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Augmenting the Simple View of Reading for Struggling Adult Readers: A Unique Role for Background Knowledge

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Abstract

This study explored the background knowledge (BK) and reading comprehension (RC) relationship for struggling adult readers. Using confirmatory factor analyses, a single-factor BK model exhibited better fit than a two-factor model separating academic knowledge and general information, which indicates that BK represents a unidimensional construct for this population. Additionally, one measure of oral vocabulary loaded with a latent factor of BK, which was separable from a latent factor of two additional oral vocabulary subtests. Using structural equation modeling, we found that BK exhibited a direct effect on RC after controlling for participants' grade level, decoding, listening comprehension, and oral vocabulary.

Introduction

Reading comprehension (RC) is a complex process and the ultimate goal of reading. With one in six adults in the United States possessing elementary reading skills (OECD, 2013), there is a growing body of research on the RC of adults who struggle with reading (e.g., Nanda, Greenberg, & Morris, 2010; Sabatini, Sawaki, Shore, & Scarborough, 2010). While it is known that several component skills including decoding, listening comprehension, and oral vocabulary knowledge are related to RC for this atypical population (Tighe & Schatschneider, 2016a; Sabatini et al., 2010), background knowledge (BK), which includes academic and general knowledge, is noticeably missing from this literature (see a recent meta-analysis, Tighe & Schatschneider, 2016b). Since BK has emerged as a strong contributor to RC in studies conducted with children and undergraduates (e.g., Cromley & Azevedo, 2007; Dole, Valencia, Greer, & Wardrop, 1991; Ozuru, Best, Bell, Witherspoon, & McNamara, 2007), we focused on exploring the relation between BK and RC for struggling adult readers, controlling for the Simple View of Reading (SVR) component skills. The SVR framework of RC was chosen due to previous successful applications of the model to samples of struggling adult readers (e.g. Barnes, Kim, Tighe, & Vorstius, 2017; Braze, Tabor, Shankweiler, & Mencl, 2007; Sabatini et al., 2010); however, there remains unexplained RC variance that may be accounted for by additional component skills, such as BK.

The Simple View of Reading

The SVR (Gough & Tunmer, 1986) posits that RC is the product of two skills: decoding and linguistic competence (which is characterized by a broader oral language construct encompassing listening comprehension and oral vocabulary knowledge). These skills have been explored with samples of struggling adult readers at varying reading levels. Irrespective of

reading levels, decoding has emerged as an important predictor of these adults' RC, with moderate to strong correlations noted (Barnes et al., 2017; Braze et al., 2007; Fracasso, Bangs, & Binder, 2016; MacArthur, Konold, Glutting, & Alamprese, 2010; Mellard, Fall, & Woods, 2010; Sabatini et al., 2010; Tighe & Binder, 2015; To, Tighe, & Binder, 2016). Additionally, in multiple studies, decoding has uniquely explained variance in RC after controlling for other component skills (e.g., oral vocabulary, listening comprehension, reading fluency; Barnes et al., 2017; Braze et al., 2007; Fracasso et al., 2016; Mellard et al., 2010; Taylor, Greenberg, Laures-Gore, & Wise, 2012).

Although listening comprehension has received relatively less attention than decoding in adult literacy research, it also appears to be moderately to strongly correlated with RC (Barnes et al., 2017, Braze et al., 2007, Fracasso et al., 2016, Mellard et al., 2010, Mellard & Fall, 2012; Sabatini et al., 2010). Additionally, listening comprehension made significant contributions to RC beyond the contributions of other skills in at least four samples of struggling adult readers (Barnes et al., 2017; Braze et al., 2007; Mellard et al., 2010; Sabatini et al., 2010).

It has been argued that oral vocabulary knowledge should be added to the SVR, under the broader linguistic competence construct, as a predictor of RC (Braze et al., 2007). In general, researchers have reported moderate to strong correlations between RC and oral vocabulary knowledge with struggling adult readers (Braze et al., 2007; Fracasso et al., 2016; Hall, Greenberg, Laures-Gore, & Pae, 2014; Mellard et al., 2010; Mellard & Fall, 2012; Nanda et al., 2010; Sabatini et al., 2010; Tighe & Schatschneider, 2016b). Moreover, oral vocabulary knowledge was a significant predictor of RC after controlling for other component skills in multiple samples of this population (e.g., decoding, morphological awareness, listening comprehension; Fracasso et al., 2016; Greenberg et al., 2010; Hall et al., 2014; Mellard et al.,

2010; Taylor et al., 2012; Tighe & Schatschneider, 2016b). Interestingly, Sabatini et al. (2010) found that oral vocabulary knowledge was separable from decoding and listening comprehension but did not significantly explain variance in RC after controlling for decoding and listening comprehension. Conversely, Braze et al. (2007) demonstrated that oral vocabulary knowledge has unique predictive utility for RC after controlling for decoding and listening comprehension.

This literature suggests that decoding, listening comprehension, and oral vocabulary knowledge are likely to explain a large portion of the variance in RC (estimates of 63-82%) for struggling adult readers. However, given the heterogeneity of struggling adult readers, these samples varied in terms of participant demographics, inclusion of native and non-native speakers of English, inclusion of varied educational grade level completions, and measures and statistical analyses employed (regression versus confirmatory factor analyses). In the current study, we aimed to re-examine the contributions of the SVR components (decoding, listening comprehension, oral vocabulary knowledge) using multiple measures to form latent variables, exclusively native speakers of English, and controlling for participants' educational grade level completion. In addition, due to the importance of BK to RC reported in research with other populations (e.g., Cromley & Azevedo, 2007; Ozuru et al., 2007), we wanted to investigate whether BK accounts for any of the additional remaining RC variance beyond the contributions of the SVR component skills.

Background Knowledge

Researchers have generally defined BK as general or academic information related to the domain of RC passages. In some studies, participants' BK was assessed with questions about the domain of the passages (Baldwin, Peleg-Bruckner, & McClintock, 1985; Cromley & Azevedo, 2007). In an experimental study, participants were considered to have higher BK once they had

received instruction in the domain of the passages (Dole et al., 1991). The domain of a text passage may be defined as narrowly as basketball history (Hall & Edmondson, 1992) or as broadly as biology (Ozuru, Dempsey, & McNamara, 2009). In Ozuru et al.'s (2009) study, undergraduates' comprehension of passages on biology topics was predicted by general biology knowledge as well as topic-specific knowledge, assessed separately. This finding suggests that even broad BK, such as general biology knowledge in this case, can contribute to RC.

