Relations Among Motivation, Executive Functions, and Reading Comprehension: Do They Differ for Students With and Without Reading Difficulties?

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Abstract

Purpose: We examined the extent to which achievement goals predict reading comprehension, measured by two response formats (free recall and constructed response), and how these relations differ for students with and without reading difficulties (RD). We further explored how executive functions (working memory and semantic verbal fluency) mediate the relations between achievement goals and reading comprehension.

Method: We fit multigroup structural equation models with data from monolingual English-speaking fifth graders (n = 146 for RD; n = 109 for non-RD) in the United States.

Results: Results revealed that achievement goals predict reading comprehension as measured by free recall but not by the constructed response format, and this pattern was moderated by RD status. For students with RD, mastery goals positively predicted performance on free recall, a relationship that was completely mediated by semantic verbal fluency, whereas performance-approach goals were negatively related to free recall. For students without RD, however, achievement goals did not predict reading comprehension as measured by either assessment format.

Conclusion: Our findings underscore the need to account for motivational differences in reading comprehension and the importance of fostering mastery goals when teaching reading comprehension, particularly for students with RD.

Keywords: achievement goals, executive functions, reading difficulties, reading comprehension, motivation

Relations Among Motivation, Executive Functions, and Reading Comprehension: Do They Differ for Students With and Without Reading Difficulties?

Proficient reading comprehension is critical in learning across various domains within and outside schools. However, mastery of reading comprehension is neither acquired naturally nor easily developed for many students with reading difficulties (RD). Such difficulties reflect the complexity of the reading comprehension process, in which various cognitive and linguistic skills must be orchestrated to create a coherent representation of the text (Duke & Cartwright, 2021; Kintsch, 1998). Moreover, motivation might further complicate this process as significant motivation is required for readers to effectively utilize their cognitive and linguistic resources to actively engage with text (Guthrie & Wigfield, 1999; Wigfield et al., 2017).

A substantial body of research documents that motivation predicts reading comprehension beyond cognitive and linguistic factors (Anmarkrud & Bråten, 2009) and even beyond prior reading comprehension level (Guthrie et al., 2007; Logan et al., 2011). Findings from these studies highlight the facilitative role of intrinsic motivation and the inhibiting role of extrinsic motivation (e.g., to achieve high grades or outperform others; Hebbecker et al., 2019; Wang & Guthrie, 2004) in the process of reading comprehension. Nonetheless, relatively little is known about whether motivation contributes to reading comprehension differentially for students with and without RD (e.g., Lee & Zentall, 2012) and the mechanism through which motivation explains reading comprehension in readers with different reading abilities.

Given that reading comprehension is a goal-directed process where a reader actively engages with texts to read for a particular purpose (Duke & Cartwright, 2021), we focused on the role of achievement goals. A reader might engage in reading to learn (mastery goals) or to perform better (performance-approach goals) or not to perform worse (performance-avoidance

goals) than others on a test. We examined how these three types of achievement goals are related to reading comprehension and whether these relations vary depending on the response format of reading comprehension (free recall vs. constructed response) assessments and on students' RD status. We also explored the mediating role of executive functions (working memory and semantic verbal fluency) as critical cognitive processes shaped by students' goals.

Our goal is to address these gaps in the literature and to advance our understanding of the various sources of reading comprehension difficulties implicated in different formats of reading comprehension assessments, as well as their relative importance for students with RD. Such knowledge will not only have implications for intervention design but also for advancing the science of reading by explicating the relations among motivation, executive function, and reading comprehension in a single model (see Duke & Cartwright, 2021) and by further imposing qualifications on existing theories based on types of reading comprehension assessment and students' reading level.

Achievement Goals and Reading Comprehension

Achievement goals refer to aims and purposes for engaging in achievement-related behaviors (Elliott & Dweck, 1988). According to the hierarchical model of achievement motivation (Elliot & Church, 1997), achievement goals serve as a cognitive schema to navigate mental processes and achievement behaviors. Students with mastery goals focus on improving their competence and task mastery, and, thus, they tend to be more intrinsically motivated and enjoy challenges even after failure. The benefits of endorsing mastery goals, such as deep cognitive strategy use and efforts, have been well-documented in the literature (Urdan & Kaplan, 2020). Contrarily, students with performance goals focus on proving rather than improving their competence. They aim to outperform others (i.e., performance-approach goals) or avoid

underperforming relative to others (i.e., performance-avoidance goals). They tend to be extrinsically motivated and interested in achieving higher grades, receiving favorable recognition from others, and winning competitions (Elliot, 2020). Whether performance-approach goals are adaptive has been a contentious issue in the achievement goal literature (Hulleman et al., 2010). Students with performance-approach goals might fare well on graded performance (e.g., achieving high course grades), but they tend to utilize surface-level cognitive strategies and demonstrate maladaptive response patterns when faced with challenges (Senko et al., 2013). Performance-avoidance goals are marked by similar negative response patterns to challenges.

Despite the prominent role achievement goal theory has played in understanding achievement motivation in the educational psychology literature (Urdan & Kaplan, 2020), Schiefele et al. (2012) have noted that very few studies have focused on achievement goals in relation to reading comprehension. Findings from a small number of studies have been inconsistent. A few studies documenting the relation between achievement goals and reading comprehension found the link to be negligible in a combined sample of struggling and typical readers (Wolters et al., 2014). Nevertheless, other studies have found achievement goals to be significant predictors of reading comprehension even after controlling for student-level covariates, including demographic, prior achievement, and other motivational variables. With respect to mastery goals, Law (2011) found them to positively predict reading comprehension in unselected samples of students; however, performance goals had a null relation with reading comprehension. In other cases, mastery goals had an indirect relation to reading comprehension via engagement or strategy use in struggling readers (Cho et al., 2019) and an unselected sample of readers (Mizelle & Carr, 1997). With respect to performance goals, Cho et al. (2018, 2019) noted the detrimental role of both performance-approach and performance-avoidance goals in

struggling readers, such that performance-approach goals were negatively predictive of reading comprehension (Cho et al., 2019) and performance-avoidance goals explained poor reading comprehension when coupled with low self-efficacy (Cho et al., 2018). Yet, other studies involving students with mixed reading abilities report the effects of performance goals on reading comprehension to be minimal (Law, 2011; Wolters et al., 2014). Taken together, the findings are inconclusive within this small set of studies, in part, because of the heterogeneity in the reading levels of students in those studies and in part because none of the prior studies directly examined how the role of achievement goals might differ based on students' reading levels.

Achievement Goals of Students With and Without Reading Difficulties

Motivation may have a differential association with reading comprehension depending on students' reading levels. Two contrasting hypotheses have been proposed (Klauda & Guthrie, 2015). The cognitive challenge hypothesis implies that the relationship between motivation and reading comprehension is stronger for students without RD than for students with RD because reading difficulties are mainly caused by severe cognitive challenges. Thus, motivation contributes little to explain individual differences in reading comprehension (Klauda & Guthrie, 2015). In contrast, the motivation challenge hypothesis posits that low motivation results in less effort and poor attention, thus making a critical contribution to reading failure. From this point of view, the association between motivation and reading is stronger for students with RD than for those without RD (Logan et al., 2011).

More specific to achievement goals, the achievement goal theory of Dweck and Leggett (1988) posits that differences in motivational patterns created by different achievement goals do not manifest themselves when students are in success situations, but that they do so only when

students encounter failure. In line with this theorization, prior experimental studies have found that the effects of achievement goals on performance become more evident when students are engaged in cognitively demanding tasks (Avery & Smillie, 2013; Crouzevialle & Butera, 2013; Lee et al., 2021). Thus, we expect that the effects of achievement goals on reading comprehension will be greater for students with RD, and for whom reading is more cognitively demanding, than they are for students without RD. More specifically, students with RD are more likely to be susceptible to negative consequences of performance goal pursuits. Prior studies have reported that students with RD are likely to pursue performance-avoidance goals due to accumulated experiences of failure (Cho et al., 2022; Baird et al., 2009; Botsas & Padeliadu, 2003), which will further lead them to adopt maladaptive strategies (Midgley & Urdan, 2001; Urdan, 2004). Additionally, performance-approach goals might be associated with poor reading comprehension outcomes in students with RD, especially when coupled with low self-efficacy (Cho et al., 2015, 2018; Tabassam & Grainger, 2002). In contrast, the benefits of mastery goals may be magnified in students with RD, as intrinsic motivation effects are found to be greater for poor readers than for typical readers (Logan et al., 2011).

