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Exploring Reading Skills and Strategies Among Struggling Postsecondary Readers

Daniel Feller

ACCEPTANCE

This dissertation, EXPLORING READING SKILLS AND STRATEGIES AMONG STRUGGLING POSTSECONDARY READERS, by DANIEL P. FELLER, was prepared under the direction of the candidate's Dissertation Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree, Doctor of Philosophy, in the College of Education & Human Development, Georgia State University.

The Dissertation Advisory Committee and the student's Department Chairperson, as representatives of the faculty, certify that this dissertation has met all standards of excellence and scholarship as determined by the faculty.

_____
Joseph Magliano, Ph.D.
Committee Chair

_____
Daphne Greenberg, Ph.D.
Committee Member

_____
Kathryn McCarthy, Ph.D.
Committee Member

_____
Scott Crossley, Ph.D.
Committee Member

_____
Date

_____
Brendan Calandra, Ph.D.
Chairperson, Department of Learning Sciences

_____
Paul A. Alberto, Ph.D.
Dean, College of Education &
Human Development

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Daniel P. Feller
Department of Learning Sciences
College of Education & Human Development
Georgia State University

The director of this dissertation is:

Joseph Magliano
Department of Learning Sciences
College of Education & Human Development
Georgia State University
Atlanta, GA 30303

CURRICULUM VITAE

Daniel P. Feller

ADDRESS: 3975 Carlinswood Way
Stone Mountain, GA 30083

EDUCATION:

Ph.D.	2022	Georgia State University Educational Psychology
M.A.	2018	Northern Illinois University Cognitive and Instructional Psychology
B.S.	2013	Weber State University Psychology

PROFESSIONAL EXPERIENCE:

2018 - Present	Research Fellow Center for the Study of Adult Literacy Georgia State University
2016 - 2019	Research Assistant Department of Psychology Northern Illinois University
2011 - 2013	Research Assistant Department of Psychology Weber State University

PUBLICATIONS:

Magliano, J. P., Talwar, A., **Feller, D. P.**, Wang, Z., O'Reilly, T., & Sabatini, J. (in press). Exploring thresholds in the foundational skills for reading and comprehension outcomes in the context of postsecondary readers. *Journal of Learning Disorders.*

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EXPLORING READING SKILLS AND STRATEGIES AMONG STRUGGLING POSTSECONDARY READERS

by

DANIEL P. FELLER

Under the Direction of Joseph Magliano

ABSTRACT

Many students enter college underprepared to meet the literacy demands they encounter. There are calls for cognitively oriented research aimed at understanding the strengths and challenges of these readers, especially those enrolled in developmental education courses designed to improve literacy skills. The purpose of this dissertation was to better understand the basis of the difficulties faced by struggling college readers.

In chapter one, the Reading Systems Framework (RFS; Perfetti & Stafure, 2014) was utilized to examine prior research on struggling college readers and accordingly, research related to word identification, lexical processes, and higher-level comprehension strategies was explored. Additionally, literature exploring complex, interactive relations between reading

systems was explored. The review illustrates the utility of the RSF to understand struggling college readers and identifies areas where more research is needed.

Chapter two presents a study that examined the relations among proficiency in component reading skills, one's propensity to engage reading strategies, and enrollment in DE courses. Participants (N = 258) completed a measure of component reading skills (word recognition/decoding, vocabulary, morphology, sentence processing) as well as a think-aloud measure, wherein they produced written responses while reading texts. Responses were scored based on evidence of reading strategies (paraphrasing, bridging, and elaboration) and their overall quality in supporting comprehension. Logistic regression was used to assess the extent to which one's proficiency in component reading skills and use of reading strategies could be utilized to predict whether participants were enrolled in DE courses. Results indicated that proficiency in reading skills was related to enrollment in DE courses but that the use of reading strategies was not. Cumulative links mixed effects models were used to assess the extent to which proficiency in component reading skills and DE enrollment were differentially related to the use of reading strategies and the overall quality of participant's responses. Results indicated that vocabulary was a positive predictor of bridging and elaboration scores. Moreover, vocabulary and word recognition/decoding positively predicted the overall quality of responses. DE enrollment was a negative predictor of elaboration scores, suggesting that DE readers were less likely to produce elaborations. Implications for theory and practice are discussed.

INDEX WORDS: reading comprehension; developmental education; reading strategies; reading proficiency; Reading Systems Framework

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DEDICATION

This dissertation is dedicated, first and foremost, to my loving partner. It's been a crazy, magical journey that has, both literally and figuratively, led us across the country, through mountains and valleys. You have been a constant source of love and support and I couldn't have made it here without you. I also dedicate this to my children. You inspired and gave me hope daily. I hope that one day you understand and appreciate what this meant for me and our family. I hope you see the beauty that a curious heart and determined mind can bring. May you never stop wondering.

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LIST OF ABBREVIATIONS

DE – Developmental Education

RSAT – Reading Strategies Assessment Tool

RSF – Reading Systems Framework

SARA – Study Aid and Reading Assessment

SVR – Simple View of Reading

EXPLORING THE STRUGGLING POSTSECONDARY READER THROUGH THE READING SYSTEMS FRAMEWORK

It is estimated that approximately 75% of community college and 50% of four-year college students lack proficiency in the literacy skills necessary to succeed in college (American Institutes for Research, 2006; ACT, 2006; Holschuh & Paulson, 2013). Without proficiency in reading, first-year students often struggle to do well in courses and, consequently, complete their degrees (Bailey, 2009; Bailey et al., 2010). This is no new problem (Stahl & Armstrong, 2018), and many institutions across the nation have established programs designed to help students in need of supplemental education (e.g., supplemental, or developmental literacy programs). While some research has explored issues specific to struggling postsecondary students, there has been a call for more theoretically grounded investigations into the difficulties faced by these readers (Perin, 2013, 2020).

Given its emphasis on a wide range of reading processes and the relations among them, the Reading Systems Framework (RSF; Perfetti & Stafura, 2014) provides a valuable lens to explore comprehension difficulties among struggling readers. The RSF specifies that comprehension emerges as a result of complex word-to-text integration processes. Specifically, the RSF assumes that comprehension involves interactions among word identification systems (e.g., decoding, word recognition), lexical processes (e.g., vocabulary, morphology), and higher-level comprehension processes (e.g., sentence processing, inferencing). The RSF is, therefore, a unique framework that spans reading processes across multiple levels and emphasizes the importance of relations that exist between these levels.

The purpose of this chapter is to explore the challenges faced by struggling postsecondary students using the RSF as a lens. This chapter focuses specifically on struggling

postsecondary readers—both those defined as struggling by institutional standards (as will be defined shortly) as well other, non-designated readers who show difficulties with reading. In discussing the challenges faced by struggling readers, an emphasis will be placed on problems within specific reading systems and problems that may arise as a result of complex interactions between reading systems. Understanding the challenges faced by struggling postsecondary students will enable researchers and educators to target specific areas for research, instruction, and intervention (McMaster et al., 2012, Perin, 2020).

The Struggling Postsecondary Reader

There are two literatures reviewed in this chapter that are germane to struggling college readers. The first literature addresses readers who are institutionally designated as struggling or "at risk" by institutional standards (e.g., Bailey 2009; Jaggars & Stacey, 2014; Scott-Clayton & Rodriguez, 2012) and the second consists of cognitively oriented research focused on individual differences among college readers (e.g., Landi, 2009; Martino & Hoffman, 2002; Welcome et al., 2009). How these types of readers are identified in both areas of research is briefly discussed below.

Readers Designated as Struggling

Students entering postsecondary education often start by completing placement tests designed to assess the extent to which they possess the skills necessary to succeed in college-level courses (Bailey & Jaggers, 2016; Elliot et al., 2012; Hughes & Scott-Clayton, 2011). Based on these test scores, students designated as underprepared by state or institutional standards may be advised or required to enroll in *developmental education* (DE) courses. DE courses (also referred to as remedial, pre-education, or basic courses) are designed to help students improve basic skills and reach the level of preparedness necessary to succeed in credit-bearing courses

(Bailey et al., 2010; Chen, 2016; Hughes & Scott-Clayton, 2011; Perin, 2020). These programs do not exist at all institutions and are found more commonly among 2-year than 4-year institutions.

Developmental education has become the subject of much controversy over the course of the last 10 to 15 years and many have called into question the effectiveness of DE programs (e.g., Bailey 2009; Bailey et al., 2010; Jaggars & Stacey, 2014; Levin & Calcagno, 2008; Scott-Clayton & Rodriguez, 2012; Silver-Pacuilla et al., 2013). Research suggests that less than half of students enrolled in DE programs end up completing enough of the required DE courses to gain access to credit-bearing courses (Bailey et al., 2010). Moreover, as few as 28% of students enrolled in DE programs graduate within eight years of enrollment (Jaggars & Stacey, 2014). Despite this lack of success, billions of dollars are spent annually on DE programs—a cost that is incurred by students, institutions, and taxpayers alike (Crisp & Delgado, 2014; Jaggars & Stacy, 2014; Strong American Schools, 2008).

Although there is a large portion of research focused on DE programs and their efficacy, much of this work is policy oriented. As such, research has typically been focused on comparing 1) DE and non-DE students in terms of retention or graduation rates (e.g., Bailey et al., 2010; Crisp & Delgado, 2014; Laskey & Hetzell, 2011), 2) the effectiveness of different types of DE programs (e.g., accelerated DE programs; Hodara & Jaggars, 2014), or 3) the effectiveness of different types of DE instruction (e.g., Ari, 2011; Caverly et al., 2004; Lavonier, 2016; Perin, 2013; Robson, 2009; Williams et al., 2014). Arguably, additional research is needed on the strengths and challenges of DE students with respect to literacy skills (Perin, 2020). The purpose of this chapter is to review what research exists through the lens of the RSF. Understanding the

literacy-related challenges faced by DE readers will allow institutions and instructors to improve DE courses and enhance student outcomes.

Non-Designated Struggling Readers

Another branch of research has focused on individual differences in reading among college students. This research tends to assess proficiency in a number of reading-related skills and examines the relations among these skills or between these skills and an outcome variable (e.g., comprehension). As opposed to research that works directly with readers designated as struggling (e.g., DE readers), this research typically samples a group of college readers and defines a subset of readers as struggling based on experimenter generated or standardized tests scores (e.g., Nelson Denny; ACT). As such, readers in these studies are often characterized as "low-skilled readers," "poor comprehenders," or "low-proficiency readers" and are compared to "high skill" or "proficient readers" from the same sample on a number of individual difference factors (e.g., Bell & Perfetti, 1994; Landi, 2009; Haenggi & Perfetti, 1994; Martino & Hoffman, 2002; Welcome et al., 2009). This chapter focuses on a portion of this cognitively oriented research, which affords greater insights into the skills and abilities possessed by struggling readers more broadly. Although readers in these studies may not be directly comparable to DE readers at every level, they represent readers at the lower end of the continuum (Cormier & Bickerstaff, 2020; Greenberg, 2008). Struggling college readers appear to be comprised of a heterogenous population with varying skill and this chapter explores the strengths and challenges of these readers through the RSF.

The Reading Systems Framework

The RSF is a broad-scope view of reading comprehension that differs from other prominent theories of reading and discourse comprehension. For example, the Simple View of

Reading (SVR; Gough & Tunmer, 1986) is a widely accepted view of reading comprehension and has been used among various populations (e.g., Rose, 2006; Sabatini et al., 2010). The SVR posits that reading comprehension is the product of decoding and oral language comprehension skill. Although the SVR has been shown to account for a large portion of variance in numerous studies (see Rose, 2006 for review), it is often criticized as an overly simplistic view of comprehension (Florit & Cain, 2011; Johnston & Kirby, 2006; Kirby & Savage, 2008). In contrast to the SVR, the RSF is informed by a more comprehensive understanding of the different levels of language processing that operate at the word, lexical, and discourse level (e.g., McClelland & Rumelhart, 1986) and theories of text comprehension (e.g., Kintch, 1988). The RSF differs from other theories of reading comprehension in that it 1) reflects comprehension more broadly by connecting multiple levels of processing as opposed to focusing on a limited set of reading processes in isolation from one another (Hannon & Daneman, 2001; McNamara & Magliano, 2009), and 2) specifies and underscores the importance of relations that exist between component reading skills, as opposed to combining multiple components reading skills into a single factor (e.g., Gough & Tunmer, 1986; Hoover & Gough, 1990).

There are a series of assumptions that underlie the RSF. First, the RSF assumes that reading involves a set of subprocesses that operate at the ***word identification***, ***lexical***, and ***comprehension*** levels. These processes operate asynchronously (i.e., may start and stop at different times) and in parallel (McClelland & Rumelhart, 1986). The RSF postulates that the systems that support processing at these different levels are highly interconnected such that there are interactions within and between various reading processes and the knowledge sources that support them (Perfetti & Stafura, 2014). For example, the RSF posits there are direct connections between the systems that support word identification (i.e., decoding, word recognition), lexical

(i.e., vocabulary, morphology), and comprehension-level processes (i.e., constructing accurate representations of sentences and establishing connections between sentences).

Second, the RSF assumes comprehension arises through complex integration processes. Like other models of comprehension, the RSF assumes that words in a text are processed and integrated into a reader's mental representation, which is continuously updated to reflect a reader's understanding (Kintsch, 1988; Perfetti et al., 2008; Zwaan & Radvansky, 1998). However, unique from other models that assume that integration operates on propositional representations constructed from reading text sentences (e.g., Kintsch, 1988), the RSF assumes that integration operates at multiple levels of processing. The RSF posits that integration primarily occurs at a word-by-word level, which is referred to as *word-to-text integration* (Perfetti & Stafura, 2014). According to Perfetti and Helder (2021), word-to-text integration "is the incremental accrual of text understanding on a word-by-word basis" (p. 16). While the exact mechanisms through which this process occurs are not described in detail, the RSF emphasizes the role of passive memory processes. Word-to-text integration involves the construction of a semantic network of the knowledge activated by lexical processing (Perfetti & Helder, 2021; Perfetti et al., 2008). The output of lexical processing then serves as input to processes that guide syntactic, sentence-level semantic processes. Thus, the RSF places the word at the center of integration process, wherein semantic representations are quickly and (largely) passively integrated into ongoing sentence-level representations. This is akin to the Landscape Model of comprehension (Linderholm et al., 2004; Tzeng et al., 2005; van den Broek et al., 2005), which moves away from the proposition as the main unit of analysis and places greater emphasis on the role each word of the text plays in the integration process (McNamara & Magliano, 2009; van den Broek et al., 2002).