The broad conceptualization of BK has been used by Strucker and Davidson (2003), who assessed adult literacy learners' BK using the Information subtest of the Wechsler Adult Intelligence Scale (WAIS-III; Wechsler, 1997). The majority of their sample of 660 adults scored below the 20th percentile. The WAIS-III Information subtest measures general knowledge as well as academic knowledge relating to science, social studies, and literature. In the current study, we evaluated the relationship between general and academic BK for struggling adult readers. Specifically, we tested whether general and academic knowledge represent one BK construct or whether they should be considered separate constructs of BK for this population.

Another important aspect of BK is its relation with vocabulary. Background knowledge has exhibited a strong correlation with vocabulary for readers of different ages, with *r*s ranging from .52 to .71 (Ahmed et al., 2016; Cromley & Azevedo, 2007). An explanation for this association may be that individuals can acquire vocabulary and general knowledge together through exposure to new contexts (Hirsch, 2003). Topical knowledge can illuminate the meaning of a new word, and familiarity with a word can facilitate the understanding of the larger topic. Thus, we were also interested in assessing the strength of the relation between BK and vocabulary knowledge constructs in our models for struggling adult readers.

Background Knowledge and Reading Comprehension

Since the 1980s, researchers have reported on the relationship between BK and RC for school-age children. Baldwin et al. (1985) found that seventh- and eighth-grade students who scored higher on assessments of BK relevant to expository passages had higher RC scores for those passages. In another study with seventh- and eighth-grade students, Recht and Leslie (1988) first had participants complete an assessment of baseball knowledge and then read a narrative passage describing part of a baseball game. Participants with high baseball knowledge were able to recall the events in the passage more accurately. Similarly, Hall and Edmondson (1992) reported a positive correlation between undergraduates' basketball knowledge and their comprehension of a passage on basketball history. This relationship remained even when participants were re-tested on the passage one week later. Together, these three studies suggest that children and young adults with high BK are more likely to understand relevant text passages.

Dole et al. (1991) used an experimental design to test the effect of BK on RC with children. In this study, fifth-grade students received two different instructional treatments regarding BK: a teacher-directed condition in which teachers taught BK to students and an interactive condition in which teachers helped participants activate their own BK. A different set of narrative and expository passages was used for each treatment. Receiving teacher-directed instruction in BK resulted in the best RC performance. This experimental finding delineates the direction of the BK-RC relationship: acquiring BK leads to better performance on RC tasks, at least for children.

Interestingly, even when Dole et al.'s participants merely activated their existing BK, they had higher RC scores than in the control condition. The effectiveness of activating BK was further demonstrated by Spires and Donley's (1998) study with ninth-grade students. In this

study, some participants were taught to connect text content to their own BK as they read a passage while others did not learn this strategy. All participants read passages and completed literal questions that directly tested the reader on content, and application questions that required the reader to make arguments or inferences beyond the content. Participants who had learned the BK activation strategy outperformed others only on the application questions. These results suggest that BK activation promotes a higher-order understanding of text for adolescents.

Ozuru and colleagues have linked BK to RC for undergraduates, providing evidence that BK is positively correlated with RC (Ozuru et al., 2007) and can explain unique variance in RC (Ozuru et al., 2009) in this population. Interestingly, Ozuru et al. (2007) reported the positive correlation between BK and RC only for participants who could not access the passage while answering the RC questions. In other words, this relationship was not found for participants who were allowed to access the passage while answering the RC questions. This pattern of results provides insight into the nuances of the BK-RC relationship and implies that BK may be most useful in recalling text content when the text itself is unavailable.

Clearly, research with children and undergraduates indicates that BK contributes to RC. It is not yet known whether a similar effect exists for struggling adult readers. Our primary aim in the current study was to test the possibility of incorporating BK into a model of reading comprehension for struggling adult readers. We used the SVR as our theoretical framework, given that this model has been successfully applied to samples of struggling adult readers (Barnes et al., 2017; Braze et al., 2007; Sabatini et al., 2010); however, we view this as a preliminary lens in which we wish to develop a more complex model that incorporates all facets of RC for this population.

Present Study

We used latent variable modeling to investigate the nature of the BK construct, inter-relations among BK and the SVR components, as well as the direct effects of BK to RC for adults who read below the high school level. The other predictors of RC in our models were the three components of the SVR: decoding, listening comprehension, and oral vocabulary knowledge. We addressed three research questions:

1. What is the underlying factor structure of BK for struggling adult readers?
2. What is an appropriate measurement model of BK in conjunction with the SVR components?
3. Does BK predict individual differences in RC after controlling for participants' highest grade completion and the components of the SVR?

Method

Participants

The participants were 222 students in adult education programs in the United States who were part of a larger study (Institute of Education Sciences, U.S. Department of Education, Grant R305C120001). All participants read between the 3rd and 8th grade levels, as indicated by their adult literacy programs. All participants were native English speakers, primarily African American, with ages ranging from 16-71 years with a mean of 37 years (*SD* = 15.54), and a mean grade level completion of 10.13 (*SD* = 1.75). (Individuals who are 16 years of age or older are allowed to enroll in adult literacy programs if they are not attending high school.) Table 1 includes a summary of the participants' demographic information.

Measures

Performance on 11 measures from the larger study was analyzed in the current study. Assessments were administered one-on-one to participants in quiet environments at their adult literacy centers over multiple sessions. Most of the measures were from the Woodcock-Johnson (WJ) III Normative Update (Woodcock, McGrew, & Mather, 2007), with the exception of the Test of Irregular Word Reading Efficiency (TIWRE; Reynolds & Kamphaus, 2007) and two measures from the Clinical Evaluation of Language Fundamentals (CELF), Fourth Edition (Semel, Wiig, & Secord, 2003). As is common with adult literacy research (e.g., Hall et al., 2014), we started administration with easier items with the aim to reduce testing anxiety, although basal and ceiling rules stated in the test manuals were followed.

Background Knowledge. We included two measures of BK, which assess academic and general knowledge, respectively. WJ Academic Knowledge (WJAK) consists of three subtests: Science, Social Studies, and Humanities. Participants are asked to answer orally presented questions about the respective domains. Administration started at Item 10 for the Science subtest, Item 11 for the Social Studies subtest, and Item 8 for the Humanities subtest.