Types of Reading Comprehension Assessment

Previous studies examining the relations between achievement goals and reading comprehension have used various types of comprehension assessments, which vary in terms of the cognitive processes involved. Given that achievement goals guide the cognitive processes used by students engaged in goal-directed reading behavior (Pintrich, 2000a), heterogeneity in reading comprehension assessments used in prior studies may have contributed to the inconsistency in how achievement goals are related to reading comprehension.

Just like how underlying cognitive processes involved in answering reading comprehension questions vary depending on the type of reading comprehension assessments (Cutting & Scarborough, 2006; Hua & Keenan, 2017), several studies have found that the relations between motivation and reading comprehension differ based on the format of the reading comprehension assessment (Andreassen & Bråten, 2010; Guthrie & Wigfield, 2005; Schwabe et al., 2015). In this study, we focused on two widely used formats of classroom reading assessments: free recall and constructed response formats. A free recall format assesses the number of idea units a student can recall and is one of the most widely used measures of reading comprehension for students with learning disabilities (Reed & Vaughn, 2012). A brief constructed response format requires readers to identify information explicitly stated in the text or make inferences and is also commonly utilized in reading tests in schools (Applegate et al., 2002).

A comparison between these two formats is important because they involve different encoding and retrieval processes of textual information and are affected by achievement goals differently (Barker et al., 2002; Graham & Golan, 1991; Ikeda et al., 2015, 2021). For example, for students to perform well on free recall items, students need to actively construct situation models by relying on relational processes that encode shared features across items. Then, students need to semantically organize details around the main ideas and efficiently retrieve the text information. These cognitive processes required to freely recall textual information are goal-oriented and demand a substantial amount of effort and attention, fueled by the student's mastery goal. Thus, the role of mastery goals may be magnified in the free recall format. By contrast, in the constructed response format, readers retrieve item-specific information prompted by the questions, and the role of mastery goals would become less salient in the constructed response

format than that in the free recall format. In fact, experimental research suggests that when a mastery goal is primed, students perform better on recall tests and remember the items for longer periods compared to when a performance-approach goal is primed (Graham & Golan, 1991; Murayama & Elliot, 2011).

Underlying Cognitive Mechanisms

Beyond understanding under what conditions achievement goals are important, elucidating the cognitive mechanism through which achievement goals explain individual differences in reading comprehension can further enhance our understanding of why achievement goals are essential in the reading comprehension process. Based on the well-established evidence that supports the relation between executive functions and reading comprehension (Butterfuss & Kendeou, 2018), and consistent with the active view of reading model (Duke & Cartwright, 2021), which depicts domain-specific executive function as a mediator between motivation and reading outcomes (Duke & Cartwright, 2021), we sought to understand how domain-specific executive function processes mediate the associations between achievement goals and reading comprehension outcomes. This framework also aligns with a recent understanding of executive function as being malleable, in which its development is guided by goals (Doebel, 2020). Therefore, we postulate that domain-specific executive function processes, particularly working memory and semantic verbal fluency, have intriguing mediational roles in explaining the association between achievement goals and reading comprehension.

Achievement goals regulate cognition and goal-directed behavior (Pintrich, 2000a), including executive function processes, by allocating limited working memory resources efficiently to achieve the goal. Working memory as a limited cognitive resource functions as one

of the key mechanisms to explicate the phenomenon (Ma et al., 2014; Navon, 1984).While working memory resources can be allocated to a wide range of cognitive processes, there is a limited quantity of resources one can utilize to perform a task. This implies that if a certain mental process requires a substantial level of cognitive resources, it could occur at the expense of other processes, thus interfering with performance due to insufficient cognitive resources for those competing processes (Reynolds, 2000). To apply this mechanism to achievement goals, setting mastery goals can help maintain attention to the task at hand, with cognitive resources allocated mainly to learning textual information. In contrast, performance goals can depreciate task performance because they evoke task-irrelevant thoughts (e.g., worries and evaluating the perception of one's performance) thereby depleting limited working memory resources otherwise used for text comprehension.

Several experimental studies have corroborated this resource-based view explaining how achievement goals can impact working memory performance by demonstrating higher working memory performance in the mastery goal manipulated condition (e.g., perform to get better) compared to a performance goal condition (i.e., perform to demonstrate their ability; Avery & Smillie, 2013; Crouzevialle & Butera, 2013; Crouzevialle et al., 2015; Lee et al., 2021). These studies have found that a task-focused nature of mastery goals concentrates individuals on the task in full force, whereas ego-focused feature of performance goals distracts individuals from the task with self-awareness and worries about negative outcomes thereby deteriorating their working memory performance. Similarly, this resource-based view leads us to reason that the indirect paths from achievement goals to reading comprehension through executive function, especially working memory, would be even stronger for students with RD because they have been shown to have limited working memory capacity than students without RD (Swanson et al.,

2009). Since students with RD require a greater level of cognitive resources to decode and comprehend text, even a small misallocation of cognitive resources to task-irrelevant thoughts can hamper their reading comprehension.

In addition to working memory, semantic verbal fluency can mediate the relationship between achievement goals and reading comprehension. Although prior research on semantic verbal fluency in relation to achievement goals and reading comprehension is limited, we were particularly interested in the mediating role of semantic verbal fluency as an indicator of language-specific executive function for several reasons. First, we considered sematic verbal fluency as tapping language-specific executive function processes (Rande et al., 2002; Swanson, 2008). Semantic verbal fluency taps the ability to efficiently access and retrieve lexical information because the task requires students to produce as many words that belong to a certain semantic category (e.g., animals) as they can in a given time (typically 1 min) without repetition and without using proper nouns (e.g., pet names). This task taxes the executive function process because an individual engages in a goal-directed behavior that requires controlled attention, inhibiting competing responses, and error monitoring. For this reason, semantic verbal fluency has been found to be associated with both vocabulary and executive function processes in individuals with language disorders (Bose et al., 2017) and without disorders (Aita et al., 2018; Escobar et al., 2018; Shao et al., 2014). Second, the cognitive process implicated in the semantic verbal fluency task is central to building a coherent mental representation of a text and mirrors the cognitive skills required for successful free recall performance. They both rely on efficient encoding and retrieval of categorically organized semantic information while inhibiting irrelevant responses. Third, this cognitive process is often considered a hallmark of the learning strategies associated with mastery goal pursuits, such as elaboration and organization (Pintrich,

2000b). Several experimental studies have found that mastery goal pursuits promote relational memory processes (Ikeda et al., 2015; Murayama & Elliot, 2011), which facilitates the retrieval of semantically organized information. For these reasons, we expect to see mastery goals positively predict performance on a semantic verbal fluency task, which then predicts reading comprehension performance on a free recall format.

Present Study

Taken together, the purpose of this study was twofold. We first aimed to explore whether achievement goals differentially predict reading comprehension, as measured by two response formats, for students with and without RD, while controlling for robust predictors of reading comprehension, extant vocabulary, and oral reading fluency (Figure 1a). We expected to find a general pattern of mastery goals being positively associated with reading comprehension, and performance goals being negatively related to reading comprehension. However, we hypothesized that the contribution of achievement goals to reading comprehension would be greater for students with RD than for those without RD because the effects of motivation (achievement goals) manifest themselves when students are confronted with cognitively challenging tasks (Avery et al., 2013; Barker et al., 2002; Graham & Golan, 1991). Given the prior findings on the contribution of mastery goals to the relational memory process, we hypothesized that the benefit of mastery goals would be magnified when reading comprehension was measured with a free recall format. Second, as an exploratory arm, we sought to delineate the cognitive mechanism of this relationship, focusing on the role of working memory and semantic verbal fluency (Figure 1b). We expected the relation between mastery goals and reading comprehension to be partially explained by the domain-general (working memory) and domain-specific (semantic verbal fluency) executive function processes.