According to the RSF, the quality of a reader's lexical representations affects the ease at which word-to-text integration processes occur (i.e., Perfetti, 2007; Perfetti & Adlof, 2012). This has been called the *Lexical Quality Hypothesis* (LQH; Perfetti, 2007). Readers with high quality lexical representation have "accessible, well-specified and flexible knowledge of word forms and meanings" (Perfetti & Adlof, 2012, p. 9). This includes knowledge of a word's spelling, pronunciation, and meaning (Perfetti, 2007). Efficient and accurate processing at lower levels allows one to have high quality representations. These high-quality representations allow a reader to quickly activate appropriate word meanings based on context with minimal processing effort, which eases the integration process. Thus, one's ability to integrate words into sentence-level representations is contingent on the activation of high-quality lexical representations (Perfetti, 2007).

Although the RSF focuses primarily on local integration processing that occurs within or between sentences (i.e., at the cross-sentence-level) through word-to-text processing, the RSF also assumes that integration occurs at the discourse level (Perfetti & Helder, 2021). Integration at the discourse level reflects inferences that establish how higher-order semantic representations derived from sentence-level processes are connected. This may require inference generation (e.g., Graesser et al., 1994) and may be influenced by a reader's goals (e.g., Helder et al., 2020; Perfetti & Helder, 2021; van den Broek et al., 2005). Moreover, integration at this higher level will inevitably rely on the successful execution of integration processes occurring at lower levels (Perfetti & Stafura, 2014; Perfetti & Helder, 2021). Thus, Perfetti and Helder (2021) state that word-to-text integration "can be characterized as the low end of a continuum that spans to higher levels" (p. 17).

One final assumption of the RSF is that the systems that support comprehension operate within a cognitive system with limited working memory capacity (Just & Carpenter, 1992). As such, inefficiency within any given process consumes cognitive resources and constrains comprehension. For example, deficiencies in word identification and/or lexical processes are thought to constrain higher-level comprehension processes at the local and global discourse levels (Pefetti & Helder, 2021; Yang et al., 2007).

Utilizing the RSF to Explore Challenges among Struggling Readers

The RSF is well suited for identifying potential weaknesses among struggling readers and exploring individual differences. Perfetti and Stafura (2014) propose two ways in individual differences can be characterized through the RSF. First, readers may struggle because they have weaknesses in one or more of the components specified in the framework (Perfetti et al., 2005; Perfetti & Stafura, 2014). These weaknesses may result from a lack of knowledge (e.g., lack of general knowledge) or may be suggestive of difficulties in the reading processes themselves (Stafura & Perfetti, 2017). With this approach, identifying problems with, for example, word identification processes (e.g., dyslexia) is fairly straightforward; however, identifying problems at higher levels of comprehension is more complex given it requires controlling for lower-level processes (e.g., Cain et al., 2004; Oakhill et al., 2003).

A second means of identifying reading difficulties through the RSF is to generate and test hypotheses regarding how weaknesses in specific components of reading may affect other reading processes (Perfetti & Stafura, 2014). Perfetti and Stafura (2014) refer to these moderational/mediational relations in terms of "pressure points" within the framework, wherein difficulties in one process affect processing up or downstream (Perfetti, 2007; Perfetti & Hart, 2002; Perfetti & Stafura, 2014). Perfetti and Stafura (2014) explicitly recognize lexical

knowledge as an important pressure point. As mentioned, the LQH proposes that high-quality lexical representations allow a reader to quickly activate appropriate word meanings, which facilitates integration processes. As such, lexical knowledge is thought to serve as a pressure point in the reading system given its relation to lower-level processes at one end (e.g., word identification processes) and higher-level comprehension processes at the other (e.g., sentence processing; local, discourse-level processes). With the concept of pressure point in mind, one might test the extent to which lexical knowledge moderates the relation between word identification processes (e.g., decoding) and higher-level comprehension processes (e.g., sentence processing, inferencing; Adlof et al., 2006; Cromley & Azevedo, 2007).

Although the RSF emphasizes the importance of moderational relations between pressure points (e.g., lexical processes), other processes (e.g., inference generation), and comprehension outcomes, it leaves open the possibility of other types of relations (i.e., mediational). Additionally, while the RSF specifically describes lexical knowledge as a pressure point, it is built to accommodate the presence of other pressure points. Research examining other types of relations and pressure points will be explored later. Having identified ways in which the RSF can be used to identify potential difficulties among readers, the following section utilizes the RSF as a lens for reviewing research conducted among struggling postsecondary readers.

Research involving Struggling Postsecondary Readers

This chapter examines research related to the RSF conducted among struggling postsecondary readers. Specifically, research related to word identification, lexical, and comprehension processes is explored. The goal of this section is to use the RSF to identify potential challenges within each reading system among struggling postsecondary readers. The subsequent section then focuses on research exploring moderational relations among reading

processes, as these have been characterized as important pressure points within the reading system. Table 1.1 summarizes the studies discussed in these sections with respect to the constructs assessed and the population sampled (DE vs. non-DE).

Table 1.1

Summary of Studies Discussed

Study	Word-Identification	Lexical Knowledge	Higher-Level Comprehension	Sample
Bell & Perfetti (1994)	X			Non-DE
Braze et al. (2007)	X	X		Non-DE
Farley & Elmore (1992)		X		DE
Feller et al. (2020a)	X	X	X	DE, Non-DE
Guo et al. (2011)		X	X	Non-DE
Kopatich & Santuzzi (2018)			X	DE, Non-DE
Kopatich et al. (2019)		X	X	Non-DE
Macaruso & Shankweiler (2010)	X			Non-DE
Magliano et al. (2020)	X	X	X	DE, Non-DE
Magliano et al. (2022)	X	X	X	DE, Non-DE
Martino & Hoffman (2002)	X	X		Non-DE
Mellard et al. (2015)	X			Non-DE
Mellard et al. (2016)	X			Non-DE
Metsala et al. (2019)		X		Non-DE
Paulson (2014)			X	DE
Shelton (2006)			X	DE, Non-DE
Thiede et al. (2010)			X	DE, Non-DE
Wang (2009)			X	DE
Welcome et al. (2009)	X	X		Non-DE
Wilson-Fowler & Apel (2015)	X	X	X	Non-DE

Word Identification Processes

Like others, we refer to word identification processes as those involved in word reading generally (García & Cain, 2014). As such, the term *word identification processes* is used here to

refer to a group of processes involved in phonological processing, orthographic processing, word decoding, and word print recognition. These sub-processes are highly interactive (e.g., Ehri, 2005; Perfetti, 2007; Meade, 2020) and are known to play a vital role in reading comprehension (e.g., Cutting & Scarborough, 2006; García & Cain, 2014; Shankweiler et al., 1999). Important to the present purpose, the RSF underscores the importance of rapid, automatic word identification processes as a limiting factor in comprehension (Perfetti, 2007; Perfetti & Stafura, 2014).

The relation between word identification processes and comprehension at the postsecondary level is complex. Generally speaking, studies involving wide ranges of participants (e.g., K-12) indicate that the relation between world identification processes and reading comprehension weakens over time (e.g., Abbott et al., 2010; García & Cain, 2014; Keenan et al., 2008). However, results at the postsecondary level have varied. On one hand, some studies involving college students have shown that word identification processes are moderate to highly correlated with reading comprehension (Cunningham et al., 1990; Holmes, 2009) and predictive of reading comprehension ability (Bell & Perfetti, 1994; Martino & Hoffman, 2002). On the other hand, some studies suggest that the correlation between word identification processes and reading comprehension may be modest (Haenggi & Perfetti, 1994; Jackson, 2005) and that poor word identification skills do not necessarily lead to poor comprehension proficiency in college readers (Jackson, 2005; Jackson & Doellinger, 2002; Welcome et al., 2009).

There may be a few important things to consider in regard to this relation. First, while the importance of word identification processes may decline over time (i.e., across grade levels), this is often in relation to other skills and processes (e.g., listening comprehension; Vellutino et al.,

2007). Thus, in a majority of cases, it refers to the *relative* importance of word identification processes rather than their importance in general. Second, although word identification processes are important, this does not preclude the fact that readers may develop compensatory mechanisms to help mitigate deficits due to poor word identification skills (e.g., Jackson & Doellinger, 2002; Welcome et al., 2009). Lastly (and most important to the present paper), the weakening of the relation between word identification processes and reading comprehension appears to be highly contingent upon a reader's skill level (e.g., Cutting & Scarborough, 2006; Keenan et al., 2008; Swanson & Berninger, 1995). As such, the relation between word identification processes and reading comprehension is typically stronger for readers with weak word identification skills than readers with strong word identification skills (see García & Cain, 2014). Thus, in sum, as stated by Jackson (2005), "literature can be used both to support the hypothesis that word-level processes are important at all levels of proficiency and to support the alternative hypothesis that the relevance of these processes as sources of individual differences becomes minimal as readers become highly skilled" (p. 114).

What is known about word identification processes in struggling postsecondary students? Underprepared postsecondary readers appear to have difficulties with word identification processes (Ari, 2011, 2016; Perin, 2013, 2020). Bell and Perfetti (1994) compared the component reading skills of a number of undergraduate skilled and less-skilled readers. Reader groups (i.e., skilled, less-skilled) were based on SAT scores as well as performance on the Nelson-Denny Reading Test. Results suggested that less-skilled readers performed significantly worse on measures related to word identification and decoding. Similarly, Martino and Hoffman (2002) compared the component reading skills of first-year college students who were either high or low comprehenders, based on ACT scores. Low comprehenders scored significantly

worse on measures of decoding, word identification, and phonological awareness than high comprehenders.

Macaruso and Shankweiler (2010) conducted a discriminant analysis to see what readings skills differentiated average and less-skilled community college readers. They found that, among a number of reading skills measured, a combination of phonological processing and verbal working memory best predicted group membership, with 77% accuracy (for review, see Perin, 2020). Investigating reading comprehension in struggling adults enrolled in high school, community college, and adult school, Braze et al. (2007) found that decoding accounted for a large portion (18%) of unique variance in reading comprehension ability. Relatedly, Mellard and colleagues (2015) explored the relative contribution of different component reading skills to reading comprehension among a group of struggling adult readers (age 16-24) enrolled in technical education programs. On average, participants read at a 7th to 8th grade reading level. Results suggested word identification processes (decoding, word reading) accounted for the largest portion of unique variance (44%). In a follow-up study, Mellard et al. (2016) found that among these struggling adult readers, the lowest performing readers could be identified based, in part, on their scores on word reading measures.

As demonstrated above, struggling postsecondary readers appear to have challenges with word identification processes. Specifically, results from the reviewed studies suggest that these readers struggle with decoding, word recognition, phonological processing, and orthographic processing. As specified by the RSF, word identification processes are a vital first-step in reading comprehension (Perfetti & Adlof, 2012; Perfetti & Stafura, 2014). Lexical and comprehension processes (e.g., lexical access, integration, inferencing) all depend upon effective word reading (Perfetti & Adlof, 2012). Moreover, given RSF assumes that cognitive resources are limited,

slow or effortful word identification processing may consume WM capacity and impair higher-level processes (e.g., Ari, 2010; García & Cain, 2014; Just & Carpenter, 1992; Perfetti, 1985, 2007). Thus strong, well-established orthographic and phonological representations are necessary, but not sufficient, for efficient comprehension.

Interestingly, less is known about word identification processes in DE readers specifically. Moreover, while results from other struggling adult reader population may be applied to these readers, more research is needed to understand word identification processes in this population and how they interact with other processes. The current section focused on important word identification processes. These processes are essential to the activation of lexical representations. The focus of this chapter now shifts to research on lexical processes.

Lexical Processes

The RSF makes central the role of lexical processes in comprehension (Perfetti & Stafura, 2014). This section is focused specifically on *lexical knowledge*—a term used here to describe both vocabulary and morphology. While some consider morphological processing to play an important role in syntactic/grammatical processing (Ackeman & Neeleman, 2007; Marantz, 1997), here we focus on the role of morphology in the context of semantic knowledge, as is the focus in the RSF (Perfetti & Stafura, 2014). This chapter focuses on lexical knowledge because these constructs are emphasized in the RSF and have received more attention in the literature.

Knowing a word involves an understanding the range of its meaning as well as the suitability of its use in a specific context (Perfetti, 2007; Stahl & Fairbanks, 1986; Wallace, 2007; Zimmerman, 1997). In general, research has identified lexical knowledge to be an essential component of comprehension (RAND Reading Study Group, 2002). Moreover, research

suggests that it is a strong predictor of reading comprehension (e.g., Allen et al., 2014; Cromley & Azevedo, 2007; Joshi, 2005; Ouellette, 2006).

What is known about the lexical knowledge of struggling DE and non-DE postsecondary readers? Despite the fact that numerous interventions among struggling postsecondary readers have targeted word knowledge (including in DE populations; see Robson, 2009; Willingham & Price, 2009), relatively few studies have focused specifically on the role of lexical knowledge in reading comprehension. In one study, Braze et al. (2007) explored the importance of vocabulary knowledge among a range of struggling adult readers (ages 16-24) enrolled in high school, community college, and adult school. Results suggested that vocabulary knowledge accounted for variance above and beyond skills involved in decoding and listening comprehension (see also Landi, 2009). Relatedly, Martino & Hoffman (2002) found that low-skilled, first-year college readers scored significantly lower on measures of vocabulary knowledge (i.e., listening vocabulary) than high-skilled readers. Investigating DE readers specifically, Farley and Elmore (1992) examined the role of vocabulary, critical thinking, and other cognitive abilities in predicting reading comprehension. They found that vocabulary (as measured by the Iowa Silent Reading Test) was the strongest predictor of reading comprehension.

Metsala et al. (2019) examined the role of morphological knowledge in first-year university students with and without a self-reported (but undiagnosed) history of reading difficulties. They found that participants with a self-reported history of reading difficulties had deficits in morphological processing even after controlling for word identification processes (phonological awareness, orthographic processing). Moreover, among first-year readers without self-reported reading difficulties, morphological knowledge accounted for variance in reading comprehension above and beyond that accounted for by word identification processes.

Together, the studies discussed above suggest that struggling postsecondary students may have difficulties with lexical knowledge that negatively impact reading comprehension. As the RSF suggests, partial or inaccurate lexical representations may hinder a reader's ability to efficiently integrate words into one's mental representation (Perfetti, 2007; Perfetti & Stafura, 2014). Interestingly, some research suggests that readers with poor lexical knowledge may rely more heavily on word identification processes (i.e., decoding), which, for struggling adult readers, may be problematic as these processes are often impoverished as well (Wilson-Fowler & Apel, 2015). Ultimately, while it is argued that increasing lexical knowledge may be one effective way to help struggling adult readers (Robson, 2009; Wilson-Fowler & Apel, 2015), more research specifically investigating lexical knowledge is needed. Having discussed word identification processing along with aspects of lexical processing, we now turn our focus toward higher-level comprehension processes.