WJ General Information (WJGI) consists of two subtests: Where and What. In the Where subtest, participants are asked to identify where one would usually find objects or things presented orally. In the What subtest, participants are asked to explain what one would usually do with objects or things presented orally. Administration started at Item 1 for both WJGI tests.

Reading Comprehension. We administered WJ Passage Comprehension (WJPC) to measure RC. Participants are asked to silently read connected texts containing one to two sentences. In each item, there is a missing word that participants have to provide orally. Administration started at Item 14.

Decoding. We included three measures of decoding, each differing in the type of stimuli or the nature of the reading task. In WJ Letter-Word Identification (WJLWI), participants are presented with real words and asked to read them out loud. Administration started at Item 33. In WJ Word Attack (WJWA), participants are presented with pseudowords and asked to read them out loud; administration started at Item 4. In the TIWRE, participants are presented with irregularly spelled words and asked to read them out loud. Administration started at Item 1.

Listening comprehension. We included two measures of listening comprehension, both of which required participants to listen to audio recordings using headphones. In WJ Story Recall (WJSR), participants hear stories and then retell them as accurately as possible. Administration started at Story 5. In WJ Understanding Directions (WJUD), participants are presented with pictures and follow increasingly complex audio instructions to sequentially point to different parts of the pictures. Administration started at Picture 2.

Oral Vocabulary Knowledge. We included three measures of oral vocabulary knowledge. In WJ Picture Vocabulary (WJPV), participants look at pictures of objects and are asked to name each object. Administration started at Item 15. In CELF Word Classes (CWC), participants listen to four words at a time and choose which two of those words are related; then, participants describe the relationship between the two words. In CELF Word Definitions, (CWD), participants listen to words in isolation and then in the context of a sentence, and are asked to provide a definition for each word. Administration started at Item 1 for the CELF subtests.

Educational Grade Level Completion. As part of the demographic information in this study, we asked participants to report the highest grade level that they have completed. This continuous variable was utilized as a control in the analyses.

Results

Participants' performance on all measures and the BK subtests is summarized in Table 2. Correlations between measures are summarized in Table 3. Most notably, RC was positively correlated with both measures of BK: WJAK (r = .62, p < .001) and WJGI (r = .57, p < .001).

Data Analytic Strategy

To address our three research questions, confirmatory factor analyses (CFAs) and structural equation models (SEMs) were run in Mplus, Version 7.4 (Muthén & Muthén, 1998-2015). Prior to running the models, 59 outliers were identified and brought to the boundaries of +/- two interquartile ranges. Given the limited amounts of missing data points (no more than 26 missing values on a single variable), maximum likelihood (ML) estimation was utilized in Mplus. For all model fit indices, we relied on Hu and Bentler's (1998) standards of acceptable fit: Root Mean Square Error of Approximation (RMSEA) values less than .08, Tucker Lewis Index (TLI) and Comparative Fit Index (CFI) values greater than .95, and Standardized Root Mean Square Residual (SRMR) values of less than .05. We present our results by research question below.

RQ1: Factor Structure of Background Knowledge

To investigate the factor structure of the background knowledge construct, a single-factor CFA was compared to a two-factor (Academic Knowledge and General Information) CFA. The single factor CFA included the three subtests of the WJAK and two subtests of the WJGI as indicators (see Figure 1). All factor loadings were significant (ps < .001) and at or above .67. This model exhibited excellent fit to the data, ($\chi^2(5) = 3.49$, p = .626, CFI = 1.00, TLI = 1.00, RMSEA = .000, and SRMR = .014; Table 4).

The two-factor CFA separated the subtests of the WJAK and WJGI as distinguishable, but correlated constructs (see Figure 2). This CFA also achieved excellent model fit, ($\chi^2(4) = 3.101$, $p = .541$, CFI = 1.00, TLI = 1.00, RMSEA = .000, and SRMR = .015; Table 4). However, the correlation between the WJAK and WJGI factors was .98, indicating that these are not separable constructs. A chi-square difference test also revealed that the single factor model provided the most parsimonious fit to the data ($\chi^2(1) = .389$, $p = .533$). Therefore, we treated background knowledge as a unidimensional factor in all subsequent models.

RQ2: Measurement Model of Component Reading Skills

To examine the factor structure of background knowledge in conjunction with the SVR component skills, a 4-factor CFA was run. This model included latent factors of background knowledge, decoding (with WJLWI, WJWA, and TIWRE as indicators), oral vocabulary knowledge (with WJPV, CWC, and CWD as indicators), and listening comprehension (with WJUD and WJSR as indicators). This model exhibited a not positive definite latent variable covariance matrix due to a perfect correlation (1.0) between the background knowledge and oral vocabulary knowledge latent factors. Therefore, we do not report model fit and instead we attempted to understand the nature of the linear dependency between these two constructs using post-hoc modeling.

Based on the modification indices, the WJPV task wanted to load on the background knowledge latent variable. This modification seemed permissible because all of our background knowledge indicators were also measures from the WJ, thus, this may be a facet of the relatedness of subtests from the same assessment. We re-ran this 4-factor model (see Figure 3) and all indicators loaded appropriately on the corresponding constructs (at or above .56, ps < .001). The model achieved acceptable fit to the data ($\chi^2(59) = 78.01$, $p = .049$, CFI = .986, TLI =

.981, RMSEA = .038, and SRMR = .042; Table 4). Inter-factor correlations were moderate to strong between constructs (*r*s = .27-.83). Given the acceptable model fit and factor loadings, we retained this measurement model to investigate predictors of reading comprehension.

To ensure that we selected the most statistically supported model, we also tested alternate models. We re-ran the preferred 4-factor model with WJPV cross-loaded onto the vocabulary and background knowledge latent factors. The global model fit indices were almost identical to those of the preferred model ($\chi^2(58) = 77.45$, $p = .045$, CFI = .986, TLI = .981, RMSEA = .039, and SRMR = .042) as well as AIC and BIC values[1]. However, in the cross-loaded model, the WJPV only loaded significantly on the BK factor (.896, $p < .001$) and exhibited a virtually zero, non-significant loading on the vocabulary factor (-.097, $p = .466$). This suggests that although global fit remains similar because only a cross-loaded task is being altered between models (losing 1 degree of freedom for cross-loading) it is not appropriate for the task to cross-load on the vocabulary factor. Thus, of these two models, the preferred model without cross-loading should be retained because it is more parsimonious. Additionally, we ran a 3-factor CFA, which included latent factors of decoding, language comprehension, and background knowledge/vocabulary (as a single construct). This model had worse fit than our preferred model ($\chi^2(62) = 104.31$, $p < .001$, CFI = .969, TLI = .961, RMSEA = .055, and SRMR = .051). The chi-square difference test between these two nested models was significant ($\chi^2(3) = 26.3$, $p < .001$), which indicates that the preferred 4-factor model provides a better fit to the data.[2]

[1] For the 4-factor model with WJPV loaded on background knowledge, AIC = 6713.18 and BIC = 6866.31. For the 4-factor model with WJPV cross-loaded on both background knowledge and vocabulary, AIC = 6714.62 and BIC = 6871.15.