Method

Participants and Procedures

The participants were 255 fifth grade students who were drawn from a multiyear cohort longitudinal study tracking various reading measures from the first- to fifth-grade years (see Compton et al., 2010). Parents and students were informed about the purpose of the research and the description of the tasks and procedures, and active informed consent was obtained from the parents and all participating students. The study procedure was approved by the Vanderbilt University Institutional Review Board. Students were assessed from the end of first grade through fourth grade on measures of word identification (Woodcock Reading Mastery Tests - Revised/Normative Update; Woodcock, 1998) and passage comprehension (Woodcock, 1998). We used a cut point of 25th percentile to represent RD and fit single indicator hidden Markov models, a form of latent transition analyses (LTA), to identify latent class membership to RD and non-RD at each time point while allowing individuals to transition between latent classes. LTA allowed us to classify students with RD into various categories depending on the time of classification (early-emerging RD vs. late-emerging RD) and the area of difficulties (Comprehension vs. Word vs. Both). Due to the small number of cases in each of these categories, we combined them into the RD group for this study, resulting in sample sizes of 146 and 109 for RD and non-RD, respectively. Although we combined different RD profiles that emerged from LTA into a single group, this approach is deemed preferable to a method that relies on each year's reading assessment when identifying the RD group, because the latter approach is subject to measurement error and could lead to instability in classification. No significant difference in gender was found, χ^2 (1) = 0.39, p = .53, but the RD group had a higher proportion of students receiving special education, χ^2 (1) = 41.33, p < .05; students receiving a

free or reduced lunch, χ^2 (1) = 7.30, $p < .05$; and African American students, χ^2 (3) = 15.86, $p < .05$, compared to the non-RD group (see Table S1 in the online supplementary materials for the frequency of each group).

Measures

Data was collected over 3, one-hour sessions on three consecutive school days by trained graduate assistants. Twenty percent of the audiotaped sessions were evaluated for interrater reliability of fidelity of implementation, and the fidelity ranged from 95% to 99%. In addition, for achievement goals and reading comprehension, we report omega (composite) reliability (McDonald, 1999) derived from the confirmatory factor analysis models, which is more appropriate than alpha when the tau equivalence assumption is not met (Raykov, 1997). Reliability for each measure is presented in Table 1.

Achievement Goals

We used the revised version of the Patterns of Adaptive Learning Strategies Survey (Midgely et al., 2000) to assess the three types of achievement goals. The students were asked to respond to five statements on mastery goals (e.g., "One of my goals in class is to learn as much as I can"), five statements on performance-approach goals (e.g., "One of my goals is to show others that I am good at my class work"), and four statements on performance-avoidance goals (e.g., "One of my goals is to keep others from thinking I'm not smart in class") on a 5-point Likert-type scale.

Reading Comprehension

Students read two fifth-grade level passages selected from the Qualitative Reading Inventory-3 (QRI-3; Leslie & Caldwell, 2001) on topics that they were familiar with (i.e., *Martin Luther King Jr.* and *The Octopus*) and answered reading comprehension questions in two

different response formats: free recall and constructed response. For the free recall response format, the students read each passage out loud and were asked to recall everything they could remember as assessors marked the ideas recalled by the student on a checklist. The number of ideas recalled was the score for each passage, and the inter-rater reliability of the randomly selected 20% responses was 90.8%. For the constructed response format, the students were asked a series of six (three implicit and three explicit) questions. An incorrect response was scored as 0, and a correct response was scored as 1. Inter-rater reliability for the constructed response was .93.

Executive Functions

We measured working memory using the Listening Recall subtest of the Working Memory Test Battery for Children (Gathercole & Pickering, 2001). The task required students to listen to a series of sentences spoken aloud, determine whether they were true or false, and then recall the final word of each sentence in order. After the two practice trials, the task starts with a 2-sentence trial. The number of sentences increased by one in every six trials until the student incorrectly recalled two or more trials at a particular sentence length. The total scores reflect the number of words recalled correctly in order. We assessed semantic verbal fluency with a measure used by Swanson (2008) to tap domain-specific executive function process. Students were asked to name all the animals they could think of in one minute, excluding pet names and repeated answers. The score was the total number of animals named minus any repetition or pet names. We recognize that the semantic verbal fluency measure reflects lexical knowledge and executive function. Yet, when vocabulary is covaried out from semantic verbal fluency performance, we expect the residual variance related to semantic fluency to tap executive processing. Working memory and semantic verbal fluency measures each consist of a single

score, and we modeled them as single-indicator latent variables controlling for measurement error.

Covariates

Receptive vocabulary knowledge was assessed with the Peabody Picture Vocabulary Test-4 assessed the students' receptive vocabulary knowledge (Dunn & Dunn, 2007). Passage oral reading fluency was assessed with two fifth-grade narrative passages (Fuchs & Fuchs, 1992) using the mean of words correct per minute from each passage.

Data Analyses

We fit a confirmatory factor analysis (CFA) and a multiple-group structural equation model. Except for testing the achievement goals measurement model[i], all analyses were conducted using the mean- and variance-adjusted weighted least square (WLSMV) estimator with the Delta parameterization available in Mplus 7.4 (Muthén & Muthén, 2015) to handle both dichotomous and continuous measures. A series of CFA models were first tested for the entire sample, and again for the non-RD and RD groups separately, to evaluate the factor structure of the constructs and their measurement invariance between the two groups for a meaningful group comparison. Once the measurement invariance was established, we fit a structural base model that examined the extent to which the achievement goals predicted each reading comprehension outcome, controlling for the effects of vocabulary and oral reading fluency. We then fit a mediation model with working memory and semantic verbal fluency as mediators between achievement goals and reading comprehension and report 95% bootstrapping confidence intervals resulting from 1000 draws. Group differences were evaluated by sequentially imposing equality constraints on each path coefficient and testing the group differences of that path coefficient in the final model using a Wald chi-square test. All the models considered here were

evaluated using the following fit statistic criteria: chi-square (χ^2) statistics, the comparative fit index (CFI) and the Tucker-Lewis index (TLI) greater than .90, the root mean square error of approximation (RMSEA) less than .06, and standardized root mean square residuals equal to or less than .08 (Hu & Bentler, 1999).

Results

Preliminary Analyses and Descriptive Statistics

We conducted preliminary analyses regarding outliers, normality, and missing data. At the observed variable level, there were no univariate outliers, and all variables were normally distributed, except for the mastery goals. There were no multivariate outliers, but we identified data to deviate from multivariate normality using Mardia's statistics (Mardia, 1980; for the non-RD group, kurtosis = 86.48, χ^2 = 13.86, $p < .05$; skewness = 7.62, χ^2= 272.55, $p < .05$; for the RD group, kurtosis = 84.32, χ^2 = 6.62, $p < .05$; skewness = 5.65, χ^2 = 217.40, $p < .05$). We addressed nonnormality using the MLR estimator when evaluating the factor structure of achievement goals. However, we note that the WLSMV estimator used in the final models does not require normality assumptions. Missingness was minimal (less than 1% for reading comprehension and semantic verbal fluency and 3% for achievement goals). Due to the large standard deviations in the oral reading fluency and vocabulary measures, we divided the corresponding measures by 10 and 100, respectively, for scaling purposes. Descriptive statistics are provided in Table 1.

Measurement Models

Measurement models were tested in three steps (see Table 2). First, we fit a series of alternative confirmatory factor analyses for the achievement goals. We compared four alternative models: a single common-factor model, 2 two-factor models (mastery vs. performance-approach + performance-avoidance; mastery + performance-approach vs. performance-avoidance), and a

three-factor model (mastery vs. performance-approach vs. performance-avoidance). Across all of these models, we estimated covariance of the residuals from two performance approach goals items to improve model fit. The three-factor model had the best model fit (Table 2). Based on this trichotomy model of achievement goals, we evaluated the between-group measurement invariance for achievement goals by fitting the configural invariance model where all the factor loadings, item intercepts, and residual variance were freely estimated in both groups. We then tested metric invariance with between-group equality constraints on factor loadings and scalar invariance where equality constraints were put on item intercepts/thresholds. Results of the model comparison based on the Sattora-Bentler scaled chi-square difference test indicated metric invariance for achievement goals (Table 3).

Second, we compared three alternative models for reading comprehension: a single common-factor model, a two-factor model (free recall vs. constructed response) where continuous items load on free recall and dichotomous items load on constructed response, and a three-factor model (free recall vs. implicit constructed response vs. explicit constructed response). In these models, four items were excluded because they caused Heywood case and did not significantly explain constructed response construct. The two-factor model had the best model fit (Table 2). We performed between-group invariance test for reading comprehension. Because the constructed response format was measured using binary items, the measurement invariance was evaluated by comparing the configural invariant model with the scalar invariant model (Bollen, 1989). The scalar invariance model with cross-group equality constraints on factor loadings and item intercepts (threshold) did not deteriorate model fit, suggesting the presence of scalar invariance (Table 3).

Third, once we established the measurement invariance of achievement goals and reading comprehension, we included vocabulary, working memory, and semantic verbal fluency as single-indicator latent variables, and a latent variable of oral reading fluency using two oral fluency passages. This full measurement model explained the data well for the total sample and both groups individually (Table 2). Then, we established between-group measurement invariance for the full measurement model. Because oral reading fluency was the only latent variable with factor loading, item intercepts, and residuals estimated, the measurement invariance tests of the full measurement model involved differences in 1 degree of freedom. Results supported the scalar invariance for the full measurement model (Table 3). This final measurement model served as a baseline for subsequent structural models and is depicted in Figure 2.