Comprehension Processes

In the RSF and in this chapter, the term *higher-level comprehension processes* is used to refer to a number of processes at the local discourse level and beyond (Stafura & Perfetti, 2017). These include processes involved in constructing accurate representations of sentences, establishing connections between sentences (i.e., bridging inference), integrating text information with prior knowledge (i.e., elaborative inference), utilizing reading strategies, and comprehension monitoring (Hannon, 2012; McNamara & Magliano, 2009). Compared to word identification and lexical processes, higher-level comprehension processes have received more attention among postsecondary students (Jackson, 2005; Landi, 2009; see also McNamara & Magliano, 2009).

It is well established that individual differences in higher-level comprehension processes account for variability in reading comprehension at the postsecondary level (McNamara & Magliano, 2009). Research has typically focused on comparing the strategy use (or inference use) of skilled and less-skilled readers (or comprehenders), as determined by scores on standardized tests of comprehension. In general, this research suggests that less-skilled readers make fewer or less accurate inferences (e.g., Long et al., 1994; Magliano & Millis, 2003; Whitney et al., 1991; Zwaan & Brown, 1996) and are less effective in monitoring comprehension and applying appropriate reading strategies than skilled readers (e.g., Chi et al., 1989; Long et al., 1994; McNamara, 2007; Pressley & Afflerbach, 1995).

A sizeable portion of research has begun to examine higher-level comprehension processes among DE readers as well. In one study, Wang (2009) examined the extent to which DE readers were able to extract main ideas from text at the local and global level. Participants read texts and answered questions about main ideas that were either explicitly stated or implied in either individual paragraphs (local level) or the text as a whole (global level). Results indicated that 45% of participants were unable to identify all explicitly stated main ideas at the local level, while 58% were unable to identify all implicitly stated ideas at the local level. At the global level, only 11% of participants were able to identify the implicit main ideas. Knowledge of text structure was also examined; 70% of participants were unable to identify implicit text sections and the central topic for each. Importantly, all implicit and global ideas required some degree of inferencing. These results suggest that DE readers struggle with identifying key information, inferring missing or implied information, and utilizing text structure to aid understanding (see also Perin, 2016).

Paulson (2014) explored the extent to which DE readers were able to use analogical processes while engaging in reading activities. Analogical processing is thought to support inferencing, as it helps a reader connect new ideas in the text to existing prior knowledge (Anderson, 2013; Gentner & Smith, 2012). In this study, participants read an expository document. A portion of the participants were given an analogy intended to help them understand the text before reading while another portion of participants read a modified version of the document that included the analogy embedded in it. A control group read the original version with no analogy present. Results indicated that neither of the experimental groups significantly benefited from the analogy suggesting that they were unable to connect text information to the analogical information they had received.

Feller et al. (2020a) explored the extent to which DE and non-DE community college readers differed in terms of their performance on different types of comprehension assessments. In this study, DE and non-DE participants completed the Study Aid and Reading Assessment (SARA; Sabatini et al., 2015; Sabatini et al., 2019), which is comprised of subscales designed to measure word decoding and recognition, vocabulary, morphology, and sentence processing. Additionally, participants completed the Readings Strategies Assessment Tool (RSAT; Magliano et al., 2011), wherein they were asked to read expository texts and think-aloud at target locations. Computational algorithms were used to assess the extent to which think-aloud responses contained evidence of bridging and elaborative inferences. Participants also completed two comprehension assessments: one designed to assess the close comprehension of single texts, and another scenario-based assessment designed to assess the extent to which readers were able to actively engage in complex problem solving with multiple texts.

Results from regression analyses suggested that, after controlling for both foundational skills, as assessed by SARA (i.e., decoding/word recognition, vocabulary, morphology, and sentence processing), as well as inferencing as assessed by RSAT (i.e., bridging and elaboration), DE status was not a significant predictor of performance on the measure of close comprehension. DE status was, however, a significant negative predictor of performance on the scenario-based assessment. This result suggests that DE readers were comparable to their non-DE peers in terms of traditional comprehension assessments but struggled to use texts to solve complex problems. Overall, these results suggests that DE readers may struggle with complex literacy tasks that involve synthesizing, comparing, and contrasting information across sources—a skill commonly required in college courses.

Utilizing the some of the same measures as Feller et al. (2020a), Kopatich and Santuzzi (2018) conducted a latent profile analysis to assess the extent to which college readers (both DE and non-DE from 2 and 4-year institutions) could be classified based on 1) their basic reading proficiency (as measured by SARA) and 2) the inference processes they engaged in while thinking-aloud to expository texts (as measured by RSAT). Four profiles emerged: high proficiency and high inference use, high proficiency and low inference use, low proficiency and high inference use, and low proficiency and low inference use. Interestingly, DE students were underrepresented in the high proficiency and high inference group. This suggests that while some DE readers may have been high in proficiency, they were low in inference use (or vice versa). In accordance with the RSF, one possible explanation for this finding is that DE readers struggle to generate inferences due to a lack of knowledge (i.e., insufficient background knowledge) or difficulties with the inference processes themselves (e.g., difficulty connecting information

across sentences). Alternatively, DE readers may have attempted to generate inferences to compensate for lower-level deficiencies (Jackson & Doellinger, 2002; Welcome et al., 2009).

In addition to the difficulties mentioned above, research suggests DE readers may have trouble monitoring their comprehension and using appropriate reading strategies. Thiede et al. (2010) had DE and non-DE participants read a series of short passages and rate the extent to which they had comprehended them. Each passage was rated either immediately after a participant had read it or retrospectively, after the participant had completed reading all of the passages. Additionally, participants were asked to report "the basis for their judgments of comprehension" (Thiede et al., 2010, p. 336) and to complete multiple-choice questions assessing comprehension for each passage. Results indicated that DE readers were more likely to cite surface-level cues from the text as the basis for their judgments of comprehension and were significantly less accurate in their judgments of comprehension than non-DE readers. The discrepancy between DE students' judgments of comprehension and performance on passage-specific comprehension questions suggests that DE readers were less able to monitor their comprehension. Moreover, it appears that DE readers relied on inappropriate sources to evaluate their comprehension, referring to their ability to recall exact information from the text rather than the text's overall meaning or how it related to background knowledge.

In regard to reading strategy use, Shelton (2006) had DE and non-DE students complete a self-report questionnaire assessing the extent to which readers used various reading strategies. DE readers reported using significantly more support strategies (e.g., underlining text, using a dictionary, taking notes, reading aloud) than non-DE readers. No other differences in strategy use were found. The use of support strategies has been negatively associated with reading proficiency. Prior research suggests that less proficient readers may depend on support strategies

to compensate for deficits in lower-level reading skills (Chang, 2006; Feller et al., 2020b). However, support strategies are often seen as superficial, as they focus the reader on surface-level features of the text (Dunlosky, 2013). Less proficient readers may rely on support strategies because they are relatively easy to use and require minimal effort (e.g., highlighting or underlining text); however, these strategies may impede deep comprehension (Dunlosky, 2013; Upton, 1997). Interventions among DE students have, at times, focused on developing strategy use (García-Navarrete et al., 2012) and metacognitive awareness of strategies use (e.g., Williams et al., 2014). While this may be beneficial, readers may benefit most from strategies that help them understand and connect discourse concepts (Graesser et al., 1994). Additional research is needed to explore strategy use among struggling readers and the efficacy of implementing reading strategy-based interventions.

Based on the studies discussed above, it appears that underprepared postsecondary students struggle with aspects of higher-level comprehension processes. Specifically, there is evidence suggesting that these readers struggle with inferencing, monitoring comprehension, using appropriate reading strategies, metacognition, and engaging texts to solve problems. Clearly, as specified in the RSF and other models of comprehension (McNamara & Magliano, 2009), deficits in these processes negatively impact comprehension.

Given the interactive nature of reading processes in RSF, it is difficult to assess higher-level comprehension processes because they depend on (and influence) the products of lower-level processes (e.g., word identification and lexical processes; Perfetti & Stafura, 2014). Thus, any examination of higher-level comprehension processes should ideally model or account for variance in other related processes (Cain et al., 2004; Oakhill et al., 2003; Perfetti & Stafura, 2014); this has rarely been done among struggling postsecondary readers (see Feller et al.,

2020a; Magliano et al., 2020). In the following section, empirical research exploring moderational/mediational relationships among reading processes is examined.

Moderational Relations Among Reading Processes

The RSF assumes that the processes and systems that support comprehension are highly interactive (Perfetti & Adlof, 2012; Perfetti & Stafura, 2014). While the previous section was dedicated to using the RSF to identify weaknesses within specific components or systems of reading, the present section explores the extent to which there is evidence of moderational relations among reading processes for struggling postsecondary readers. This section draws upon studies previously discussed, as well as others, with an eye on examining potential pressure points in the reading system (Perfetti, 2007; Perfetti & Stafura, 2014). The first section focuses specifically on the role of lexical knowledge as a pressure point, given the emphasis the RSF places on this relation. Then, research exploring other potential relations that are consistent with the RSF is examined.

The LQH and Evidence in Support of Lexical Knowledge as a Pressure Point

A large portion of evidence in support of the Lexical Quality Hypothesis comes through experimental research involving event related potentials (ERPs). ERP research typically involves presenting words one at a time and monitoring neural activity through electrodes placed on the scalp. ERPs are thought to be related to the ease to which words can be integrated into one's evolving mental representations of a sentence or text (see Kutas & Federmeier, 2011). Perfetti and colleagues have conducted a number of experimental studies examining lexical processing through ERPs in non-DE, postsecondary readers. Their research shows that less-skilled readers (as measured by performance on the standardized tests of comprehension) have greater difficulty and are slower at integrating lexical information into sentence-level representations than skilled

readers (Perfetti et al., 2008; Yang et al., 2005, 2007). They argue that less-skilled readers have lower-quality, less-flexible lexical representations and, as such, more effort and/or time is needed to activate the appropriate meaning of a word in a given context (Perfetti & Hart, 2002; Perfetti et al., 2008). These studies provide evidence for the LQH among postsecondary readers and demonstrate the importance of the lexical processing in reading comprehension; however, few, if any, have been conducted among DE readers.

Apart from ERP research, relatively little literature examines lexical knowledge as a moderator or mediator among adult populations (for research with children, see Brinchmann et al., 2016; Levesque et al., 2017; Nagy et al., 2006; Swart et al., 2017). One study that provides support for the LQH among non-DE college readers was conducted by Wilson-Fowler and Apel (2015). In this study, researchers were interested in the extent to which morphological awareness related to word identification processes as well as sentence comprehension. Results from a path analysis indicated that morphological awareness had a moderate to strong direct effect on word reading, spelling, and sentence comprehension. Moreover, aspects of lexical knowledge (e.g., word spelling) partially mediated the relation between morphological awareness and sentence comprehension. These results are consistent with the LQH and suggest that word knowledge plays a central role in connecting word identification processes to comprehension-level processes (Perfetti & Stafura, 2014).

Relatedly, Guo et al. (2011) took an SEM approach to exploring the relations among reading processes in college readers. Participants completed measures of vocabulary (expressive and receptive), morphological awareness, syntactic awareness, and reading comprehension (Gates-MacGinitie, Nelson-Denny). Morphological awareness had a significant direct effect on reading comprehension. Moreover, vocabulary knowledge had a strong, direct effect on reading

comprehension over and above the effects of morphological and syntactic awareness and mediated the relation between syntactic awareness and reading comprehension. Consistent with the RSF, this study highlights the importance of word knowledge in reading comprehension. Additionally, it demonstrates that there may be complex interactions that exist within sub-processes of word knowledge (i.e., syntactic, morphological, and vocabulary knowledge).

Lastly, Welcome et al. (2009) compared proficient readers with "resilient" readers, who had comparable comprehension scores despite poor word identification skills. Undergraduate participants completed measures related to word identification and reading comprehension. Additionally, participants completed a semantic decision task designed to assess the speed and accuracy at which participants could access semantic knowledge. Results suggested that, while resilient readers struggled with aspects of word identification (e.g., pseudoword naming, masked word recognition), their ability to quickly and accurately access semantic knowledge was similar to that of skilled readers. The authors argue that this allowed resilient readers to compensate for deficiencies in word identification processes. As such, this study is consistent with the LQH and suggests that lexical knowledge plays an important role in comprehension.

Evidence in Support of Other Potential Pressure Points

Although Perfetti and Stafura (2014) do not explicitly describe other pressure points, they acknowledge that others may exist in the context of the RSF. One potential pressure point that has received attention in recent years is that of inferencing. It is well established that inference processes are crucial to comprehension (McNamara & Magliano, 2009); however, a growing body of research has explored the extent to which inferencing mediates the relation between lower-level processes (i.e., word identification, lexical processing) and comprehension in postsecondary populations (Cromley et al., 2010; Kopatich et al., 2019; Magliano et al., 2020).

This relation has been referred to as the Inference Mediation Hypothesis (IMH) and research related to it is discussed below.

Kopatich et al. (2019) directly tested the IMH using path analysis. Postsecondary students completed a think-aloud task (i.e., RSAT), wherein they reported their thoughts while reading and answered open-ended comprehension questions about the text. Think-aloud responses were hand-coded for evidence of bridging (i.e., establishing connections across text sentences) and elaborative inferences (i.e., establishing connections across text sentences; McNamara & Magliano, 2009). Participants also completed a series of measures associated with reading proficiency (vocabulary, print exposure, and general reading comprehension (Gates-MacGinitie)). These measures were grouped and termed "language-specific resources," due to their shared variance using a principal component analysis. In line with the IMH, results indicated that language-specific resources had a direct effect on performance for the comprehension questions and an indirect effect on performance through inferencing. Specifically, both bridging and elaborative inferences appeared to partially mediate the relation between language-specific resources and comprehension.