[2] Please note, in line with reviewer suggestions, we also considered a single construct of BK/vocabulary as well as a single construct of language comprehension/vocabulary (in line with the SVR); however, the 4-factor CFA reported with separate BK (with WJPC), oral vocabulary, decoding, and language comprehension provided the most parsimonious fit to the data.

RQ3: Predictors of Reading Comprehension

A 4-factor SEM was run to investigate the unique and shared contributions of the background knowledge, decoding, oral vocabulary knowledge, and listening comprehension predictors to reading comprehension (see Figure 4). We also controlled for the participants' highest grade level completed in this model. A single, observed measure (WJPC) was used as our outcome reading comprehension assessment. The model exhibited excellent fit to the data ($\chi^2(81) = 122.13$, $p = .002$, CFI = .974, TLI = .966, RMSEA = .048, and SRMR = .044; Table 4). The four latent factors and grade level accounted for approximately 67% of the reading comprehension variance. Controlling for other predictors in the model, background knowledge ($\beta = .35$, $p = .017$, $R^2 = 3.8\%$), decoding ($\beta = .38$, $p < .001$, $R^2 = 12.2\%$), and listening comprehension ($\beta = .49$, $p = .006$, $R^2 = 10.0\%$) all exhibited significant direct effects on reading comprehension. Oral vocabulary knowledge ($\beta = -.19$, $p = .382$) and grade level ($\beta = .05$, $p = .291$) were not significant, unique predictors of reading comprehension (see Figure 4).

Discussion

The main purposes of this study were to investigate the factor structure of BK and test whether BK should be included in an RC model with the SVR components for struggling adult readers. We found that BK represents a single dimension encompassing broad academic and general knowledge for our sample. However, once we added oral vocabulary knowledge to our model, one measure also loaded with our BK latent factor. After controlling for decoding, listening comprehension, and oral vocabulary knowledge, this BK factor was a significant predictor of RC, explaining 4.8% of unique variance. These findings indicate a role for BK in the context of the SVR skills, which has implications for research and practice.

Struggling Adult Readers' Background Knowledge

To the best of our knowledge, this is the first study to include struggling adult readers' performance on the WJAK and WJGI. In the best fitting model for BK, the three WJAK subtests and the two WJGI subtests all loaded onto one factor (see Figure 1). These results imply that participants' knowledge across different domains is so highly interrelated that it is best represented by a single latent ability. One of the aims of our study was to examine evidence for conceptualizing struggling adult readers' BK. Our findings demonstrate that BK is comprised of both academic and general knowledge for this population.

Enhanced BK may result in practical benefits for individuals in adult education programs. According to Strucker (2013), academic and general knowledge is necessary for success on the newest version of the General Educational Development (GED®[3]) test, which provides individuals the opportunity to complete a high school equivalency degree. The GED® was revised in recent years to be more challenging in terms of content knowledge, especially in science and social studies (Strucker, 2013). Moreover, the College and Career Readiness standards for reading and writing emphasize the importance of building knowledge in various domains (Pimentel, 2013). Such knowledge is expected to aid adults in evaluating texts, contributing to discussions, and writing persuasive compositions in postsecondary and professional settings.

The Role of Background Knowledge in Conjunction with the Simple View of Reading

This study adds to the prior empirical evidence for using the SVR framework with struggling adult readers (Barnes et al., 2017; Braze et al., 2007; Sabatini et al., 2010). Scores on

[3] The authors and this work are not affiliated with or endorsed by ACE or GED Testing Service LLC. Any reference to "GED" in the title or body of this work is not intended to imply an affiliation with, or sponsorship by, ACE, GED Testing Service LLC, or any other entity authorized to provided GED® branded goods or services.

the RC measure were positively correlated with scores on measures of decoding, listening comprehension, and oral vocabulary knowledge. In Model 3, decoding and listening comprehension explained unique variance in RC after controlling for all other predictors (see Figure 4). Oral vocabulary knowledge did not make a significant unique contribution to RC, even when we reran the model after excluding the BK factor. It appears that after taking into account the contributions of decoding and listening comprehension, oral vocabulary knowledge does not have a significant direct effect on RC, which is congruent with Sabatini et al.'s (2010) findings.

Notably, BK was highly correlated with RC, which reflects relations reported in research with other populations (e.g., Hall & Edmondson, 1992; Ozuru et al., 2007). Adding BK in the same model as the SVR components revealed a significant direct effect of BK on RC. The results of Model 2 indicate that BK is an independent construct that is separable from decoding and listening comprehension (see Figure 3). This measurement model did not demonstrate a clear separation between BK and oral vocabulary knowledge; WJPV loaded onto the BK factor, likely because it is a WJ subtest, similar to the BK measures. The model also showed that BK was strongly correlated with oral vocabulary knowledge and listening comprehension (*r*s > .70) but not with decoding ($r = .28$).

Overall, Model 3 illustrates that while decoding and listening comprehension are certainly important predictors of RC for struggling adult readers, BK also makes a significant, unique contribution (see Figure 4). Together BK and the SVR components accounted for approximately 67% of variance in RC. The findings of the model suggest that researchers studying RC in the adult literacy context may find it meaningful to also measure BK and explore its predictive utility for RC. Predictors other than decoding and listening comprehension should

be tested in models to sufficiently explain individual differences in the RC skills of a heterogeneous population such as adults with low literacy skills (Barnes et al., 2017; Braze et al., 2007).

Limitations

One limitation of the current study was the measurement of RC. Because the larger study only included a single RC measure, RC was included as an observed variable instead of a latent factor, unlike BK, decoding, listening comprehension, and oral vocabulary knowledge. Additionally, the format of WJPC is different from that of the RC measures used in previous BK studies. Most researchers asked participants to answer multiple-choice or open-ended questions about the text passages they had read (e.g., Dole et al., 1991; Ozuru et al., 2009; Spires & Donley, 1998), while Recht and Leslie (1988) asked participants to recall the content of a narrative passage by verbally recounting the events and also by nonverbally reenacting the events with figures. In contrast to these approaches, the WJPC requires the test takers to read items ranging from one to three sentences and orally fill in a missing word in each item. Although we found evidence for the BK-RC relationship that has been reported by other researchers, it is important to note that our results may have been different had we assessed RC using questions or retelling instead of a cloze format.