Correlations Among Latent Variables

Table 4 presents the zero-order correlations among the nine latent constructs for the non-RD group (upper diagonal) and the RD group (lower diagonal). In the non-RD group, mastery goals were positively related to working memory (r = .39). Semantic verbal fluency, working memory, and vocabulary were positively associated with free recall (.38 < rs < .49) and constructed responses (.27 < rs < .71). We noticed slightly different patterns in the RD group. Mastery goals were positively associated with free recall, semantic verbal fluency, vocabulary, and oral reading fluency in addition to working memory (.20 < rs < .49). Performance-approach goals had negative relationships with constructed responses, semantic verbal fluency, and vocabulary (-.33 < rs < -.19). Semantic verbal fluency, working memory, vocabulary, and oral reading fluency were all positively related to free recall (.44 < rs < .49) and constructed responses (.40 < rs < .73).

Structural Models

Base Model

Figure 3 represents the structural model tested using the multigroup structural equation model. The multigroup structural model, in which all structural parameters were freely estimated in both the non-RD and RD groups, represented the data well, χ^2 (630) = 667.74, CFI = 0.94, TLI = 0.94, RMSEA = 0.02. In the non-RD group, the base model explained 21.8% of the variance in free recall and 51.9% of the variance in constructed responses. Vocabulary was the only significant predictor of free recall (β = .41, $p < .01$) and constructed responses (β = .64, $p < .001$). None of the achievement goals predicted reading comprehension outcomes, and they only explained 1% of the unique variances in both free recall and constructed response performance.

For students with RD, the model explained 49.8% of the variance in free recall and 64.7% in constructed responses. Controlling for the significant effects of vocabulary (β = .27, $p < .01$) and oral reading fluency (β = .37, $p < .001$), achievement goals significantly predicted free recall, explaining approximately 10% of the unique variance. Mastery goals positively predicted free recall (β = .32, $p < .01$), whereas performance-approach goals negatively predicted free recall (β = -.26, $p = .04$). However, achievement goals did not predict constructed responses beyond the effects of vocabulary (β = .62, $p < .001$) and oral reading fluency (β = .31, $p < .001$). Achievement goals explained about 2% of the unique variance in constructed responses. Wald chi-square tests indicated that only the path from mastery goals to free recall significantly differed across the two groups, χ^2 (1) = 3.91, $p < .05$.

Mediation Model

To further explore the mechanisms by which mastery and performance-approach goals explain reading comprehension, we included semantic verbal fluency and working memory in the model as mediators (see Figure 4 and Table 5)[ii]. This model showed a good fit to data, χ^2

(714) = 752.94, CFI = 0.95, TLI = 0.94, RMSEA = 0.02. In the non-RD group, mastery goals positively predicted semantic verbal fluency (β = .23, p = .04), which in turn positively predicted free recall (β = .31, p = .02) and constructed responses (β = .40, p < .01). Yet, these indirect effects were not statistically significant. Mastery goals also predicted working memory (β = .42, p < .001), which in turn positively predicted free recall (β = .30, p < .01). The specific indirect effect of mastery goals predicting free recall through working memory was statistically significant (β = .13, 95%CI [.01, .43]).

In the RD group, mastery goals' predictive path to free recall observed in the base model was now completely mediated by semantic verbal fluency. Mastery goals positively predicted semantic verbal fluency (β = .30, p < .001), which in turn positively predicted free recall (β = .23, p = .01). However, this specific indirect effect was not statistically significant (β = .07, 95% CI [-.01, .15]). Mastery goals also positively predicted working memory (β = .52, p < .01), and yet working memory predicted neither free recall (β = .12, p = .20) nor constructed responses (β = .09, p = .47). Performance-approach goals negatively predicted semantic verbal fluency (β = -.29, p < .01), which again predicted free recall (β = .23, p = .01). This indirect path was statistically significant (β = -.07, 95%CI [-.16, -.01]).

Discussion

Research on achievement goals and reading comprehension has taken place in silos (Schieffe et al., 2012). Particularly, there is a lack of research on achievement goals explicating the students for whom and the tasks for which achievement goals are important for reading comprehension and the cognitive mechanisms that explain these relations. The present study aimed to remedy this gap by examining a model linking achievement goals, executive functions, and reading comprehension, with specific focus on how these factors relate to each other

differentially for students with and without RD, using two different assessment response formats. We extended the prior literature on achievement goals and reading comprehension in three important ways. First, to our knowledge, this is the first study to directly compare the RD vs. non-RD to elucidate for whom achievement goal matters in reading comprehension. Second, we contrasted the two widely used classroom reading assessment formats, the free recall and constructed response formats, one of which (free recall) relies heavily on the relational encoding processes known to be utilized when pursuing mastery goals. Therefore, our study highlights the important role of mastery goals in reading comprehension, which might have been eroded in prior studies that used a single, standardized measure of reading comprehension. Third, guided by the Active View of Reading (Duke & Cartwright, 2021), we modeled achievement goals and language-specific executive functions alongside vocabulary and oral reading fluency as critical components of reading comprehension to explore the mechanism by which achievement goals are related to reading comprehension outcomes.

We conclude that the relations between achievement goals and reading comprehension are not universal; instead, they are moderated by students' RD status and the response format of the reading comprehension assessment. Our findings indicate for students with RD, mastery goals are positively associated with reading comprehension as measured with free recall where performance-approach goals showed negative associations with free recall and that these relations are mediated by semantic verbal fluency. On the contrary, effects of achievement goals on reading comprehension were mostly negligible for students without RD with one exception. Given that the reading comprehension passages were of the fifth-grade level, which are likely to be challenging for students with RD, the differential effects of achievement goals on reading

comprehension by the RD status is consistent with the theoretical notion that achievement goals exert effects primarily under failure situations (Dweck & Leggett, 1988).

Achievement Goals and Reading Comprehension

This study underscores the facilitative role of mastery goals and the debilitating role of performance-approach goals in reading comprehension for students with RD, particularly in the free recall format. The pattern that emerged in the RD group is consistent with that in previous studies with struggling readers in upper elementary grades who used latent reading comprehension outcome (Cho et al., 2018, 2019): Mastery goals exert an indirect positive relation with reading comprehension, whereas performance-approach goals show a direct, marginally significant, negative relation to reading comprehension. Moreover, such findings confirm the larger literature base on reading motivation, which highlights the facilitative role of intrinsic motivation and the detrimental effect of extrinsic motivation (Hebbecker et al., 2019; Wang & Guthrie, 2004). The results from this study add to the evidence that stronger endorsement of performance-approach goals or related constructs, such as competition and extrinsic motivation, hinders reading comprehension for struggling readers (Cho et al., 2018; Schiefele et al., 2016).

For students without RD, findings regarding the null relations between achievement goals and reading comprehension coincide with the results from prior studies with students of mixed reading levels (Graham et al., 2008; Wolters et al., 2014), with one exception (Law, 2011), where mastery goals predicted reading comprehension as measured by researcher-developed questionnaires that require deep understanding of the texts among Chinese students. This difference might be attributable to the fact that Asian countries tend to have performance goal-oriented classroom practices that place emphasis on memorization (Shin et al., 2018); thus,

students' mastery goals may become particularly important for students regardless of their reading level when students are asked to deeply engage with texts.

The present findings support the motivation challenge hypothesis because the benefits of mastery goals and the deleterious effects of performance-approach goals were evident only in the RD group. Despite the fact that vocabulary and oral reading fluency exerted substantial effects on reading comprehension outcomes, students with RD's reading comprehension performances were not completely confined by their language and foundational reading skills, thus refuting the cognitive challenge hypothesis. This finding complements prior research documenting more pronounced effects of motivation for poor readers compared to advanced readers (Logan et al., 2011). We note that this pattern of findings contrasts with the general conclusion supporting the cognitive challenge hypothesis based on a wide range of engagement and reading outcomes made by Klauda and Guthrie (2015). Yet, looking more specifically at reading comprehension outcome, standardized regression coefficients of motivation variables tend to be larger for struggling readers (−.21 to .16) than for advanced readers (from −.13 to .10), although motivation by reader group interaction terms were not statistically significant. Thus, their finding on reading comprehension outcomes tends to coincide with our conclusions.