Similarly, Magliano et al. (2020) tested the IMH among postsecondary readers with a wide range of reading ability (i.e., both DE and non-DE readers). As in Kopatich et al., participants in this study completed a think-aloud task (i.e., RSAT) designed to assess the extent to which students produced bridging and elaborative inferences (in contrast to Kopatich et al., think-aloud responses were coded using computational algorithms, rather than hand-coding; see also Feller et al., 2020a). Foundational reading skills (e.g., decoding/word recognition, vocabulary, morphology, and sentence processing) were also measured (using SARA) along with two comprehension measures—one that reflected close comprehension of a text and a scenario-

based assessment that reflected the extent to which readers were able to use multiple texts to solve complex problems (see Feller et al. 2020a, described previously). Consistent with the IMH, bridging and elaboration partially mediated the relation between foundational reading skills and performance on both comprehension assessments. Moreover, it appeared that bridging inferences played a stronger role in mediating performance on the measure of close comprehension, whereas elaborative inferences played a stronger role in mediating performance on the scenario-based assessment. Additionally, follow-up analyses suggested that the IMH could be applied similarly to both DE and non-DE students, which represented 58% and 42% of the sample, respectively.

These results are consistent with Kopatich et al. (2019) and other research among college students (Cromley et al., 2010) and suggest that inferencing may serve as a potential higher-level pressure point in the reading system. Clearly, proficiency in foundational skills (i.e., word identification, lexical knowledge activation) supports inference generation. Given a limited processing capacity, less proficient readers may exhaust valuable cognitive resources on lower-level processes at the cost of higher-level inference processes (Cain et al., 2004; Cain & Oakhill, 2007; Perfetti et al., 2005; Sabatini, 2015). Inferences are a vital aspect of comprehension as they allow readers to fill in gaps in cohesion, relate what they're reading to what they know, and create a coherent mental model for a text (McNamara, 2004; McNamara & Magliano, 2009). One's ability to generate accurate, high-quality inferences may be dependent upon successful processing at the word, lexical, and sentence level as well as other factors such as the amount of relevant background knowledge possessed (Ozuru et al., 2009; Perfetti et al., 2005).

While Magliano et al. (2020) examined the influence of foundational reading skills on inferencing broadly (i.e., as a single factor derived from a principal component analysis), there

may be specific relations that exist between component reading skills and inferences. To explore this possibility, Feller et al. (2020a) used a subset of the data used by Magliano et al. (2020) and assessed the extent to which individual foundational reading skills (i.e., decoding/word recognition, vocabulary, morphology, sentence processing) predicted the spontaneous use of bridging and elaborative inferences, as evidenced in think-aloud responses (i.e., RSAT). Results suggested that word decoding/recognition and morphology were significant predictors of the use of elaborative inferences (i.e., using prior knowledge to understand the text), whereas sentence processing was a significant predictor of bridging inferences (i.e., establishing connections across text sentences).

This result is consistent both with the IMH and partially consistent with the RSF. Consistent with the RSF, a readers' ability to accurately access word knowledge in a given context appeared to be a vital step toward generating elaborative inferences. This result is in line with other research that suggests that readers with a lower vocabulary need greater contextual constraints in order to generate inferences than readers with higher vocabulary (Monzó & Calvo, 2002).

One could also argue, however, that this result is also partially inconsistent with the RSF. Processes involved in word reading and semantic processing should support bridging (Perfetti & Helder, 2022); however, Feller et al. (2020) did not find support for this claim. The authors speculate that word identification processes and lexical knowledge may have influenced bridging inferences indirectly through sentence processing (Barnes et al., 2015; Feller et al., 2020a) but future research is needed to examine this claim. Nonetheless, it may be that foundational reading skills differentially support inference processes and that these inference processes support comprehension.

Finally, Magliano et al. (2022) examined whether there were thresholds in the foundational skills of reading and whether these thresholds affected one's propensity to engage comprehension processes (i.e., paraphrasing, bridging, and elaboration). A *threshold* refers to a point at which the relation between a given skill and comprehension becomes negligible due to a lack of proficiency (Wang et al., 2019). Magliano et al. (2022) found evidence of thresholds in foundational skills. Students below the thresholds were more likely to be enrolled in DE programs than not. Moreover, thresholds in foundational skills were found to be related to the propensity to engage comprehension processes such that students who fell below certain thresholds (i.e., decoding/word recognition, vocabulary) were more likely to engage in paraphrasing and elaboration but less likely to engage in bridging. Additional research is needed to explore the extent to which lower-level processes involved in word identification, lexical processing, and sentence representation differentially support inference processes and comprehension.

Conclusions Regarding the RSF and Struggling College Readers

Over the past decade, there has been a call for theoretically grounded investigations into the difficulties faced by underprepared postsecondary students (Bailey et al., 2010; OECD, 2018; Perin, 2013). The purpose of this paper was to explore such difficulties using the Reading Systems Framework. The RSF spans a broad set of comprehension processes and serves as a valuable tool for exploring sources of comprehension difficulties (Perfetti et al., 2005; Perfetti & Stafura, 2014). In this chapter, the RSF was utilized to explore the challenges faced by struggling postsecondary readers in two manners. These two manners will be discussed along with any conclusions and points of discussion that can be drawn.

First, the RSF was used to identify sources of potential weakness within specific comprehension processes and the knowledge systems that support them. Together, the reviewed research suggests that underprepared postsecondary students appear to struggle, at least to some extent, with word identification (decoding, word identification, phonological processing, and orthographic processing), lexical (vocabulary, morphological processing), and comprehension processes (inferencing, monitoring comprehension, using appropriate reading strategies, metacognition, and engaging texts to solve problems). Moreover, regarding knowledge systems, studies suggest that struggling postsecondary students may lack knowledge of text structure (Wang, 2009) and general background knowledge (McNamara & O'Reilly, 2010; Ozuru et al., 2009), which contribute to comprehension problems (Perfetti & Stafura, 2014).

Based on this review, it is hard to pinpoint any one area as the sole cause of comprehension problems. It may be that struggling postsecondary readers, like other struggling adult readers, possess a broad range of skills and that these readers differ one from another (Mellard et al., 2015; Sabatini et al., 2010). In other words, struggling postsecondary readers may possess fragmented skills, being relatively proficient with certain processes while lacking proficiency in others. The wide range of problems among this population, and the potential existence of different reading profiles, makes intervention and instruction challenging.

It is worth noting that many of the reading problems mentioned here may compound one another. Utilizing the "Matthew Effect Theory" (i.e., rich get richer, poor get poorer; Stanovich, 1986), Ari (2013) argued that struggling college readers' difficulties may arise from initial deficits in processing at the word identification level. According to this view, poor word recognition skill limits a reader's exposure to print, which in turn negatively impacts their exposure to diverse vocabulary, complex syntax, and general background knowledge (Ari, 2013;

Bast & Reitsma, 1998; Hayes & Ahrens, 1988; Stanovich, 1986). Findings among college populations appear to be consistent with this argument (see Ari, 2013), suggesting that reading processes may be highly interactive both developmentally and in the context of a specific reading situation.

Second, the RSF was used to explore the extent to which there was evidence in support of "pressure points" in the reading system, focusing on the role of certain processes as moderators or mediators in the comprehension system. While other pressure points may exist, this chapter focused on lexical processing and inferencing as two important pressure points. Lexical knowledge is thought to moderate the relation between word reading processes and higher-level comprehension processes (Perfetti & Stafura, 2014). Evidence in support of this in postsecondary populations has been found through both experimental, ERP research as well as SEM approaches (Perfetti et al., 2008; Wilson-Fowler & Apel, 2015; Yang et al., 2005). Additionally, inferencing is thought to partially mediate the relation between lower-level comprehension processes (at the word and sentence level) and reading comprehension (Ahmed et al., 2016; Cromley & Azevedo, 2007; Kopatich et al., 2019; Magliano et al., 2020). Research among struggling postsecondary readers is consistent with inferences serving as a pressure point (Cromley et al., 2020; Feller et al., 2020a; Kopatich et al., 2019; Magliano et al., 2020; Magliano et al., 2022).

What can be learned about struggling readers enrolled in DE courses? First, it appears that there may be at least some differences between DE and non-DE readers (Feller et al., 2020a; Kopatich & Santuzzi, 2018; Shelton, 2006). In the studies examined here, DE readers reported using more supplemental reading strategies (Shelton, 2006), were less likely to have high scores on measures of both reading proficiency and inference use (Kopatich & Santuzzi, 2018), and appeared to struggle with academic literacy tasks that required using text to solve complex

problems (Feller et al., 2020a). Given that DE status was not a significant predictor of the measure of close comprehension (Feller et al., 2020a), DE readers may have developed ways to cope with problems in component reading skills and processes, which is consistent with other research among other struggling readers (Jackson & Doellinger, 2002; Welcome et al., 2009). However, since DE status was a non-significant predictor of inferencing in Feller et al. (2020a), it appears that DE readers may not compensate for lower-level deficiencies through inferencing any more than their struggling non-DE peers. They may, however, compensate with other reading strategies, as Shelton (2006) suggests. Another possibility is that DE readers are more highly motivated or have higher self-efficacy; however, this possibility appears unlikely given prior research in opposition to this claim (Cantrell et al., 2013; Dean & Dagostino, 2007; Perin, 2016).

One consistent theme that emerged from this chapter is that additional research is needed to understand reading processes among struggling postsecondary students. Compared to research on children, research on postsecondary adults is sparse. While higher-level processes have traditionally received more attention in this population, additional research is needed to understand how lower-level processes connect to and influence these processes and vice versa.

Research specific to DE students appears to be especially shallow. Understanding the specific challenges faced by DE readers may be of high interest for a number of reasons. First, given the controversy surrounding DE programs, understanding what skills and abilities, if any, differentiate DE readers from other adult reader populations is of importance. From the research reviewed here, it appears that there may be at least some differences between DE and non-DE readers (Feller et al., 2020a; Kopatich & Santuzzi, 2018). Understanding these differences more fully will allow researchers and educators to tailor interventions to address student needs.

Second, research exploring the difficulties of DE readers may have important implications for educational policy. Some institutions have begun to include DE coursework within Adult Basic Education centers (ABE; Cormier & Bickerstaff, 2020). Struggling college students may very well fall at the higher end of the adult literacy spectrum (Cormier & Bickerstaff, 2020; Greenberg, 2008; Perin, 2020). Reforms involving the integration of DE programs with ABE programs may save resources and make more sense financially; however, additional research is needed to explore the extent to which DE readers differ from readers enrolled in Adult Basic Education courses (see Schuster, 2012). Minimally, educational policy makers should consider accelerated programs targeted at the specific reading problems these students confront (Cormier & Bickerstaff, 2020; Hodara & Jaggars, 2014).

This review emphasizes the importance of measuring component reading processes in college readers. This may at first appear surprising given that students at the college level are typically thought to be proficient in all the basic reading skills they need to succeed (Hoover & Gough, 1990; Stahl & Armstrong, 2018). However, as demonstrated, individual differences in component reading processes appear to account for considerable variance among postsecondary students, especially those who are struggling (e.g., Braze et al., 2007; Feller et al., 2020a; Martino & Hoffman, 2002; Mellard et al., 2015). Clearly, deficits at the word identification and lexical levels serve as a significant barrier for students both in terms of reading comprehension and college success in general (Magliano et al., 2020; Perin, 2013).

Another gap in research that was revealed was the lack of studies using complex modeling to understand reading comprehension among postsecondary students. Not only is research including lower-level reading processes relatively scant but a majority of this research has focused on the contribution of specific skills to comprehension in a regression approach

(e.g., Cartwright, 2007; Mellard et al., 2015; Savage & Wolforth, 2007). These studies have their value; however, understanding complex relations between reading processes often requires more sophisticated modeling (e.g., SEM, path analysis; Gunzler et al., 2013). Future work should continue to explore interactions among reading processes using these types of approaches.

The present is consistent with arguments that greater efforts are needed to ground DE instruction in real-world academic literacy tasks (Grubb & Gabriner, 2013; Feller et al., 2020a; Magliano et al., 2020). To date, many DE courses focus on supplemental reading strategies (e.g., using a dictionary, graphic organizers), deconstructing sentences, and identifying main ideas (Bailey & Jaggars, 2016; Cormier & Bickerstaff, 2020; Grubb et al., 2011). While these skills are undoubtedly useful, there is debate about the extent to which these skills are directly applicable to college reading tasks. As stated by Cormier and Bickerstaff (2020), DE instruction often "fails to prepare students for the complexities of college literacy tasks, which require critical and flexible rather than formulaic thinking" (p. 545; see also Grubb & Gabriner, 2013; Hern & Snell 2013). Admittedly, it is a tall order to create instruction aimed at fortifying both basic foundational reading skills (e.g., rapid word recognition, vocabulary) and complex skills involved in reading to solve problems. Additional research may help to identify which readers are best suited for different types of instruction.

Reading comprehension is a complex multi-faceted process with which many postsecondary students struggle. This study suggests that the RSF provides a valuable lens for exploring the challenges faced by struggling postsecondary readers. Additional research examining the abilities of such readers is in high demand. Such research may have significant impacts on instruction, intervention, and policy nationwide.

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EXPLORING WHAT DIFFERENTIATES STRUGGLING FROM NON-STRUGGLING COLLEGE READERS

While it would be optimal that students possess adequate reading skill by the time they reach college, over half of university students are deemed "non-proficient" in terms their ability to read at a collegiate level (ACT, 2006; Holschuh & Paulson, 2013). In fact, it is estimated that 75% of community college and 50% of four-year college students lack proficiency in the literacy skills needed to succeed in college (ACT, 2006; American Institutes for Research, 2006; Holschuh & Paulson, 2013). As such, a large number of struggling college readers enroll in developmental education (DE) courses aimed at improving reading and writing (Bailey et al., 2010; Perin, 2020). Developmental education has become the subject of much controversy, and many have called into question the effectiveness of DE programs (e.g., Bailey 2009; Bailey et al., 2010; Jaggars & Stacey, 2014; Levin & Calcagno, 2008; Scott-Clayton & Rodriguez, 2012; Silver-Pacuilla et al., 2013). Given that most studies related to DE programs focus on assessing their efficacy rather than on the psychology of struggling college readers, more research is warranted to better understand the literacy skills that struggling college readers possess (Armstrong et al., 2015; Simpson et al., 2004). Considering calls for more research on struggling colleges readers that is grounded in cognitive theory (Bailey et al. 2010; Perin, 2013, 2020), this study seeks to understand the factors that differentiate struggling readers from other readers, as operationalized by placement in a DE program.