Similarly, the nature of our listening comprehension measures may have influenced the results. Gough and Tunmer (1986) referred to linguistic comprehension as the ability to interpret spoken "sentences and discourses" (p. 7). Our approach of testing participants' comprehension of auditory directions or short stories differs from other ways of assessing listening comprehension in samples of struggling adult readers. For instance, Mellard and colleagues have administered the Listening to Paragraphs subtest of the CELF, in which participants listen to paragraphs and

orally answer questions about each paragraph (Mellard et al., 2010; Mellard & Fall, 2012). Other researchers have used the WJ Oral Comprehension subtest, in which participants listen to short passages and provide a missing word to complete each passage (Barnes et al., 2017; Sabatini et al., 2010). It is possible that the effect of listening comprehension on RC in the current study may have been different had we used these other measures instead of the WJSR and WJUD assessments.

Another limitation is that we restricted our sample to only native speakers of English, because some literature has suggested differences in reading-related constructs (e.g., word reading and fluency) between native and non-native speakers of English (e.g., Nanda et al., 2010). This decision limited the sample size and the generalizability of results to non-native speakers of English.

Finally, the low Cronbach's alpha reliability coefficients for some of the BK measures, in particular the WJAK Social Studies (.558; Table 2), warrant further investigation into what constitutes appropriate measurement of BK for this population. Items on particular subtests of the WJAK may not be content-aligned with instruction from adult literacy classes and information needed to pass the Science and Social Studies portion of the GED®. Measurement of component skill constructs remains a concern for struggling adult readers as some studies have reported that some norm-referenced assessments (e.g., Comprehensive Test of Phonological Processing [CTOPP]) may be not as reliable for struggling adult readers (e.g., Nanda, Greenberg, & Morris, 2014; Pae, Greenberg & Morris, 2012). Future work with larger sample sizes of adults to permit the use of IRT-based analyses is needed in order to fully understand more of the item structure nuances of using these assessments with struggling adult readers.

Future Research

A few directions for future research can be identified. In an intervention implemented by Dole et al. (1991), teachers taught fifth-grade students facts, ideas, and concepts related to the content of text passages before students read those passages. This direct BK instruction led to higher RC scores than the control condition. Researchers may examine the effects of teaching BK to struggling adult readers. Some pre-reading instruction may already happen in many adult literacy classes, especially in terms of relevant vocabulary being taught before reading text (Curtis, 2006), but BK instruction need not be limited to text-specific information. Concepts from various domains of general and academic knowledge may be taught in a BK intervention. Some Adult Basic Education and Adult Secondary Education programs have increased their focus on instruction in content knowledge, because this approach is expected to improve GED® performance (Strucker, 2013). Given the current study's findings, it is possible that gains in BK, decoding, and listening comprehension could improve struggling adult readers' RC skills.

Another avenue for future research can be identified from the factor model that provided the best fit to the data. In this 4-factor model, WJPV loaded with BK measures instead of other vocabulary measures. There is prior evidence for strong correlations between vocabulary and BK (Ahmed et al., 2016; Cromley & Azevedo, 2007), and both "word knowledge" and "world knowledge" have been found to improve RC (Hirsch, 2003). Researchers may wish to further investigate the relation between BK and vocabulary for struggling adult readers. It is possible that in this population, BK is largely acquired through informal learning, and thus, the ability to visually identify objects and actions (measured by WJPV) can serve as a proxy for general knowledge. It is also possible that differences between vocabulary and BK tasks may be measure-specific, such that WJ subtests loaded together versus CELF subtests. Yet another

possibility is that WJPV does not provide context cues, unlike the CELF subtests, in which target words are used in sentences or presented with related words. Future research should explore different types of BK and oral vocabulary knowledge tasks to further understand the relations and separateness of these constructs with struggling adult readers.

In the Direct and Inferential Mediation (DIME) model proposed by Cromley and Azevedo (2007), BK is one of the five predictors of RC, alongside word reading, inferential ability, vocabulary, and reading strategies. The model additionally hypothesizes that reading strategies mediate the effect of BK on RC, and inferential ability mediates the effects of BK, reading strategies, and vocabulary on RC. The path from BK to RC in the DIME model has emerged as statistically significant for three samples, which included readers in 7th grade through university (Ahmed et al., 2016; Cromley & Azevedo, 2007; Cromley, Snyder-Hogan, & Luciw-Dubas, 2010). Researchers may want to test if the DIME model provides an adequate account of RC for struggling adult readers. This suggested line of research could potentially offer a complex theoretical framework for reading that may be applied to adult literacy, and would move beyond current applications with just SVR skills.

Another direction for future research is comparing struggling adult readers to other populations in terms of BK and its role in predicting RC. Researchers may want to explore the strengths and weaknesses in different knowledge domains of struggling adult readers, skilled adult readers, and school-age children and adolescents. Based on Strucker and Davidson's (2003) report of adult literacy learners' BK performance, it is likely that struggling adult readers will demonstrate a deficit in BK, especially compared to skilled adult readers. Additionally, in two studies analyzing the DIME model with typically developing readers, BK had the largest total

effect on RC out of all five predictors (Cromley & Azevedo, 2007; Cromley et al., 2010). It is possible that this effect may be smaller for struggling adult readers due to their BK deficit.

Finally, the heterogeneity of the struggling adult reader population should be considered in future studies. Researchers may wish to test our model, or a similar model that incorporates BK as a predictor of RC, for native versus non-native speakers of English, as adult literacy programs are comprised of many non-native speakers, in particular Spanish-speakers (Lesgold & Welch-Ross, 2012). Similarly, it may be important to consider generational differences in component skills for older and younger adults, as some evidence has suggested that older struggling adult readers might exhibit deficits in word-level skills (MacArthur, Konold, Glutting, & Alamprese, 2012). Findings from this type of work could lead to interventions that would enable adult literacy practitioners to provide more focused instruction to adult literacy learners that addresses the specific needs of their demographic groups.