Our results substantiating the motivation challenge hypothesis extend our understanding of the various sources of reading difficulties by highlighting the unique contributions of achievement goals to reading comprehension. Achievement goals explained 10% of the unique variance in free recall beyond that which can be explained by vocabulary and oral reading fluency in students with RD. This finding also supports the Active View of Reading (Duke & Cartwright, 2021), which considers motivation and executive functions as key contributors of reading difficulties and as instructionally malleable factors that have the potential to improve

reading comprehension. It is also important to note that this conclusion should not be interpreted as considering achievement goals to be the primary source of reading difficulties because vocabulary and oral reading fluency had stronger effects than achievement goals on both reading comprehension outcomes.

Additionally, the current results suggest that the effects of achievement goals vary as a function of the response format of reading comprehension assessments. In general, the effects of mastery and performance-approach goals were more salient for reading comprehension measured with a free recall format than with a constructed response format. When students with RD were asked to recall as much as possible of what they had read, those with higher mastery goals could recall more ideas than those with higher performance-approach goals. Successful free recall requires students to organize ideas with semantic clusters for efficient retrieval. Thus, our finding is consistent with experiments documenting the benefit of mastery goals for the relational encoding process (Ikeda et al., 2015, 2021; Murayama & Elliot, 2011) and efficient memory retrieval (Graham & Golan, 1991). Performance-approach goals negatively predicted free recall performance, but this negative effect was much smaller in the constructed response assessment. This may be due to the item-specific encoding and retrieval process utilized by performance goals (Murayama & Elliot, 2011), which may have facilitated performance in the constructed response format.

Executive Functions as Potential Underlying Mechanisms

We further explored the hypothesized mediational link by modeling indirect effects of mastery and performance-approach goals on free recall via working memory and semantic verbal fluency. These mediational paths align with the hierarchical model of achievement motivation (Elliot & Church, 1997) that theorizes that achievement goals are considered proximal regulators

of achievement-related behaviors, which in turn explain achievement outcomes. For students with RD, pursuing mastery goals was associated with better performance on semantic verbal fluency task, which in turn positively predicted free recall of the ideas from the texts read. This suggests that when students with RD set mastery goals and aim to read for understanding, they may fare well in encoding information in semantically organized ways that can then be easily retrieved when recalling what they read.

Our findings confirm that achievement goals are related to executive function-related processes and support the resource-based view that mastery goals facilitate the full utilization of cognitive resources for learning and performing the task, whereas performance-approach goals may deteriorate performance on executive function tasks because limited attentional resources are diverted to task-irrelevant processes, particularly for students with RD whose cognitive resources are relatively more restricted. Notably, mastery goals had a positive relation to both working memory and semantic verbal fluency, regardless of the students' reading level. This finding suggests that when students set goals for learning and mastery, they are more likely to focus on the task at hand and are better at inhibiting irrelevant responses, which can further promote their learning. However, the way performance-approach goals are related to executive functions varied by RD status. For students without RD, performance-approach goals were not associated with executive functions, whereas for students with RD, performance-approach goals were negatively related to semantic verbal fluency. Thus, when students with RD set goals to demonstrate and prove their reading ability to others, such goals can put pressure on them in ways that can interfere with their performance on executive function tasks by evoking task-irrelevant thoughts and worries.

The present study also highlights the role of executive functions in reading comprehension measured by the free recall format but not with the constructed response format. As expected, semantic verbal fluency was a strong predictor of free recall beyond vocabulary and oral reading fluency. Semantic verbal fluency tasks tap efficient retrieval of relevant information from long-term memory and efficient organization while inhibiting irrelevant responses (Whiteside et al., 2016), and these skills might have particularly benefited students' performance under the free recall format. The mediational link semantic verbal fluency has between mastery goals and free recall is not primarily attributable to vocabulary and fluency that might be involved in verbal fluency tasks, but instead reflects the effects of executive function implicated in the semantic verbal fluency task because we had controlled for the breadth of vocabulary and oral reading fluency. We also noted that executive functions did not mediate the relation between performance-approach goals and free recall. The mechanism through which performance-approach goals explain reading comprehension may have been elucidated if we had measured mind wandering (Soemer et al., 2019) or anxiety (Taboada Barber et al., 2021), given the causal association between performance goals and task-irrelevant thoughts and anxiety established in prior experimental studies (Lee et al., 2021).

Another interesting finding is that while working memory did not mediate the relation between mastery goals and free recall in students with RD, the relation between mastery goals and free recall performance was completely mediated by both working memory and semantic verbal fluency in students without RD. Although it is yet unknown why the different processes in executive function systems are utilized for students with and without RD, we suspect that the reason why working memory played a mediating role in explaining the relation between mastery goals and free recall only for students without RD may be attributable to the fact that working

memory capacity in students with RD is quite restricted by their intrinsic cognitive challenges to make significant contributions to reading comprehension.

Limitations and Future Directions

The findings should be interpreted in light of several limitations of this study. First, while research indicates that different cognitive processes are involved in various types of texts (narrative vs. expository) and that different levels of inference are required for each item (Eason et al., 2012), this study did not examine all the possible sources of variance in reading comprehension questions. This was partly due to the unavailability of the various assessments administered and partly due to the results of our factor analyses not differentiating the levels of inferences (literal vs. inferential questions). Examining how motivation relates to reading comprehension depending on the type of text and the level of inference would be a worthy future research endeavor. Second, we acknowledge that some of the measures did not have high enough reliability (reliability ranged from .62 to .97). Although measurement error is addressed in our study by employing the latent-variable modeling approach, we recommend future studies to include measures with high psychometric properties and multiple measures of executive functions. Third, we only focused on two language-specific executive functions—verbal working memory and semantic verbal fluency—as mediators. However, other behavioral indicators, such as reading amount and strategy use, as well as psychological factors such as anxiety, might explain the mechanism through which achievement goals are associated with reading comprehension. Fourth, this study focused only on achievement goals, but there are other reading motivation constructs (such as intrinsic motivation, anxiety, engagement) that may also contribute to reading comprehension. Modeling other constructs represented in the Active View of Reading Model (Duke & Cartwright, 2021) to differentiate the possible contributions of

motivational constructs that are interconnected will be a fruitful endeavor with implications for intervention design. Fifth, we note differences in demographics between the non-RD and RD groups. When we included demographic variables as covariates in the model, the models did not converge in most cases, and they often resulted in less than optimal model fit when the model converged (see Figures S1 and S2, and Table S3 in the online supplementary materials). It would be important to control for the effects of demographics and further understand whether the role of achievement goals is more crucial for students from minoritized backgrounds in future studies. Finally, we acknowledge that this study relied on concurrent and correlational survey data, which prohibits us from making causal claims. Our finding should be taken as a first step toward understanding the important role of achievement goals in executive functions and reading comprehension. We suggest future studies use an experimental design where achievement goals are manipulated.

Conclusion

The findings of this study stress the need to account for motivational differences in reading comprehension and the schematic role of achievement goals in navigating goal-directed, language-specific executive function processes, particularly for students with RD. Furthermore, our findings underscore the importance of encouraging students to endorse mastery goals rather than performance-approach goals. What is promising is that achievement goals are malleable and, although to a lesser degree, executive functions can also be improved, at least in the short term, indirectly through mastery goal setting (Lee et al., 2021) and directly through training (see Melby-Lervåg & Hulme, 2013 for a review on working memory and see Hurks, 2012 for verbal fluency). Even with simple manipulation, priming different types of achievement goals by giving instruction on what their goals are (e.g., improve your skill, prove your superior ability, do not

demonstrate your inferior ability, etc.) has been found to be effective in changing achievement goals and performance on tasks related to executive functions (Crouzevialle & Butera, 2013; Lee et al., 2021). Moreover, a well-established body of literature supports that achievement goals are impacted by classroom instructional practices (classroom goal structure). For example, mastery-oriented instructional strategies include a focus on collaboration rather than on competition, avoiding normative evaluation procedures, and providing learning tasks that can build on students' interests and goals (Ames, 1992). Prior studies have found that offering challenging and collaborative assignments with explicit scaffolds maintains mastery goal pursuit and prevents low-achieving students from adopting performance goals (Anderman et al., 2001; Meece & Miller, 1999; Miller & Meece, 1997). Thus, future interventions for students with RD may consider incorporating motivational strategies to support mastery goal adoption as part of reading instruction.

Disclosure Statement

Authors have no potential conflict of interest.