College readiness to read (and enrollment in DE programs) is typically determined by placement tests or other standardized test scores (e.g., ACCUPLACER®, ACT COMPASS®, SAT; Hu & Hu, 2021; Hughes & Scott-Clayton, 2011). Placement tests are typically multiple-choice and are designed to assess one's ability to determine the meaning of words and derive

meaning from short passages of text (College Board, 2019). However, there has been some criticism of commercialized placement tests in that they do not measure higher-level strategy use and do not utilize texts similar to those found in college textbooks (Conley, 2010). On one hand, while placement tests measure aspects of basic reading skill, it possible that some students struggle with comprehension despite proficiency in basic reading skills (Alvermann et al., 2006; McMaster et al., 2012). As such, some argue that instruction in higher-level reading processes is essential, regardless of proficiency in lower-level processes (Cain & Oakhill, 1999; Rapp et al., 2007). However, on the other hand, proficiency in lower-level reading processes is thought to support one's ability to engage in higher-level reading strategies (Cain & Oakhill, 2007; Kopatich et al., 2019; Magliano, Higgs, et al., 2020; Magliano et al., 2022). Additional research is needed to understand how well placement tests cover aspects of basic reading proficiency and to understand how basic reading proficiency relates to DE status and the use of higher-level reading skills (Magliano et al., 2022).

The purpose of the present study was to assess 1) the extent to which proficiency in lower-level reading skills and reading strategies use differentiates DE from non-DE readers, 2) the extent to which proficiency in lower-level reading skills supports reading strategy use, and 3) whether DE enrollment is related to strategy use once lower-level reading skills are accounted for. In this chapter, the nature of comprehension is discussed with the Reading Systems Framework (RSF; Perfetti & Stafura, 2014) presented as the motivating theoretical framework. Research using constructed responses as measure of higher-order comprehension strategies in college readers is also discussed. Finally, an overview of the present study, research questions, hypothesis and predictions are discussed.

The Nature of Comprehension

Theories of reading comprehension assume that comprehension emerges with the construction of a mental representation (i.e., mental model) of a text in memory (Kintsch, 1988; McNamara & Magliano, 2009a; Rapp et al., 2007). Mental model construction involves the coordination of a number of skills and processes (McNamara & Magliano, 2009a; Perfetti & Stafura, 2014). In the present study a distinction is made between lower-level foundational skills and higher-level reading skills, which many argue can be separated and examined relatively independently from one another (Perfetti & Adlof, 2012; Rapp et al., 2007; Sabatini et al., 2019). Lower-level skills, called "foundational skills" here, are those involved in activating word knowledge and representing sentences (National Reading Panel, 2000; Rapp et al., 2007) and include skills such as word decoding and recognition, vocabulary knowledge, morphological processing, and sentence processing (Sabatini et al., 2019). Higher-level skills are typically considered to be more top-down in nature and are thought to be more directly related to comprehension itself (Landi, 2009; Rapp et al., 2007). These include skills such as generating inferences and utilizing higher-level reading strategies (McNamara & Magliano, 2009a).

Underprepared college readers struggle with the foundational skills of reading. Some research suggests that underprepared college readers have difficulties with both word (decoding, word identification; Ari, 2011, 2016; Magliano et al., 2022; Perin, 2013, 2020) and lexical processes (vocabulary, morphological processing; Farley & Elmore, 1992; Martino & Hoffman, 2002; Metsala et al., 2019; Willingham & Price, 2009). Moreover, variability in foundation skills appears to account for a large portion of variance in reading comprehension among this population (Feller et al., 2020; Magliano, Higgs, et al., 2020; Perin, 2020). Thus, foundational

reading skills are critical to comprehension and may help explain why students struggle with reading.

Some theories of comprehension have emphasized the importance of higher-level reading skills in addition to foundational skills (Graesser et al., 1994). According to these theories, reading is a meaning making process that requires effortful processing (Graesser et al., 1994; McNamara & Magliano, 2009a; Pressley & Afflerbach, 1995). As such, comprehension is supported when readers reason through a text and engage in self-explanation—the act of explaining the meaning of a text to oneself (Chi et al., 1989; Graesser et al., 1994; McNamara, 2004). Individuals vary in the extent to which they self-explain while reading and the ability to self-explain is highly related to comprehension outcomes (Chi et al., 1994; Magliano et al., 1999; McNamara & Magliano, 2009b; Wolfe & Goldman, 2005).

While self-explanation is considered a reading strategy (McNamara, 2004), it is distinct from other types of strategies. Reading strategies can include a large number of activities used before (e.g., previewing the text), during (e.g., re-reading), or after (e.g., summarization) reading that aim to facilitate one's understanding of the text(s) (Alexander & Judy, 1988; Pressley & Afflerbach, 1995; Shoerey & Mokhtari, 2001). These traditional strategies are often the focus of developmental reading studies and strategy courses (Armstrong & Reynolds, 2011; García-Navarrete et al., 2012). However, self-explanation can be construed as a strategy intended to support comprehension during reading and in the service of helping readers establish coherence. While readers may employ a broad range of strategies in service of self-explanation (Magliano et al., 2019; McNamara & Magliano, 2009), the present study focuses on a small number of cognitive strategies involved in the construction of a mental representation of a text. Specifically, there was a focus on paraphrasing, bridging, and elaboration given their role in prior research

and importance in major theories of comprehension (see McNamara & Magliano, 2009a). Paraphrasing involves restating text content in one's own words and is often considered a starting point for self-explanation (McNamara et al., 2007). While paraphrasing facilitates the understanding of text content and strengthens its representation in the mental model, research suggests that an overreliance on this strategy may be indicative of shallow, sentence-focused processing and may, therefore, be detrimental to comprehension (e.g., Magliano et al., 2005; McNamara et al., 2007; Millis et al., 2006). Given that constructing a mental model involves connecting ideas across a text and with one's knowledge (McNamara & Magliano, 2009a), this strategy should be paired with bridging and elaboration.

Bridging involves establishing intra-textual connections. Making connections across sentences and paragraphs is essential in establishing a coherent mental model (Graesser et al., 1994). Individual differences in the propensity to generate bridging inference while reading is positively predictive of comprehension outcomes (Graesser et al., 2003; Kopatich et al., 2019; Magliano et al., 2011; Singer et al., 1992).

Elaboration involves bringing in relevant background knowledge and connecting it to text content in a meaningful way (McNamara & Magliano, 2009a). Elaboration strengthens mental models, as activated information from the text becomes interconnected with prior knowledge (McNamara & Kintsch, 1996; Ritchie & Karge, 1996). One's ability to make elaborative inferences has been shown to be related to comprehension (Magliano et al., 2011; Nokes & Dole, 2004). Thus, both bridging and elaboration have been widely shown to be predictive of reading comprehension (Cromley & Azevedo, 2007; Magliano et al., 2011; Magliano & Millis, 2003; Singer & Halldorson, 1996).

Utilizing the Reading Systems Framework to Explore Comprehension among Struggling College Readers

The RSF was designed to help motivate and test hypotheses about struggling readers Perfetti & Stafura, 2014). It has recently been applied to studies exploring the relation between foundational and higher-order reading strategies in college populations (Feller et al., 2020; Magliano et al., 2022). The RSF assumes that words in a text are processed and integrated into a reader's mental model (Kintsch, 1988; Perfetti et al., 2008; Perfetti & Stafura, 2014). Importantly, the RSF assumes that there are direct connections between the systems that support word identification (i.e., decoding, word recognition), word knowledge (i.e., vocabulary, morphology), and local discourse level processes (i.e., constructing accurate representations of sentences, and establishing connections between sentences).

According to the RSF, the quality of a reader's lexical representation affects the ease at which integration processes occur (i.e., Perfetti, 2007; Perfetti & Adlof, 2012). This has been called the *Lexical Quality Hypothesis*. Readers with high quality lexical representation have "accessible, well specified and flexible knowledge of word forms and meanings" (Perfetti & Adlof, 2012, p. 9). This includes knowledge of a word's spelling, pronunciation, and meaning (Perfetti, 2007). High quality representations allow a reader to quickly activate appropriate word meanings based on context with minimal processing effort, which eases the integration process.

In the context of the current study, the RSF assumes that deficiencies in foundational skills may constrain higher-level reading processes, such as paraphrasing, bridging, and elaboration. Thus, the quality and successful execution of these strategies should be related to proficiency in processing at different levels (Cromley & Azevedo, 2007; Magliano, Higgs et al., 2020; Perfetti & Stafura, 2014). Initial support for this claim has emerged, wherein one's

propensity to engage in bridging and elaboration has been shown to be related to proficiency in foundational reading skills (Feller et al., 2020; Kopatich et al., 2019; Magliano, Higgs, et al., 2020; Magliano et al., 2022). Moreover, foundational skills may be differentially related to paraphrasing, bridging, and elaboration (Feller et al., 2020); however, this warrants further investigation. In the present study, we seek to further investigate the relation between foundational skills and reading strategies and explore this point more in a subsequent section.

Constructed Responses as a Window into Struggling College Readers

There are a growing number of studies that have utilized think-aloud responses to explore reading strategy use among struggling college readers (e.g., Feller et al., 2020; Magliano et al., 2011; McNamara, 2007; McNamara et al., 2007). Think alouds are a form of constructed response wherein participants are instructed to report whatever thoughts come to mind as they read (Ericsson & Simon, 1993; Pressley & Afflerbach, 1995). Think-aloud methodologies have been widely used to study the comprehension strategies of struggling elementary (e.g., Gillam et al., 2009; McMaster et al., 2012), middle/high school (e.g., McNamara et al., 2004); and college readers (e.g., Magliano & Millis, 2003; Magliano et al., 2011; 2020).

Thinking aloud is sensitive to individual differences in the propensity to engage in strategies associated with self-explanation (Magliano et al., 2011; Magliano & Millis, 2003). For example, Magliano et al. (2011) had college readers take the Reading Strategy Assessment Tool (RSAT), wherein students read texts and thought aloud at target locations. They used simple computational assessments of paraphrasing, bridging and elaboration. Using keyword matching, a paraphrasing score was generated based on the number of content words that overlapped between the target sentence (i.e., the sentence that was just read) and content words in the protocol. A bridging score was generated by counting the number of content words produced in a

protocol that were not found in the target sentence but were found in the prior discourse. Lastly, an elaboration score was calculated based on the number of content words that were neither found in the target sentence nor the prior discourse. RSAT scores were averaged across texts and were found to be predictive of performance on a standardized comprehension test for texts not used in RSAT.

There are a few studies that have explored the relation between foundational skills and reading strategies among struggling college readers, as operationalized by enrollment in DE programs. Magliano et al. (2022) explored the extent to which there were thresholds in the foundational skills of reading among DE and non-DE readers. A threshold refers to a point at which the relation between a given skill and comprehension becomes negligible due to a lack of proficiency (Wang et al., 2019). They found evidence of thresholds in foundational skills. Moreover, they found that a higher percentage of the students below the thresholds were enrolled in DE programs than not. This study also explored the extent to which thresholds in foundational skills were related to the propensity to engage in paraphrasing, bridging, and elaboration during a think-aloud task (RSAT). They found that students who fell below certain thresholds (i.e., decoding/word recognition, vocabulary) were more likely to engage in paraphrasing and elaboration but less likely to engage in bridging.

Relatedly, Feller et al. (2020) explored the extent to which proficiency in foundational skills was related to the propensity to engage in bridging and elaboration. Furthermore, they explored whether struggling community college readers differed from other readers in terms of their use of bridging and elaborative strategies. In this study, DE and non-DE participants completed the Study Aid and Reading Assessment (SARA; Sabatini et al., 2015; Sabatini et al., 2019), which is comprised of subscales designed to measure word decoding and recognition,

vocabulary, morphology, sentence processing, and reading comprehension. Additionally, participants completed the Reading Strategies Assessment Tool (RSAT; Magliano et al., 2011), wherein they were asked to read expository texts and think-aloud at target locations. Computational algorithms were used to assess the extent to which think-aloud responses contained evidence of bridging and elaborative inferences.

Results from regression analyses suggested that foundational skills were differentially predictive of the propensity to engage in bridging and elaboration when reading. Proficiency in sentence processing was predictive of bridging scores, whereas proficiency in word recognition/decoding and vocabulary was predictive of elaboration scores. Feller et al. (2020) speculated that activation at the word-level may be more closely related with elaboration and that sentence-level representations might be more important for bridging; however, this claim warrants further investigation. The results are partially consistent with the Lexical Quality Hypothesis of the RSF. Specifically, proficiency in word-level processing was predictive of elaborative, but not bridging inferences. However, Perfetti and Stafura (2014) specifically argue that the quality of lexical processes should also affect bridging processes.

In regard to DE status, results suggested that DE status was not predictive of bridging and elaboration scores. However, this study only assessed potential differences in bridging and elaboration after controlling for proficiency in foundational skills. This leaves open the possibility that DE and non-DE students differ in terms of strategy use and that potential differences may be related to variability in foundational skills. The present study explores this possibility. Findings from Feller et al. (2020) run counter to those of Magliano, Lampi, et al. (2020). Magliano, Lampi, et al. (2020) had DE and non-DE students think aloud to texts and complete a comprehension assessment based on those same texts. Think-aloud responses were

hand-coded for the presence of a number of strategies associated with self-explanation, including paraphrasing, bridging, and elaboration. Additionally, RSAT provided computer-generated scores of these processes. Results suggested that, after controlling for comprehension of the texts used in the think-aloud task, DE and non-DE readers were comparable in the extent that they paraphrased and bridged. DE readers were, however, found to produce fewer elaborations than their non-DE peers. Magliano, Lampi, et al. (2020) speculated that DE readers may have had less background knowledge to support elaboration than non-DE readers.

The Current Study

The differences between Feller et al. (2020) and Magliano, Lampi, et al. (2020), along with the inconsistency with the Lexical Quality Hypothesis with respect to bridging inferences, warrant a replication of Feller et al. (2020). The proposed dissertation provides a partial replication of that study and adds to the extant literature in a number of ways. First, as mentioned, there is no clear consensus on whether DE and non-DE readers differ in their use of reading strategies. Magliano, Lampi, et al. (2020) found differences between DE and non-DE readers in terms of their propensity to engage in elaboration, whereas Feller et al. (2020) found no differences between DE and non-DE readers. There are, however, two things worth noting. First, as mentioned, Feller et al. (2020) only assessed differences in strategy use after controlling for proficiency in foundational skills. It is possible that differences in strategy use existed, but that these differences were related to variability in foundational skills. Second, Magliano, Lampi, et al. (2020) was conducted on a fairly small sample (n = 46) from a single, 4-year institution. Conversely, Feller et al. (2020) utilized a larger sample (n = 264) comprised solely of students enrolled in 2-year institutions. Given that 2-year institutions are open-access, DE and non-DE readers may be more similar in terms of the skills they possess than students in 4-year

institutions. The present study seeks to assess differences between DE and non-DE readers in terms of strategy use and to explore the extent to which results found in prior research replicate across different samples.