Conclusion

The main aim of this study was to investigate the possibility of extending the SVR for struggling adult readers by exploring the contribution of BK to RC. We found that BK can be measured by assessments of both academic and general knowledge, which is important for the GED® test (Strucker, 2013) and College and Career Readiness (Pimentel, 2013). Alongside the two SVR components, BK emerged as a significant predictor of RC after controlling for highest grade completed and the SVR components of decoding, listening comprehension, and oral vocabulary knowledge. Our recommendations for future research with struggling adult readers include identifying their strengths and weaknesses in BK and validating the DIME model of RC.

Note

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Table 1

Number of Participants from Different Demographic Groups

Groups	*n*	%
Gender		
Female	135	60.81
Male	82	36.94
Not reported	5	2.25
Age		
16 – 19 years	29	13.06
20 – 29 years	68	30.63
30 – 39 years	28	12.61
40 – 49 years	30	13.51
50 – 59 years	46	20.72
60 – 69 years	18	8.11
70 – 79 years	1	0.45
Not reported	2	0.90
Highest Completed Grade Level		
Grades 1 – 5	4	1.80
Grades 6 – 8	29	13.06
Grades 9 – 10	66	29.73
Grades 11 – 12	102	45.95
Not reported	21	9.46
Racial Identity		
Black or African American	206	92.79
White	7	3.15
Other	5	2.25
Not reported	4	1.80
Hispanic or Latina/o Identity		
Hispanic or Latina/o	9	4.05
Non-Hispanic and Non-Latina/o	206	92.79
Not reported	7	3.15

Note. $N = 222$. All participants were native English speakers, defined as individuals who satisfied one of these three criteria: (1) speaks only English, (2) speaks more than one language but learned English first, (3) speaks more than one language and did not learn English first, but spoke English growing up, speaks only English at home, and speaks English most often.

Table 2

Participants' Performance on Measures

Measure	Raw Scores			Standard Scores			Cronbach's Alpha
	Mean	Standard Deviation	Range	Mean	Standard Deviation	Range	
WJPC	29.24	4.11	20-39	83.72	9.01	51-107	.794
WJAK (total)	47.09	5.11	31-58	81.16	8.22	45-96	
Science	16.40	2.07	11-22				.663
Social Studies	18.63	2.14	13-24				.558
Humanities	12.17	1.87	8-16				.604
WJGI (total)	26.09	4.40	8-36	82.80	7.45	55-107	
Where	13.34	2.20	8-18				.730
What	12.86	2.23	7-18				.655
WJPV	25.77	3.26	17-35	82.19	5.77	64-101	.745
CWC	22.76	7.56	0-43	11.67	3.55	3-18	.824
CWD	17.00	8.02	0-37	4.84	3.15	1-12	.854
WJSR	36.31	11.26	14-71	85.15	10.51	56-117	.819
WJUD	37.83	6.46	24-51	83.93	8.95	49-116	.882
WJLWI	54.89	8.64	33-72	82.21	10.96	42-106	.930
WJWA	16.56	7.82	2-31	81.11	12.04	35-115	.893
TIWRE	38.34	4.29	29-48	87.66	11.46	46-110	.882

Note. Standard scores are age-based standard scores for subtests of the Woodcock Johnson (WJ) III Normative Update, scaled scores for subtests of the Clinical Evaluation of Language Fundamentals (CELF) IV, and the Reading Efficiency Index for the Test of Irregular Word Reading Efficiency. The standardization scale for CELF Word Definitions has a mean of 10, and the standardization scale for CELF Word Classes has a mean of 20. Due to the fact that the CELF is only standardized through the age of 21, we only have standard scores for 46 of our participants for the CELF subtests. Standard scores for all other measures are on a normalized scale that has a mean of 100 and standard deviation of 15 and include our entire sample. WJPC = WJ Passage Comprehension; WJAK = WJ Academic Knowledge; WJGI = WJ General Information; WJPV = WJ Picture Vocabulary; CWC = CELF Word Classes; CWD = CELF Word Definitions; WJSR = WJ Story Recall; WJUD = WJ Understanding Directions; WJLWI = WJ Letter-Word Identification; WJWA = WJ Word Attack; TIWRE = Test of Irregular Word Reading Efficiency.

Table 3

Correlations

Measures	1	2	3	4	5	6	7	8	9	10	11
WJPC	-										
WJAK	.620***	-									
WJGI	.572***	.767***	-								
WJPV	.546***	.723***	.746***	-							
CWC	.534***	.555***	.505***	.470***	-						
CWD	.412***	.577***	.559***	.518***	.554***	-					
WJSR	.361***	.426***	.302***	.344***	.354***	.307***	-				
WJUD	.517***	.451***	.371***	.344***	.425***	.280***	.349***	-			
WJLWI	.544***	.217**	.237**	.233**	.310***	.290***	.063	.185**	-		
WJWA	.356***	.109	.115	.138	.238**	.199**	.046	.282***	.730***	-	
TIWRE	.517***	.178*	.192**	.242**	.246***	.240**	.081	.221**	.819***	.679***	-
Grade	.067	.108	-.010	-.018	-.034	-.060	.010	.030	.171*	.078	.145*

Note. *** $p < .001$; ** $p < .01$; * $p < .05$. WJPC = WJ Passage Comprehension; WJAK = WJ Academic Knowledge; WJGI = WJ General Information; WJPV = WJ Picture Vocabulary; CWC = CELF Word Classes; CWD = CELF Word Definitions; WJSR = WJ Story Recall; WJUD = WJ Understanding Directions; WJLWI = WJ Letter-Word Identification; WJWA = WJ Word Attack; TIWRE = Test of Irregular Word Reading Efficiency; Grade = highest grade completed.