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Table 1

Descriptive Statistics of Observed Variables for Non-Reading Difficulty (Non-RD) and Reading Difficulty (RD) Groups

		Non-RD (n = 109)					RD (n = 146)				
	Reliability	*M* (*SD*)	Min	Max	Skewness	Kurtosis	*M* (*SD*)	Min	Max	Skewness	Kurtosis
Achievement goals	*ω = .80*										
Mastery	.72	4.64 (0.47)	2.2	5.0	-2.01	5.95	4.60 (0.58)	2.2	5.0	-2.24	5.59
Performance-approach	.82	3.20 (1.05)	1.0	5.0	-0.08	-1.02	3.69 (1.05)	1.0	5.0	-0.61	-0.48
Performance-avoidance	.62	3.44 (1.02)	1.0	5.0	-0.32	-0.84	3.19 (1.18)	1.0	5.0	-0.20	-0.96
Reading comprehension	*ω = .81*										
Free Recall	.76	19.69 (6.13)	5.5	33.5	0.24	-0.45	13.68 (6.14)	0.0	33.0	0.29	0.12
Constructed Response	.63	0.68 (0.19)	0.1	1.0	-0.52	0.01	0.46 (0.23)	0.0	1.0	0.00	-0.36
Executive functions											
Semantic Verbal Fluency	.67	15.31 (4.66)	6.0	27.0	0.18	-0.54	12.95 (4.09)	1.0	28.0	0.52	1.10
Working Memory	.85	12.78 (3.38)	3.0	22.0	0.11	0.41	10.87 (3.60)	0.0	19.0	-0.54	0.55
Control variables											
Vocabulary/100	.96	1.58 (0.17)	1.1	1.9	-0.10	-0.47	1.37 (0.19)	91.0	1.8	-0.01	-0.42
Oral Reading fluency/10	.97	12.84 (2.60)	6.9	19.8	0.13	0.07	7.94 (3.10)	0.4	15.5	-0.31	-0.03

Note. Reliability is reported as sample-derived coefficient alpha, except in the following cases: Alternate forms reliability is reported for free recall and oral reading fluency; Kuder-Richardson Formula 20 reliability for semantic fluency task as reported in Swanson's (2008) study of students aged 8-9. Omega reliability is derived from the confirmatory factor analysis models; thus, only available at the overall construct level.

Table 2.
Fit Statistics for Confirmatory Factor Models and Model Comparison Tests

Achievement Goals							
Group	Model	χ^2	df	SCR	RMSEA [90%CI]	CFI	TLI
Total	One-Factor	323.71*	77	1.30	0.11 [0.10, 0.13]	0.61	0.54
	Two-Factor A [App vs. Av]	277.53*	76	1.29	0.10 [0.09, 0.12]	0.68	0.62
	Two-Factor B [M vs. P]	188.26*	76	1.21	0.08 [0.06, 0.09]	0.82	0.79
	Three-Factor	134.50*	74	1.20	0.06 [0.04, 0.07]	0.91	0.88
Non-RD	One-Factor	186.61*	77	1.12	0.11 [0.09, 0.14]	0.67	0.60
	Two-Factor A [App vs. Av]	182.90*	76	1.12	0.11 [0.09, 0.14]	0.67	0.61
	Two-Factor B [M vs. P]	109.15*	76	1.10	0.06 [0.03, 0.09]	0.90	0.88
	Three-Factor	103.27*	74	1.09	0.06 [0.03, 0.09]	0.91	0.89
RD	One-Factor	253.97*	77	1.22	0.13 [0.11, 0.15]	0.53	0.45
	Two-Factor A [App vs. Av]	214.47*	76	1.21	0.12 [0.10, 0.13]	0.63	0.56
	Two-Factor B [M vs. P]	175.81*	76	1.11	0.10 [0.08, 0.12]	0.74	0.68
	Three-Factor	131.10*	74	1.10	0.08 [0.05, 0.10]	0.85	0.81
Reading Comprehension							
Group	Model	χ^2	df	SCR	RMSEA [90%CI]	CFI	TLI
Total	One-Factor	49.33	35		0.04 [0.00, 0.07]	0.97	0.96
	Two-Factor	41.93	34		0.03 [0.00, 0.06]	0.98	0.98
	Three-Factor	36.46	32		0.02 [0.00, 0.05]	0.99	0.99
Non-RD	One-Factor	39.33	35		0.03 [0.00, 0.08]	0.94	0.92
	Two-Factor	35.15	34		0.02 [0.00, 0.07]	0.98	0.98
	Three-Factor	30.17	32		0.00 [0.00, 0.07]	1.00	1.04
RD	One-Factor	35.44	35		0.01 [0.00, 0.06]	1.00	1.00
	Two-Factor	29.55	34		0.00 [0.00, 0.05]	1.00	1.03
	Three-Factor	27.32	32		0.00 [0.00, 0.05]	1.00	1.03
Full Measurement Model							
Total	Nine-Factor	439.15*	344		0.03 [0.02, 0.04]	0.93	0.91
Non-RD	Nine-Factor	368.73*	344		0.03 [0.00, 0.05]	0.91	0.89
RD	Nine-Factor	369.56*	344		0.02 [0.00, 0.04]	0.95	0.94

Notes. RD = Reading Difficulties; App = Approach; Av = Avoidance; M = Mastery goals; P =Performance goals; SCR = scaling correction factor, used in M*plus* with MLR estimator. CFI = Comparative fit index; TLI = Tucker-Lewis index; RMSEA = Root mean square error of approximation; CI = Confidence interval; $^{*}p < .05$

Table 3

Summary of Steps in Measurement Invariance Tests

Step	*df*	χ^2	SCF	RMSEA [90% CI]	CFI	TLI	Δdf	$\Delta\chi^2$
Achievement goal model								
Configural invariance	146	204.26*	1.08	0.06 [0.04, 0.07]	0.92	0.90	-	-
Metric invariance	157	217.30*	1.11	0.06 [0.04, 0.07]	0.92	0.90	11	13.68
Scalar invariance	168	258.08*	1.10	0.07 [0.05, 0.08]	0.87	0.86	11	45.51*
Reading comprehension model								
Configural invariance	68	62.50	-	0.00 [0.00, 0.04]	1.00	1.03	-	-
Scalar invariance	78	72.76	-	0.00 [0.00, 0.04]	1.00	1.02	10	10.05
Full measurement model								
(Reading comprehension + achievement goals + vocabulary + oral reading fluency + semantic verbal fluency + working memory)								
Configural invariance	707	749.76*		0.02 [0.00, 0.04]	0.94	0.94	-	-
Metric invariance	708	750.75*		0.02 [0.00, 0.04]	0.94	0.94	1	0.99
Scalar invariance	709	752.19*		0.02 [0.00, 0.04]	0.94	0.94	1	1.44

Note. SCF = Scaling Correction Factor; CI = Confidence interval.

*$p < .05$

Table 4

Correlations among Latent Variables for the Non-Reading Difficulty (Non-RD; n=109) and Reading Difficulty (RD; n =146) Groups

		Variables	1	2	3	4	5	6	7	8	9
Achievement Goals	1	Mastery	-	.22*	.27*	.01	.11	.20	.39*	.10	.14
	2	Performance-approach	.30*	-	.82*	-.21	-.23	-.11	-.04	-.27*	-.06
	3	Performance-avoidance	.19	.49*	-	-.07	.00	.02	.25	.01	.09
Reading Comprehension	4	Free recall	.40*	-.23	-.05	-	.72*	.49*	.38*	.45*	.20
	5	Constructed response	.25	-.31*	-.08	.73*	-	.63*	.27*	.71*	.28
Executive Function	6	Semantic verbal fluency	.22*	-.19*	-.10	.48*	.40*	-	.35*	.47*	.02
	7	Working memory	.49*	.01	.16	.44*	.40*	.28*	-	.14	.20*
Control	8	Vocabulary	.20*	-.33*	-.00	.47*	.73*	.32*	.34*	-	.23*
	9	Oral Reading fluency	.27*	.04	.01	.49*	.42*	.20*	.27*	.15*	-

Notes. Values upper diagonal are from non-RD and lower diagonal are from RD. $^{*}p < .05$.