A second contribution of this study is that it makes use of a rich hand-coding of constructed responses. Feller et al. (2020) relied on automated scoring from RSAT to code for strategy use. Although RSAT coding has been shown to be predictive of standardized measures of comprehension (Magliano et al., 2011), it relies on rudimentary word counts to calculate an estimation of the presence of strategies. As such, it is insensitive to the accuracy and quality of the strategies used. The present study utilized a detailed coding scheme intended to detect the presence and quality of strategies used by participants. Additionally, the present study assessed paraphrasing and the overall quality of constructed responses in terms of their contribution toward understanding of the text, both of which were not assessed in prior research. Coding for the quality of strategic processes in a more detailed manner may help elucidate differences between DE and non-DE readers.

Lastly, while there is value in identifying potential differences between DE and non-DE readers, additional research is needed to understand how DE enrollment and strategy use relate to proficiency in foundational skills. Feller et al. (2020) found that foundational skills differentially predicted bridging and elaboration scores. However, this finding needs to be replicated. The present study explored whether various foundational skills were differentially predictive of strategy use and whether variability in foundational skills accounted for potential differences in strategy use between DE and non-DE readers.

The purpose of the present study was to 1) assess the extent to which proficiency in foundational reading skills and the use of reading strategies differentiated DE from non-DE

readers and 2) assess the relationship among foundational skills, strategy use, and DE status. In this study, DE and non-DE students from a 4-year institution read and thought aloud to two texts (history, science) and completed measures associated with proficiency in foundational reading skills. Constructed responses were hand-coded for strategy use (paraphrasing, bridging, elaboration) and given an overall quality score. *Overall quality scores* reflect the contributions that a constructed response makes towards understanding. As such, overall quality scores were meant to reflect how well participants were using the think-aloud activity to engage strategies (paraphrasing, bridging, elaboration) and create meaning (McCarthy et al., 2021). The overall quality of each response was rated on a scale ranging from 0 to 3 (Poor, Fair, Good, Great). Details of the coding scheme are discussed below (see Methods section) and can be found Appendix A (adapted from McCarthy et al., 2021).

This study started by assessing potential differences between DE and non-DE readers in terms foundational skills and strategy use (paraphrasing, bridging, elaboration). The study then explored the extent to which proficiency in foundational reading skills were related to reading strategy use and overall quality scores. Finally, the relations among foundational skills, reading strategy use, overall quality, and DE status were explored. This allowed for an exploration of the extent to which variability in foundational skills explained potential differences in strategy use observed between DE and non-DE readers. Research questions were as follows:

RQ1: To what extent do DE readers differ from non-DE readers in terms of proficiency scores related to foundational skills of reading (e.g., decoding/word recognition, vocabulary, morphology, sentence processing)?

RQ2: To what extent do DE readers differ from non-DE readers in terms of their use of comprehension strategies (e.g., paraphrasing, bridging, elaboration)?

RQ3: How does proficiency in foundational skills relate to strategy use and the overall quality of responses? In other words, is proficiency in various foundational skills differentially predictive of the use of different reading strategies?

RQ4: Do DE readers differ from non-DE readers in terms of their use of comprehension strategies once lower-level reading skills are accounted for?

In terms of RQ1, it was hypothesized that DE readers would have lower proficiency in foundational skills than non-DE readers and, therefore, SARA scores would be predictive of whether participants were enrolled in a DE course. For RQ2, it was hypothesized that DE readers would struggle with comprehension strategies relative to non-DE readers and, therefore, predicted that lower paraphrasing, bridging, and elaboration scores would be associated with DE enrollment. For RQ3, this study afforded an exploration of whether the findings from Feller et al. (2020) replicated in a 4-year institution. If findings were to replicate, sentence-level processes would be more predictive of bridging and word-level foundational skills (e.g., decoding, vocabulary, morphology) would be more predictive of elaboration. However, the Lexical Quality Hypothesis would predict that individual differences at word-level processes would be positively correlated with both bridging and elaborative strategies. Lastly, for RQ4, it was hypothesized that differences in foundational skills would underly differences in higher-order comprehension skills; therefore, differences between DE and non-DE readers were predicted to be non-significant when variance in foundational skills was accounted for. This result would be consistent with the RSF which speculates that lower-level processes support discourse-level processes and would also replicate Feller et al. (2020). If, however, difference between DE and non-DE readers persist after controlling for foundational skills, there may be other factors beyond foundational reading skills at play.

Methods

Participants

This study utilized archival data collected from 258 individuals as a part of a larger study examining struggling college readers (Magliano, Higgs, et al., 2020). All participants were enrolled in a large, 4-year institution in the Midwest. Participants received monetary compensation, course credit, or gift certificates for their participation, depending on the study time and the number of sessions they completed (out of two). Of the 258 participants, 57% (*n* = 146) of the individuals were enrolled in DE courses. Placement in the DE program was based on ACCUPLACER test scores (College Board, 2019). Additional demographic information for the sample is presented in Table 2.1.

Table 2.1

Demographic Information

Characteristic	*n*	%
DE Status		
DE	146	56.6
Non-DE	112	43.4
Sex		
Female	159	61.6
Male	93	36.0
Not Reported	6	2.3
First Language		
English	228	88.4
Other	24	9.3
Not Reported	6	2.3

Age		
18-22 years	230	89.1
23-25 years	6	2.3
26-29 years	2	0.7
30-37 years	1	0.3
Not Reported	19	7.4
Race and Ethnicity		
Black/African American	129	50.0
White	61	23.6
Hispanic/Latinx	37	14.3
Asian	6	2.3
Multi-racial	19	7.3
Not Reported	6	2.3

Measures

Reading Strategies Assessment Tool

All think-aloud data used in the present study were collected via the Reading Strategies Assessment Tool (RSAT; Magliano et al., 2011). RSAT is a computer-based tool designed to assess the extent to which participants engage in inference processes while reading. In RSAT, participants read texts presented one sentence at a time on a computer screen. At target locations throughout the text, participants are stopped and presented with the prompt “What are you thinking now?” Participants are instructed to think-aloud by typing their thoughts about their understanding of the text into a text box.

In the current study, participants read and thought aloud to two texts. One of the texts was a history text about the Louis the XVI and the French Revolution (19 sentences) and the other was a science text about the power of erosion (22 sentences). Students produced think-aloud responses at 6 or 7 locations, respectively. Text order was counterbalanced, and participants were given one practice text before starting. For think-aloud responses in the practice text, participants were given feedback if their responses were less than five words (i.e., "We are interested in your thoughts about the text. In your responses to the prompts, please tell us more about your understanding of what you are reading."). While RSAT has a means of computing automated scores using computational algorithms, automated scoring was not used in this study. Instead, protocols were hand-coded for the presence and quality of specific strategies (see below).

Study Aid Reading Assessment

The Study Aid Reading Assessment[1] (SARA; Sabatini et al., 2019) is a web-based assessment battery consisting of a series of subtests intended to measure a series of component reading skills. In the present study, subtests assessing decoding/word recognition, vocabulary, morphology, and sentence processing will be utilized. SARA has been normed on large samples of readers from grades 5 to 10 (Sabatini et al., 2019) and has been used among struggling college readers (Feller et al., 2020; Magliano, Higgs, et al., 2020). Each subtest has been shown to have good reliability (all Cronbach's α estimates > .80) and there is evidence of concurrent validity given SARA's ability to predict standardized state test scores (O'Reilly et al., 2012; Sabatini et al., 2013; Sabatini et al., 2019). While reliability could not be calculated for the present sample, SARA has been shown to have good reliability among college populations as well (with Cronbach's α estimates of .89, .86, .91, and .84 for decoding/word recognition, vocabulary,

[1] SARA is previously known as RISE or ReadReady

morphology, and sentence processing, respectively; Feller et al., 2020). Each subtest used in the present study is defined in more detail below.

Word Recognition and Decoding. To assess proficiency in word reading, SARA tests one's proficiency in word recognition (i.e., the accumulation of sight word knowledge for real words in one's native language) and decoding (i.e., the ability to generate plausible pronunciations for printed words; Sabatini et al., 2019). In this task, participants determined whether a stimulus was a word, non-word, or pseudohomophone (i.e., a word sounding exactly like a real word) as quickly as possible. Non-words consisted of made-up words that covered a broad range of spellings and morphological patterns (e.g., clort, plign), whereas pseudohomophones were non-words intended to sound like real words when decoded properly (e.g., maik – make; brane - brain). Real words were selected to cover a wide frequency range and were intended to assess one's ability to automatically recognize a word without needing to decode it (e.g., elect, symbolic; Ehri, 2005; Sabatini et al., 2019). This subtest consisted of 52 items.

Vocabulary. To assess vocabulary knowledge, participants were presented with a target word and asked to select the appropriate synonym or meaning-related word. This task specifically targeted tier 2 (i.e., general academic words) and tier 3 words (i.e., words used less frequently outside of a specific domain/discipline; Beck et al., 2008) as well as polysemous words (i.e., words with more than one meaning) with lesser-known secondary meanings (Papamihiel et al., 2005; Sabatini et al., 2019). This subtest consisted of 35 items.

Morphology. For this task, participants were presented with sentences and asked to fill in the blank with the morphologically correct word. This subtest focused on derivational morphology wherein participants were required to understand how prefixes and/or suffixes

attached to a root (e.g., “For many people birthdays can be a time of great: happiness, unhappy, happily). This subtest consisted of 37 items.

Sentence Processing. The sentence processing measure focused on one’s ability to construct meaning from print at the sentence level (Sabatini et al., 2019). Participants read sentences and filled in the blank with the appropriate word (e.g., “The dog that chased the cat around the yard spent all night: barking, meowing, writing). This subtest consisted of 25 items.

Demographic Questionnaire

A demographic survey was administered, which included questions about the participant’s DE enrollment, first language status, sex, age, and race (see Table 2.1).

Protocol Analysis

The present study took advantage of a detailed coding system, developed as a part of a large-scale grant, that coded protocols for evidence of paraphrasing, bridging, and elaboration (McCarthy et al., 2021). The coding scheme was designed to reflect both the extent to which participants were engaging specific strategies as well as the quality of those strategies. For example, if a participant were to receive the highest rating for bridging, this would not only indicate that bridging occurred in the protocol but would also be indicative of the successful execution of that strategy (which, in this case, would be complete idea units from previous location in the text). The coding of paraphrasing and elaboration ranged from 0 to 2 while the coding of bridging ranged from 0 to 3. The entire coding rubric can be found in Appendix A (adapted from McCarthy et al., 2021).

In addition to strategy scores, the present study examines overall quality scores. *Overall quality scores* reflect the contributions that a constructed response makes towards understanding. Protocols were rated on a scale ranging from 0 to 3 (Poor, Fair, Good, Great). A detailed coding

rubric can be found in Appendix A (adapted from McCarthy et al., 2021). Constructed responses designated as poor (0) are those that are semantically depleted (e.g., Ok, makes sense) or unrelated to the text (e.g., I'm too hungry to think right now). Constructed response that are designated as fair (1) reflect paraphrasing the sentence that was just read, simple metacognitive statements (e.g., Ok, I think I'm starting to understand what's going on), or vague statements about the discourse contexts (e.g., this is about erosion). Constructed response that are good (2) contain one or two bridging and elaborative statements, but these inferences are not fully specified. Constructed responses designated as great (3) contain multiple ideas and clearly specify how the students is understanding what was just read in terms of the larger discourse context and/or their relevant knowledge of the topic.

Protocols that contained fewer than or about 12 characters were not coded. Additionally, protocols that contained nonsensical strings (i.e., nonwords, words in a sequence with no meaning) or content that was copied and pasted from the text were not coded. Interrater reliability (Cohen's kappa) was conducted on 20% of the sample. Reliability for the coding of the presence of strategies was .74, .73, and .77 for paraphrasing, bridging, and elaboration, respectively. Reliability for the coding of overall quality scores was also acceptable (k = .71).

Procedure

Participants completed a battery of measures related to reading proficiency, motivation, and metacognition as part of a larger, two-session study (see Feller et al., 2020; Magliano, Higgs, et al., 2020). The present study focuses on a subset of these measures (RSAT and SARA). All measures were accessed via web links with instructions for each measure provided on the websites. RSAT and SARA were all completed in a computer lab with trained study administrators as a part of the first study session which lasted approximately 60-90 minutes. A

portion of the participants completed this study session during class time, while others completed it outside of class time.

Analytic Approach

All analyses were conducted in the R statistical environment (R Core Team, 2018). To assess the association between foundational reading skills and the likelihood of being enrolled in DE courses (RQ1), a binary logistic regression model was assessed using the lme4 package (Bates et al., 2015). DE enrollment (non-DE = 0, DE = 1) served as the binary outcome variable. SARA subscores (i.e., word recognition/decoding, vocabulary, morphology, sentence processing), sex (0 = male, 1 = female), and L2 status (0 = native, 1 = non-native) served as predictor variables and were entered simultaneously (i.e., in a single step) into the model. The data were examined to determine whether binary regression assumptions were tenable. Scatter plots indicated that there was a linear relationship between the logit of the outcome and each predictor variable. No influential values (i.e., outliers) were found among predictor variables, as measured by Cook's Distance. Variance inflation factors were all below 2, indicating minimal concern of multi-collinearity (Johnston et al., 2018).

To assess the extent to which DE and non-DE students differed in terms of their strategy use (RQ2), a general linear mixed effects model (glmer; i.e., logistic regression) was constructed with DE enrollment (non-DE = 0, DE = 1) as the binary outcome variable. The analysis was conducted using the lme4 package (Bates et al., 2015) in R. Paraphrasing, bridging, and elaboration scores were entered as fixed effects in a single step along with sex (0 = male, 1 = female) and L2 status (0 = native, 1 = non-native). Given the repeated measures design at the item level (i.e., participants produced multiple think-aloud responses), subject (i.e., participant) was treated as a random factor. The data were examined to determine whether binary regression

assumptions were tenable. Scatter plots indicated that there was a linear relationship between the logit of the outcome and each predictor variable. No influential values (i.e., outliers) were found among predictor variables, as measured by Cook's Distance. Variance inflation factors were all below 2, indicating minimal concern of multi-collinearity (Johnston et al., 2018).

To address the remaining research questions (RQ3 and RQ4), separate cumulative link mixed models were built with paraphrasing, bridging, elaboration, and overall quality scores serving as dependent variables. Cumulative link mixed models are designed to handle ordinal outcome variables, as they predict the cumulative odds of a binary outcome (i.e., the likelihood of any particular outcome or higher; Christensen, 2015). All models were built using the clmm function within the ordinal package in R (Christensen, 2015) and the logit function was used.

