognition Accuracy	SRI-2 Passage Comprehension	TOWRE Sight Word Efficiency	TOWRE Phonemic Decoding Efficiency
<i>Success to ability</i>				
50th vs. 20th		2.43	0.01	3.81
80th vs. 50th	NT	1.56	0.79	5.17 [*]
80th vs. 20th		0.11	0.12	15.31 ^{***}
<i>Success to effort</i>				
50th vs. 20th		0.95		
80th vs. 50th	NT	1.19	NT	NT
80th vs. 20th		2.36		
<i>Success to external causes</i>				
50th vs. 20th				
80th vs. 50th	NT	NT	NT	NT
80th vs. 20th				
<i>Failure to ability</i>				
50th vs. 20th	0.06			0.19
80th vs. 50th	0.41	NT	NT	6.02 [*]
80th vs. 20th	0.50			7.20 [*]
<i>Failure to effort</i>				
50th vs. 20th				
80th vs. 50th	NT	NT	NT	NT
80th vs. 20th				
<i>Failure to external causes</i>				
50th vs. 20th				
80th vs. 50th	NT	NT	NT	NT
80th vs. 20th				
<i>Rapid automatized naming</i>				
50th vs. 20th	3.03		8.01 ^{**}	0.90

Quantile	SRI-2 Word Recognition Accuracy	SRI-2 Passage Comprehension	TOWRE Sight Word Efficiency	TOWRE Phonemic Decoding Efficiency
80th vs. 50th	1.59	NT	15.22 ***	5.52 *
80th vs. 20th	5.55 *		18.03 ***	5.08 *
Phonological awareness				
50th vs. 20th	14.36 ***			4.40 *
80th vs. 50th	10.88 ***	NT	NT	10.71 **
80th vs. 20th	29.65 ***			1.03
Age				
50th vs. 20th	5.00 *	3.94 *		
80th vs. 50th	1.88	4.47 *	NT	NT
80th vs. 20th	7.57 **	10.41 **		

Note. NT = not tested because the overall test for quantile equality was nonsignificant. SRI-2 = Standardized Reading Inventory, second edition; TOWRE = Test of Word Reading Efficiency.

* $p < .05$.

** $p < .01$.

*** $p < .001$.