Table 5.
Indirect, Direct, and Total Effects of Achievement Goals on Reading Comprehension via Semantic Verbal Fluency and Working Memory

	Indirect Effect	Direct Effect	Total Effect
	β (95% CI)	β (95% CI)	β (95% CI)
Students without reading difficulty (Non-RD)			
Mastery → Free recall		-.20 (-.99, .25)	-.01 (-.60, .45)
via Semantic verbal fluency	.07 (-.02, .24)		
via Working memory	.13 (.01, .43)		
Mastery → Constructed response		-.07 (-.75, .44)	.05 (-.54, .49)
via Semantic verbal fluency	.09 (-.03, .23)		
via Working memory	.02 (-.10, .16)		
Performance Approach → Free recall		-.16 (-3.20, 2.48)	-.22 (-3.19, 2.45)
via Semantic verbal fluency	-.04 (-.17, .03)		
via Working memory	-.02 (-.18, .05)		
Performance Approach → Constructed response		-.21 (-2.63, 1.65)	-.27 (-2.66, 1.66)
via Semantic verbal fluency	-.06 (-.18, .04)		
via Working memory	-.00 (-.08, .05)		
Students with reading difficulty (RD)			
Mastery → Free recall		.22 (-.07, .58)	.35 (.09, .66)
via Semantic verbal fluency	.07 (-.01, .15)		
via Working memory	.07 (-.06, .19)		
Mastery → Constructed response		.03 (-.27, .46)	.11 (-.17, .44)
via Semantic verbal fluency	.03 (-.04, .10)		
via Working memory	.05 (-.09, .21)		
Performance Approach → Free recall		-.21 (-.65, .10)	-.29 (-.72, .10)
via Semantic verbal fluency	-.07 (-.16, -.01)		
via Working memory	-.01 (-.06, .02)		
Performance Approach → Constructed response		-.10 (-.41, .37)	-.14 (-.44, .29)
via Semantic verbal fluency	-.03 (-.12, .04)		
via Working memory	-.01 (-.07, .02)		

Note. CI = Confidence interval.

Figure 1.

Conceptual Base Model (a) and Mediation Model (b).

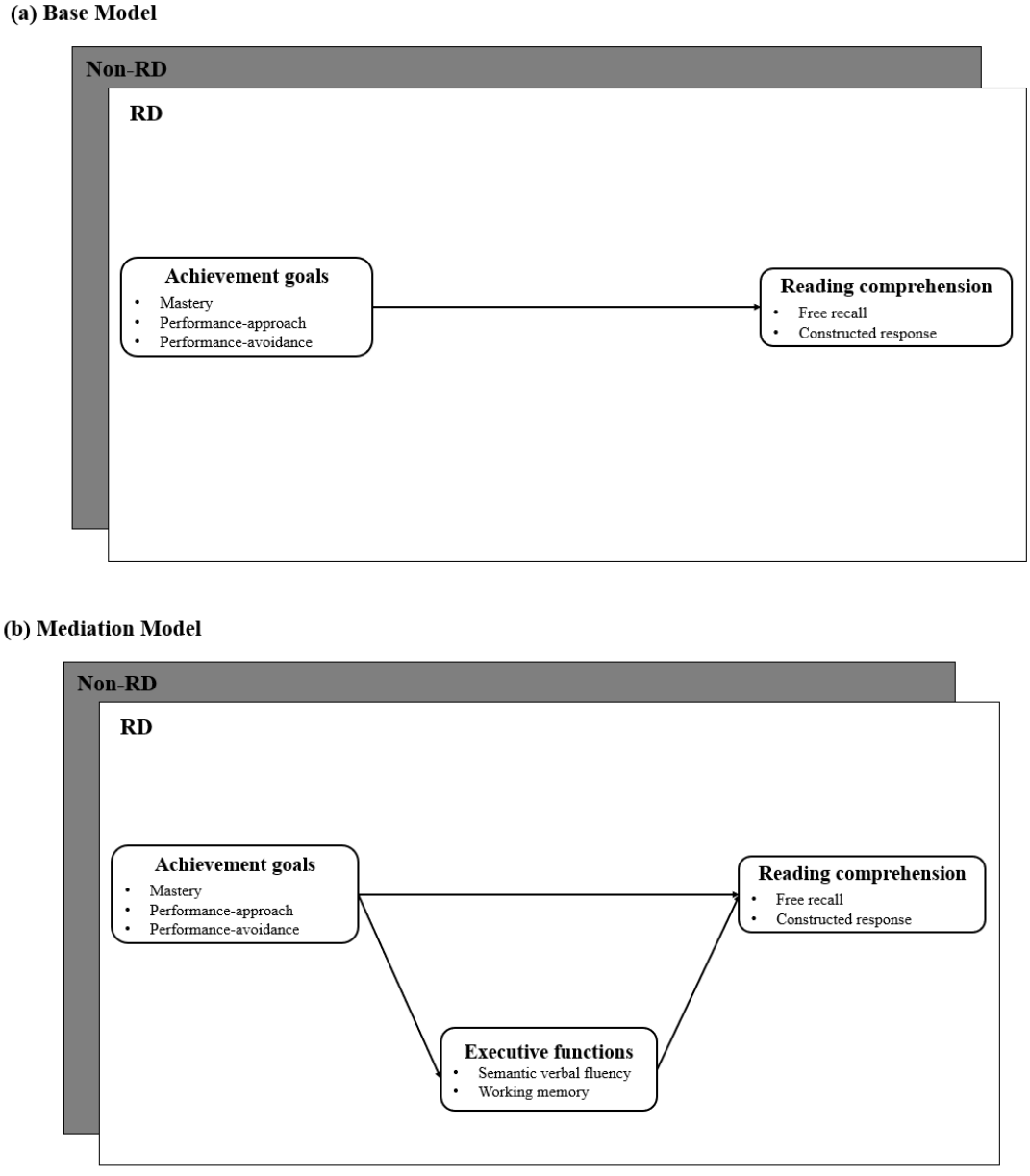
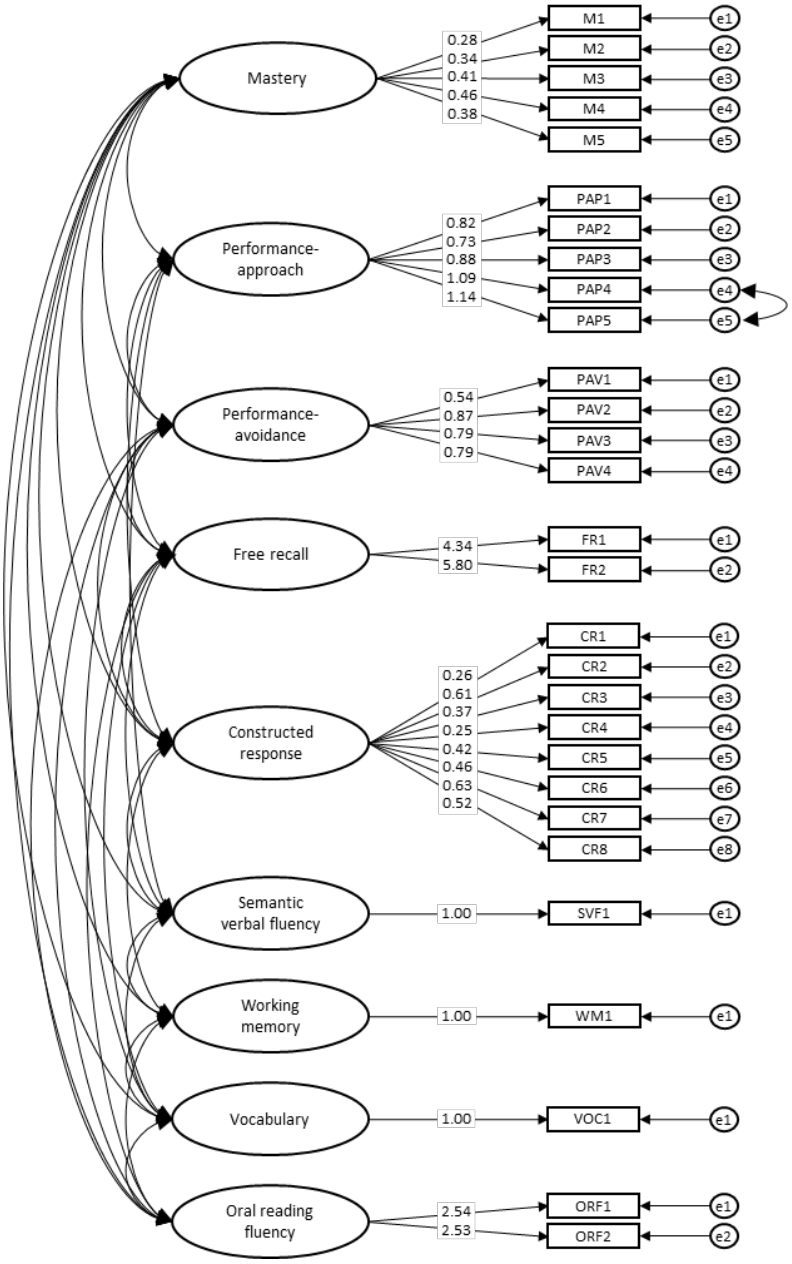


Figure 2.