To select the best-fit model, a model-building approach was adopted (Royston & Sauerbrei, 2008). First, null models were fitted with strategy or overall quality scores at the item-level as the outcome variables. Given that strategy/overall quality scores were directly related to trial order (i.e., think-aloud locations), trial order was entered as a random slope and subject (i.e., participant) was entered as a random effect (i.e., intercept). Null models were used as a baseline comparison for three additional models: Full Models, Pruned Models, and Interactions Models. Full models were fitted by adding the following variables as fixed effects: DE status (0 = non-DE, 1 = DE), sex (0 = male, 1 = female), L2 status (0 = native, 1 = non-native), SARA subscores (i.e., decoding/word recognition, vocabulary, morphology, sentence processing), and text type (0 = history, 1 = science). Pruned Models were then created by eliminating non-significant fixed effects from the Full Model. Lastly, Interactions Models were created, wherein four interaction terms were tested in the models. Interaction terms examined the relation between each SARA subscore and DE enrollment (i.e., decoding/word recognition*DE, vocabulary*DE,

morphology*DE, and sentence processing*DE) in predicting the outcome variables. Interactions between SARA subscores and L2 status were not tested due to the small number of non-native readers in the sample (n = 24). When testing the models with all interaction terms entered simultaneously (i.e., at once), all models failed to converge. As such, interaction terms were added to the Full Models one at a time to assess significance. Significant interaction terms were then added to the models, one at a time, starting with the terms with the most significant effects. Final Interactions Models were fitted by removing non-significant predictors.

To compare model fit, the ANOVA function from the car package in R was used (Fox et al., 2012). This function calculates an AIC value that assesses the relative quality of a model (i.e., model fit). AIC values are commonly used as a means of model selection, with smaller values being associated with better fit (Wagenmakers & Ferrell, 2004). Additionally, a chi-squared value is generated based on a likelihood ratio test (i.e., the difference between the log-likelihood for Model X and log-likelihood for Model Y). Each model was compared to a null model, containing only the random effects structure and no fixed effects. The Full, Pruned, and Interactions models were then compared to one another. AIC values and likelihood ratio test results are presented in the results section, along with coefficients from the best-fit models. Results from other models (i.e., models that were not the best-fit) can be found in Appendices B and C, respectively.

Data related to RQ3 and RQ4 were examined to determine whether the assumptions of ordinal regression were tenable. Each model contained an ordered, categorical dependent variable as the outcome and there were no issues with multi-collinearity (VIF < 2). The Brandt Test (Brant, 1990) was used to assess the proportional odds assumption (i.e., parallel regression assumption). According to this assumption, the coefficients describing the relation between each

pair of outcome groups (i.e., the lowest versus all higher categories; the next lowest category and all higher categories, etc.) should be the same (Sasidharan & Menendez, 2014; UCLA Statistical Consulting Group, 2016). If this is the case, only one model is needed to assess the relation between the pairs of groups, as opposed to multinomial regression where different models are needed for each pairing (UCLA Statistical Consulting Group, 2016). Results from the Brant tests are reported with each corresponding model below.

Results

Descriptive statistics, broken down by DE status, are shown in Table 2.2. Correlation coefficients among variables are presented in Table 2.3. Bi-variate (Pearson) correlations were conducted among continuous variables and point-biserial correlations were conducted for categorical-to-continuous variables (i.e., correlations with DE status). Paraphrasing, bridging, elaboration, and overall scores were averaged across participant to create continuous variables for the correlation matrix.

Table 2.2

Descriptive Statistics by DE Status

	DE (N = 146)			**NON-DE (N = 112)**		
Variable	**Mean**	**SD**	**Scoring Range**	**Mean**	**SD**	**Scoring Range**
Paraphrasing	0.41	0.70	0-2	0.54	0.78	0-2
Bridging	0.75	1.0	0-3	0.93	1.12	0-3
Elaboration	0.65	0.92	0-2	0.84	0.97	0-2
Overall Quality	1.21	0.71	0-3	1.50	0.72	0-3
WRDC	36.69	8.0	18-50	43.63	6.02	21-52
Vocabulary	25.63	4.81	12-35	30.78	3.30	18-35
Morphology	28.47	6.24	8-37	34.18	3.14	18-37
Sentence	19.63	3.89	7-25	22.98	2.09	16-25

Note. WRDC = Word Recognition and Decoding.

Table 2.3

Correlations Among Variables

	Para	Bridge	Elab	Overall	WRDC	VOC	MORPH	SENT	DE
Para	1								
Bridge	.49**	1							
Elab	-.37**	-.29**	1						
Overall	.24**	.52**	.29**	1					
WRDC	.21*	.21**	.09	.44**	1				
VOC	.21*	.24**	.18*	.53**	.64**	1			
MORPH	.20*	.13*	.14*	.36**	.66**	.73**	1		
SENT	.20*	.17*	.07	.33**	.52**	.56**	.62**	1	
DE	-.14*	-.10	-.17*	-.34**	-.43**	-.51**	-.48**	-.46**	1

Note. *$p < .05$, **$p < .001$. Para = Paraphrasing; Elab = Elaboration; Overall = Overall Quality; WRDC = SARA Word Recognition and Decoding; VOC = SARA Vocabulary; MORPH = SARA Morphology; SENT = SARA Sentence Processing.

There was a significant, positive correlation between paraphrasing and bridging scores. Elaboration was negatively correlated with both paraphrasing and bridging scores. All three strategy scores (i.e., paraphrasing, bridging, elaboration) were positively correlated with overall quality scores, with bridging having the strongest relation. There was a significant, negative correlation between DE enrollment and all skills measured, apart from bridging.

RQ1: To what extent do DE readers differ from non-DE readers in terms of proficiency scores related to foundational skills of reading?

To assess the association between foundational reading skills and the likelihood of being enrolled in DE courses, a binary logistic regression model was tested. Model estimates are presented in Table 2.4. The logistic regression model was statistically significant, $\chi^2(6) = 120.59$, $p < .001$, AIC = 237.53. SARA vocabulary, morphology, and sentence processing were all significant, negative predictors of enrollment in DE courses, indicating that decreasing scores on these foundational skills were associated with an increased likelihood of being enrolled in DE courses. Specifically, each unit increase in vocabulary, morphology, and sentence processing

was associated with a 15%, 14%, and 27% decrease in the odds of being enrolled in DE courses, respectively. Sex was a positive predictor of DE status, with participants who identified as female being 2.16 times (16%) more likely to be enrolled in DE courses than participants who identified as male. L2 status was a non-significant predictor.

Table 2.4

Model Estimates for General Linear Model Predicting DE Status (non-DE = 0, DE = 1)

	Estimate	*SE*	*z-value*
Fixed Effects:			
(Intercept)	15.66***	2.20	7.12
SARA WRDC	0.01	0.03	0.19
SARA Vocabulary	-0.16**	0.06	-2.82
SARA Morphology	-0.15*	0.06	-2.37
SARA Sentence	-0.32***	0.09	-3.68
Sex (Female)	0.77*	0.35	2.18
Native English	0.04	0.56	0.07

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

To further evaluate the quality of the logistic regression model, a confusion matrix was constructed using the caret package in R (Kuhn, 2008). The logistic regression equation (i.e., intercept, coefficients) was used to predict the probability that each participant would be enrolled in a DE course. This was then compared to a participant's actual DE status. As such, predicted values were compared to actual values. The confusion matrix is shown in Table 2.5. Overall, the model was a good fit, as indicated by model metrics (accuracy = 80.08%, sensitivity = 78.77%, specificity = 81.90%, misclassification error rate = 19.92%).

Table 2.5

Confusion Matrix for RQ1

	Predicted Values	
	Non-DE	DE

Actual Values	Non-DE	86	26
	DE	24	115

RQ2: To what extent do DE readers differ from non-DE readers in terms of their use of comprehension strategies (e.g., paraphrasing, bridging, elaboration)?

To assess the extent to which DE and non-DE students differed in terms of their strategy use, a general linear mixed effects model (glmer; i.e., logistic regression) was tested. Model estimates are presented in Table 2.6. The logistic regression model was statistically significant, $\chi^2(5) = 210.81$, $p < .001$, AIC = 396.00. There were no significant predictors of DE status. Given that there were no significant predictors in the model, the model was not evaluated further (i.e., no binary classification/confusion matrix).

Table 2.6

Model Estimates for Generalized Mixed Model Predicting DE Status (non-DE = 0, DE = 1)

	Estimate	*SE*	*z-value*
Fixed Effects:			
(Intercept)	14.37***	2.42	5.94
Paraphrase	-0.26	0.93	-0.29
Bridging	-0.51	1.31	-0.39
Elaboration	-0.25	0.71	-0.36
Sex	0.79	2.33	-0.18
Native English	-0.43	1.33	0.59
Random Effects:		*SD*	
Subject	5385	73.58	

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

RQ3 & 4: How does proficiency in foundational skills relate to strategy use and the overall quality of responses? Do DE readers differ from non-DE readers in terms of their use of comprehension strategies once foundational reading skills are accounted for?

To address the remaining research questions (RQ3 and RQ4), four separate cumulative link mixed models were built with paraphrasing, bridging, elaboration, and overall quality scores serving as dependent variables. Models are discussed individually below. Results from the Brant tests are also reported with each corresponding final model.

Cumulative Links Mixed Model for Paraphrasing. The Full Paraphrasing Model significantly improved model fit when compared to the null model, $\chi^2(9) = 44.43$, $p < .001$; AIC = 5165.2. A Pruned Paraphrasing was created, wherein Text Type and Trial Order remained as fixed effects. A likelihood ratio test indicated that the Full Paraphrasing Model was a significantly better fit than the Pruned Paraphrasing Model, $\chi^2(7) = 35.74$, $p < .001$. Finally, the Full Paraphrasing Model was compared to an Interactions Paraphrasing Model (see Appendix B). Results suggested that the models did not differ significantly ($\chi^2(4) = 9.07$, $p = .06$); however, the Full Paraphrasing Model was a better a fit than the Interactions Paraphrasing Model based on the AIC values (AIC = 5165.2, AIC = 5166.3, respectively). As such, model estimates for the Full Paraphrasing Model are presented in Table 2.7. The proportional odds assumption was met for all fixed effects (Brant test values; $p > .05$).

Table 2.7

Model Estimates for Ordinal Mixed Model Predicting Paraphrasing Scores

	Estimate	*SE*	*z-value*
Fixed Effects:			
SARA WRDC	0.02	0.01	1.60
SARA Vocabulary	0.02	0.02	0.96
SARA Morphology	0.02	0.02	1.35
SARA Sentence	0.01	0.03	0.39

Text Type (history)	-0.46**	0.16	-2.94
Trial Order	0.04**	0.02	2.76
DE Enrollment	-0.11	0.15	-0.72
Sex	0.05	0.13	0.39
Native English	-0.24	0.21	-1.14
Random Effects:		*SD*	
Subject (intercept)	1.57	1.25	
Trial Order (slope)	0.01	0.07	

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

Results indicated that Text Type was a significant, negative predictor of paraphrasing, with the history text being negatively associated with log odds of paraphrasing. Specifically, the odds of receiving a lower rather than higher bridging score (0 or 1 rather than a 2) were 1.58 times (58%) higher for the history text than the science text. Trial order was a significant, positive predictor of paraphrasing, such that increasing trial order (i.e., as participants progressed from the beginning of the text toward the end) was associated with an increase in the log odds of receiving a higher paraphrasing score.

Cumulative Links Mixed Model for Bridging. The Full Bridging Model significantly improved model fit when compared to the null model, $\chi^2(9) = 47.96$, $p < .001$; AIC = 6311.0. A Pruned Bridging was created, wherein SARA Vocabulary and Trial Order remained as fixed effects. A likelihood ratio test indicated that the Pruned Bridging Model did not significantly differ from the Full Bridging Model, $\chi^2(7) = 5.66$, $p = .58$; however, the AIC value was lower for the Pruned Model than the Full Model, indicating better fit (AIC = 6302.6, AIC = 6311.0, respectively). Given that significant interactions were found, the Pruned Bridging Model was then compared to the Interactions Bridging Model. Results from a likelihood ratio test indicated that the Interactions Bridging Model differed significantly from the Pruned Bridging Model,

$\chi^2(3) = 9.16$, $p < .05$; AIC = 6299.5. As such, model estimates for the Interactions Bridging Model are presented in Table 2.8.

Table 2.8

Model Estimates for Ordinal Mixed Model Predicting Bridging Scores

	Estimate	*SE*	*z-value*
Fixed Effects:			
SARA WRDC	0.05**	0.02	2.99
SARA Vocabulary	0.06***	0.02	3.39
Trial Order	-0.05***	0.01	-3.97
DE Enrollment	2.23**	0.85	2.61
DE*WRDC	-0.05*	0.02	-2.57
Random Effects:		*SD*	
Subject (intercept)	1.02	1.01	
Trial Order (slope)	0.01	0.07	

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

Results indicated that SARA Vocabulary was a significant, positive predictor of bridging, such that increases in vocabulary were associated with an increased log odds of receiving a higher bridging score. Specifically, in terms of odds ratios, each unit increase in vocabulary was associated with a 7% increase in the odds of receiving a higher rather than lower bridging score (e.g., 1, 2, or 3 rather than 0). Trial Order was a significant, negative predictor of bridging, such that increasing trial order (i.e., as participants progressed from the beginning of the text toward the end) was associated with a decrease in the log odds of receiving a higher bridging score.

DE enrollment was a positive predictor of bridging. The odds of having a higher rather than lower bridging score (0 rather than 1 or 2) were 9.30 times higher for DE students than non-DE students. SARA Word Recognition/Decoding was also a significant, positive predictor of bridging, such that increases in word recognition/decoding were associated with an increase in the log odds of receiving a higher bridging score. Both the main effects of DE enrollment and

Word Recognition/Decoding were qualified by a significant, negative DE by Word Recognition/Decoding interaction. The interaction is displayed in Figure 2.1.