Table 4

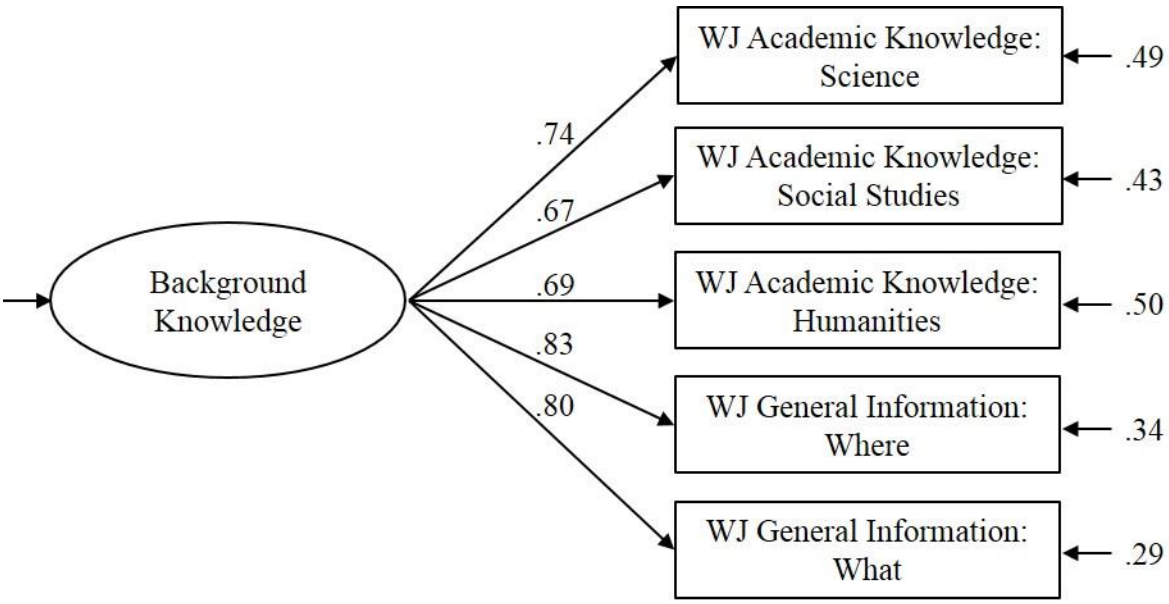
Fit Indices for all Tested Models

Model	Description	*df*	χ^2	*p*	RMSEA	CFI	TLI	SRMR
1(a)	One-factor CFA for BK	5	3.485	.626	.000	1.000	1.000	.014
1(b)	Two-factor CFA for BK	4	3.101	.541	.000	1.000	1.000	.013
2	CFA for BK, OVK, LC, D	59	78.007	.049	.038	.986	.981	.042
3	SEM for RC	81	122.130	.002	.048	.974	.966	.044

Note. BK = background knowledge; CFA = confirmatory factor analysis; D = decoding; LC = listening comprehension; OVK = oral vocabulary knowledge; RC = reading comprehension; SEM = structural equation model.

Figure 1

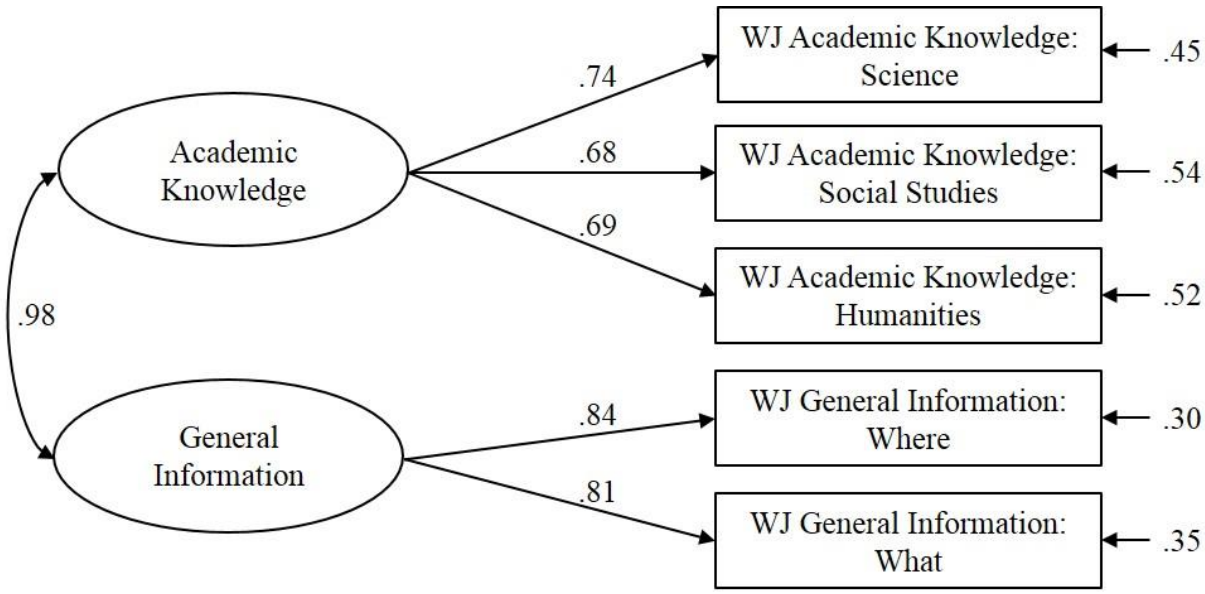
Model 1(a): One-Factor Confirmatory Factor Analysis for Background Knowledge



Note. Standardized estimates are shown.