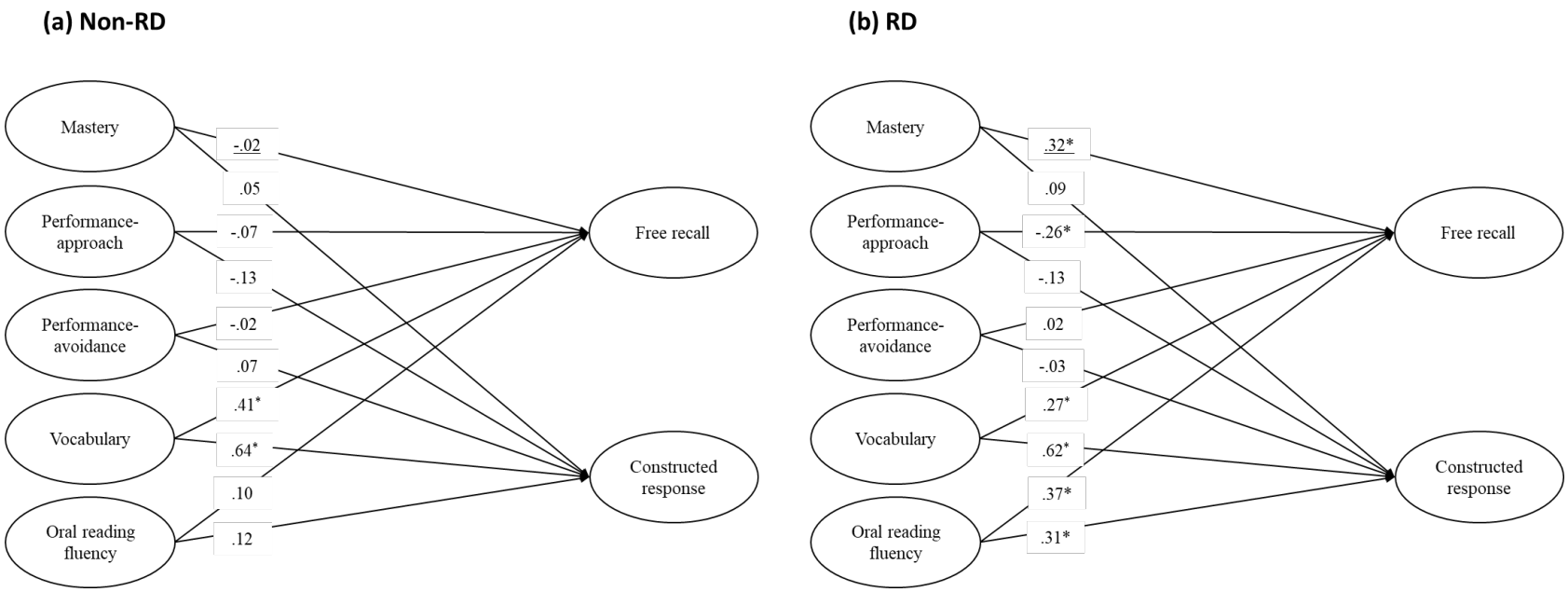
Final Measurement Model



Note. This figure demonstrates the final measurement model only with factor loading estimates. Values for item intercepts, residual variances, and latent variable covariances are not presented in this figure.

Figure 3.

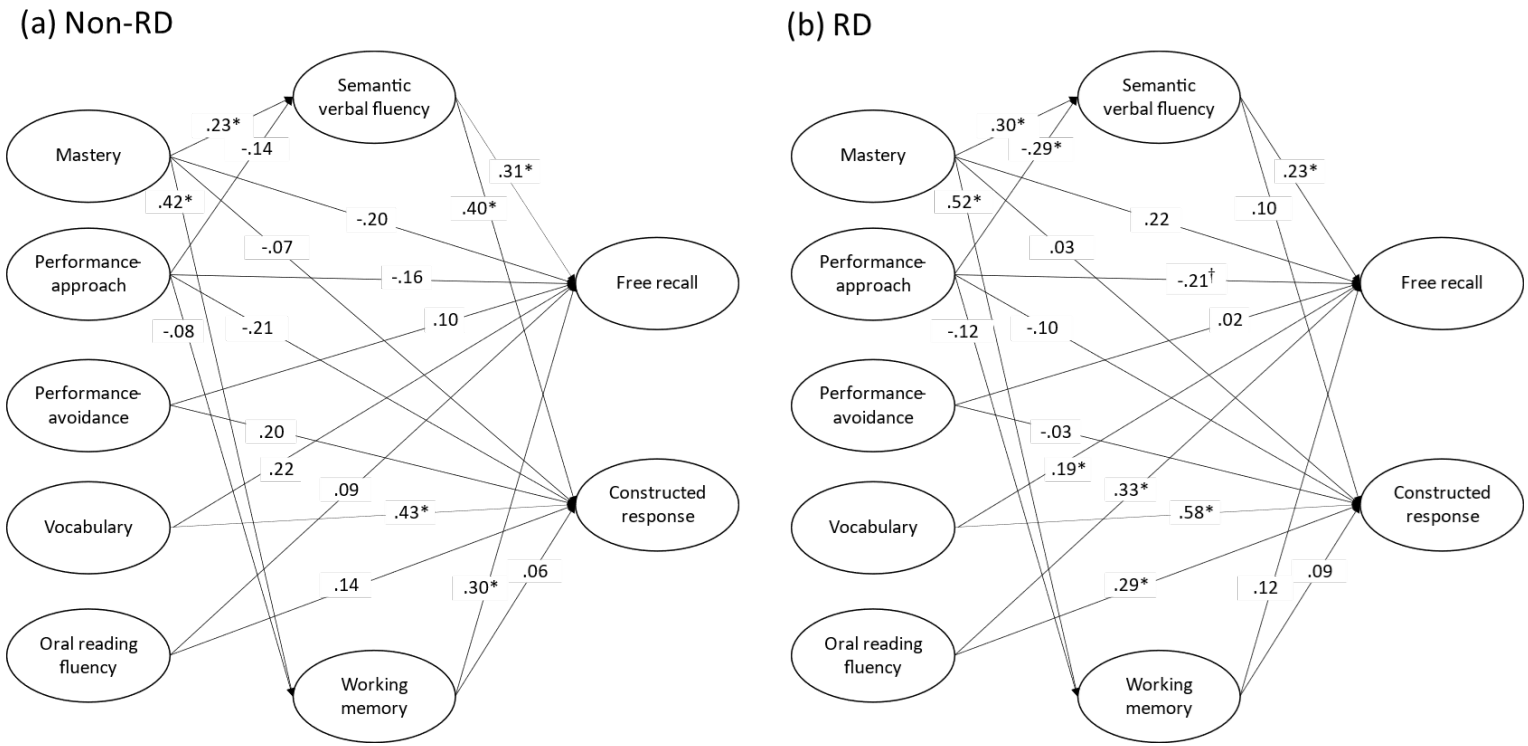
Base Model



Note. The base model results with standardized path coefficients from students without reading difficulty (a) and with reading difficulty (b). Underlined coefficients are statistically different for non-RD and RD groups. Covariances among exogenous latent variables are modeled but not depicted in the figure for simplicity.
*$p < .05$s

Figure 4.

Mediation Model



Note. The mediation model results, with unstandardized path coefficients from students without reading difficulty (a) and with reading difficulty (b). Covariances among exogenous latent variables and covariance between semantic verbal fluency and working memory are modeled but not depicted in the path diagram for simplicity. Semantic verbal fluency, working memory, and vocabulary are depicted as circles because they are modeled as single-indicator latnet variables with measurement error fixed to (1-reliability) * variance.
$^{*}p < .05$, $^{\dagger}p = .08$

[i] The CFA for achievement goals with polytomous items was conducted using a robust maximum likelihood estimator to account for deviations from normality, with the full-information maximum likelihood estimator for the unbiased estimates (Enders & Bandalos, 2001).

[ii] Paths from performance-avoidance goals to executive functions were not included in the model because of the null relationship between performance-avoidance goals and reading comprehension in the base model ($ps \geq .85$) and a lack of research evidence supporting the relationship between performance-avoidance goals and executive functions. In addition, to improve model fit, we added residual covariances between two performance-approach goal items and between control variables and executive functions.