Figure 2

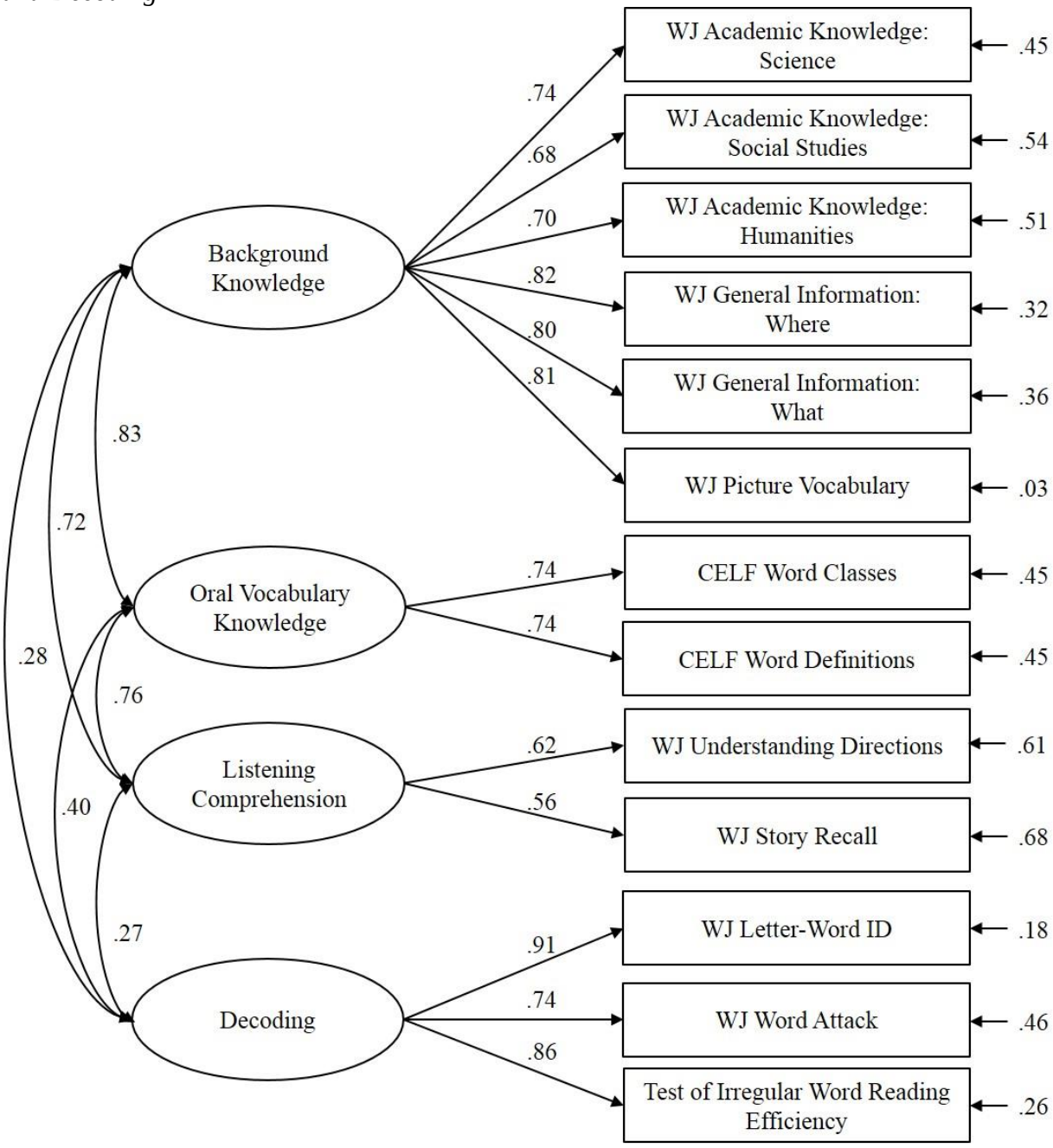
Model 1(b): Two-Factor Confirmatory Factor Analysis for Background Knowledge



Note. Standardized estimates are shown.

Figure 3

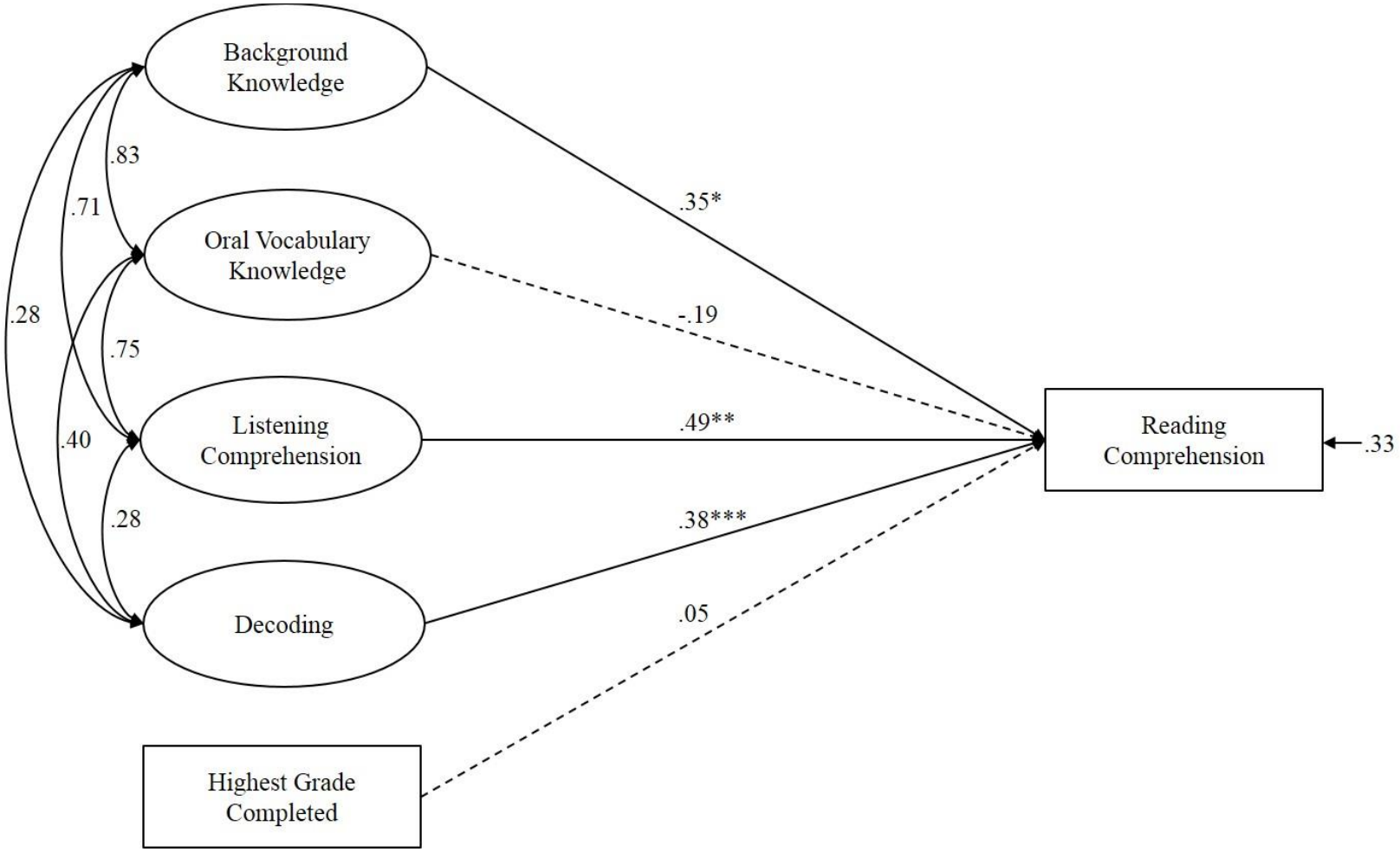
Model 2: Confirmatory Factor Analysis for Background Knowledge, Listening comprehension, and Decoding



Note. Standardized estimates are shown.

Figure 4

Model 3: Structural Equation Model for Reading Comprehension



Note. *** $p < .001$; ** $p < .01$. *$p < .05$ Standardized estimates are shown.