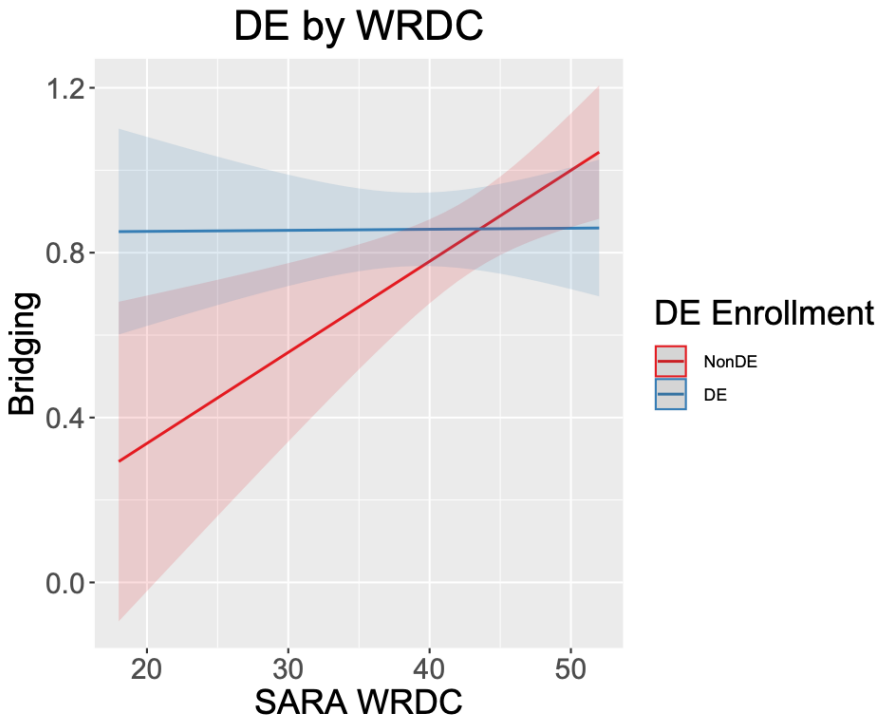

Figure 2.1 Interaction between DE enrollment and SARA Word Recognition/Decoding. Bridging is treated as a continuous variable in the figure for ease of interpretation.

The proportional odds assumption was not met for this analysis, with SARA Vocabulary appearing as a potentially problematic predictor (Brant test values; $p < .05$). This suggests that the slope (i.e., coefficient) representing the relation between vocabulary and bridging may not be stable across all levels of bridging. In cases where the proportional odds assumption is violated, it is recommended that the analysis be treated as multinomial (Sasidharan & Menendez, 2014). However, this ignores the ordered nature of the data and makes the interpretation of results difficult (e.g., examining the relation between vocabulary and each score for bridging; O'Connell, 2006; Sasidharan & Menendez, 2014). Additionally, it should be noted that the proportional odds assumption is considered by many to be "anti-conservative, that is it nearly always results in rejection of the proportional odds assumption, particularly when the number of independent

variables is large (Brant, 1990), the sample size is large (Allison, 1999; Clogg & Shihadeh, 1994), or there is a continuous independent variable in the model (Allison, 1999)" (O'Connell, 2006, p. 29). The current analysis contained a continuous independent variable and was conducted on a large sample size. As such, it is unsurprising that the assumption was violated. Nonetheless, given this limitation, results from this model should be interpreted cautiously. This point is discussed further in the discussion section.

Cumulative Links Mixed Model for Elaboration. The Full Elaboration Model significantly improved model fit when compared to the null model, $\chi^2(9) = 101.86$, $p < .001$; AIC = 4544.8. A Pruned Elaboration Model was created, wherein DE Enrollment, SARA Vocabulary, Text Type, and Trial Order remained as fixed effects. The likelihood ratio tests indicated that the Pruned Elaboration Model did not significantly differ from the Full Elaboration Model, $\chi^2(5) = 4.37$, $p = .50$; however, the AIC value was lower for the Pruned Model than the Full Model, AIC = 4539.2, AIC = 4544.8, respectively. Given that there were no significant interactions, no Interaction Model was created for elaboration. Model estimates for the Pruned Elaboration Model are presented in Table 2.9.

Table 2.9

Model Estimates for Ordinal Mixed Model Predicting Elaboration Scores

	Estimate	*SE*	*z-value*
Fixed Effects:			
SARA Vocabulary	0.04*	0.02	2.33
Text Type (history)	1.22***	0.16	7.45
Trial Order	-0.07**	0.02	-2.86
DE Enrollment	-0.35*	0.17	-2.05
Random Effects:		*SD*	
Subject (intercept)	1.15	1.07	
Trial Order (slope)	0.02	0.14	

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

Results indicated that SARA Vocabulary was a significant, positive predictor of elaboration, such that increases in vocabulary were associated with an increased log odds of receiving a higher elaboration score. Put in terms of odds ratios, each unit increase in vocabulary was associated with a 4% increase in the odds of receiving a higher rather than lower elaboration score (e.g., 1 or 2 rather than 0). Text type was also a significant, positive predictor of elaboration, with the history text being positively associated with log odds of elaborating. The odds of receiving a higher rather than lower elaboration score (e.g., 1 or 2 rather than 0) were 3.39 times higher for the history text than the science text. Trial Order was a significant, negative predictor of elaboration, such that increasing trial order (i.e., as participants progressed from the beginning of the text toward the end) was associated with a decrease in the log odds of receiving a higher elaboration score. Finally, DE enrollment was a significant, negative predictor of elaboration. The odds of having a lower rather than higher elaboration score (0 rather than 1 or 2) were 1.43 times (43%) higher for DE students than non-DE students. The proportional odds assumption was met for all fixed effects (Brant test values; $p > .05$).

Cumulative Links Mixed Model for Overall Quality. The Full Overall Quality Model significantly improved model fit when compared to the null model, $\chi^2(9) = 123.95$, $p < .001$; AIC = 6280.2. A Pruned Overall Quality Model was then created, wherein SARA Word Recognition/Decoding, SARA Vocabulary, Text Type, and Trial Order remained as fixed effects. A likelihood ratio test indicated that the Pruned Overall Quality Model did not significantly differ from the Full Overall Quality Model, $\chi^2(5) = 3.51$, $p = .62$; however, the AIC value was lower for the Pruned Model than the Full Model, indicating better fit (AIC = 6273.7, AIC = 6280.2, respectively). Given that there were no significant interactions, no Interactions

Model was created for elaboration. Model estimates for the Pruned Overall Quality Model are presented in Table 2.10.

Table 2.10

Model Estimates for Ordinal Mixed Model Predicting Overall Quality Scores

	Estimate	*SE*	*z-value*
Fixed Effects:			
SARA WRDC	0.03*	0.01	2.08
SARA Vocabulary	0.12***	0.02	6.09
Text Type (history)	0.83***	0.15	5.71
Trial Order	-0.09***	0.02	-4.37
Random Effects:		*SD*	
Subject (intercept)	2.27	1.51	
Trial Order (slope)	0.02	0.14	

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

Results indicated that SARA Word Recognition/Decoding was a significant, positive predictor of overall quality scores, such that increases in word recognition/decoding were associated with an increased log odds of receiving a higher overall quality score. Each unit increase in word recognition/decoding was associated with a 3% increase in the odds of receiving a higher rather than lower overall quality score (e.g., 1 or 2 rather than 0). SARA vocabulary was also a significant, positive predictor of overall quality scores with increases in vocabulary being associated with an increased log odds of receiving a higher overall quality score. In terms of odds-ratios, each unit increase in vocabulary was associated with a 13% increase in the odds of receiving a higher rather than lower overall quality score (e.g., 1 or 2 rather than 0). Text type was also a significant, positive predictor of overall quality, with the history text being positively associated with log odds of higher overall quality scores. The odds of receiving a higher rather than lower overall quality score (e.g., 1 or 2 rather than 0) were 2.29 times higher for the history text than the science text. Lastly, Trial Order was a significant,

negative predictor of overall quality scores, such that increasing trial order (i.e., as participants progressed from the beginning of the text toward the end) was associated with a decrease in the log odds of receiving a higher overall quality score. The proportional odds assumption was met for all fixed effects (Brant test values; $p > .05$).

Discussion

Many students arrive at college underprepared to meet college reading demands (Bailey, 2009). Understanding the challenges struggling college readers face is of importance both in terms of testing theories of reading literacy, informing policies, and developing and testing interventions (Bailey et al., 2010; Perin, 2020). The current study was motivated by the RSF and explored the extent to which DE and non-DE students differed in terms of proficiency in foundational reading skills and higher-level reading strategies as evidenced in constructed responses. This study provided a partial replication of Feller et al. (2020), who conducted a study on community college students, and an extension of Magliano, Lampi, et al. (2020) that constituted a small-scale study comparing strategies revealed by constructed responses.

Answers to Research Questions

Four research questions were addressed in this study. RQ1 examined the extent to which proficiency in foundational reading skills was related to the likelihood of being enrolled in DE courses. Consistent with hypotheses, results indicated that DE enrollment was significantly, negatively associated with proficiency in vocabulary, morphology, and sentence processing (but not word recognition/decoding). Moreover, results from the confusion matrix indicated that DE enrollment could be predicted with a high degree of accuracy (i.e., accuracy = 80.08%, misclassification error rate of 19.92%).

Results from RQ1 are consistent with other research suggesting that DE readers struggle with foundational reading skills (Ari, 2011; 2016; Halldórsdóttir et al., 2016; Magliano et al., 2022). Moreover, given that placement in DE programs is largely based on performance on standardized placement tests (i.e., ACT®; COMPASS®; Hughes & Scott-Clayton, 2011), this result suggests that there is a strong relation between SARA and standardized tests of reading comprehension. While placement tests have been criticized for providing a single, unidimensional comprehension score (Magliano, Lampi, et al., 2020; Magliano & Millis, 2003), SARA provides a measure that is more sensitive to the specific strengths and challenges of readers.

One final point related to RQ1 pertains to the non-significant relation between DE enrollment and SARA word recognition/decoding. This result was contrary to hypotheses, which predicted that all foundational readings skills would be negatively predictive of DE enrollment. This finding suggests that, while DE students may struggle with word reading processes (Ari, 2016; Feller et al., 2020), word recognition and decoding were not as useful in differentiating DE students from non-DE students as other subcomponent reading skills in this sample. Feller et al. (2020) reported a non-significant trend in terms of word recognition scores positively predicting comprehension performance in a sample of community college student. Moreover, Magliano et al. (2022) found that relatively few college students struggled with word recognition/decoding compared to other SARA subskills in a study that involved participants from the Feller et al. and Magliano et al. It may be the case that some institutions have some proportion of students entering college with challenges with word recognition, whereas others do not. This may be a more prevalent issue in community college settings that typically do not have admission criteria, and therefore may have greater variability in entering students with respect to foundational skills

of reading, which would have implications on a diversity of strengths and challenges for DE students.

RQ2 examined the extent to which DE readers could be distinguished from non-DE readers based on their use of comprehension strategies (e.g., paraphrasing, bridging, elaboration). Consistent with hypotheses, the means shown in Table 2.2 indicate that non-DE students had higher paraphrasing, bridging, and elaboration scores than DE students. However, contrary to hypotheses, the results from the logistic regression model indicated that paraphrasing, bridging, and elaboration were all non-significant predictors of DE enrollment. Prior studies have shown that the relation between strategy use and comprehension outcomes exists when variance is accounted for by foundational skills, and it may be similarly the case for predicting DE enrollment (Feller et al., 2020; Magliano, Lampi, et al., 2020). The analyses conducted to address RQ3 and RQ4 afforded assessing if this was the case for the present study.

RQ3 and RQ4 examined how proficiency in foundational reading skills related to strategy use and the overall quality of constructed responses and how DE status related to these same outcomes when controlling for foundational skills of reading. In terms of paraphrasing, none of the foundational skills measured were significantly predictive of the log odds of paraphrasing (RQ3). While less proficient readers have been shown to paraphrase more than proficient readers (Magliano & Millis, 2003; McNamara, 2017; McNamara et al., 2006), proficiency in foundational skills was unrelated to the use of paraphrasing when thinking aloud. Additionally, DE status did not significantly predict paraphrasing scores (RQ4). These results are consistent with Magliano, Lampi, et al. (2020), who found no differences between DE and non-DE readers in terms of paraphrasing scores when controlling for comprehension scores. Paraphrasing involves understanding and transforming text content (McNamara et al., 2007; McNamara &

Magliano, 2009a). These results suggest that DE and non-DE students are equally effective at paraphrasing, which is encouraging.

With respect to bridging, results indicated that vocabulary was a significant, positive predictor, such that increases in vocabulary scores were associated with an increase in the log odds of bridging (RQ3). Results from the present study are consistent with prior research suggesting that vocabulary knowledge is related to inference generation among both children (Cain & Oakhill, 2014) and college readers (Barnes et al., 2015; Singer et al., 1992). Bridging involves establishing relations between what one is currently reading and prior discourse constituents (McNamara & Magliano, 2009a). Understanding word meanings may reduce one's cognitive load and allow them to engage higher-level strategies (Singer et al., 1992; Singer & Ritchot, 1996).

Word recognition and decoding was also a significant, positive predictors of bridging. This result is consistent with prior research that suggests that one's ability to quickly decode words is related to their ability to generate bridging inferences (Hamilton et al., 2016). Efficient decoding is thought to free up mental resources (i.e., working memory) and allow readers to engage in higher-level processing (i.e., verbal efficiency theory; Hamilton et al., 2016; Perfetti, 1985; van Dyke & Shankweiler, 2012).

Interestingly, DE status significantly positively predicted bridging scores after controlling for proficiency in foundational skills (RQ4). This result was not predicted given that less proficient readers tend to bridge less than proficient readers (e.g., Magliano & Millis, 2003). Moreover, mean bridging scores were lower for DE students than non-DE students. The present study is, however, consistent with Magliano, Lampi, et al. (2020) who found a positive relation between hand-coded bridging scores and DE enrollment that approached significance (p = .08).

It is possible that this relation may be a product of the sample and course curriculum. The DE program from which the sample was drawn specifically targets good students at underperforming schools. Moreover, DE courses often focus on bridging as a potential tool to aid struggling readers (García-Navarrete et al., 2012). Additional research is needed determine if this effect can be replicated.

A significant interaction also emerged, wherein word recognition and decoding interacted with DE status in predicting bridging scores. As illustrated in Figure 2.1, the relation was such that increasing word recognition/decoding scores were associated with an increase in bridging scores, but only for non-DE students. Conversely, for DE students, the relation between word recognition/decoding was relatively flat. One possible explanation is that DE students have developed compensatory mechanisms that allow them to compensate for poor word reading skills and engage in higher-level processing (Jackson, 2005; Jackson & Doellinger, 2002; Welcome et al., 2009). Additionally, more DE than non-DE students may fall below a "decoding threshold"—a point for which the relation between decoding and reading comprehension becomes insignificant (Magliano et al., 2022; Wang et al., 2019). Notwithstanding, this interaction was not predicted, and one should be cautious in interpreting this result as additional research is warranted before more definitive explanations can be provided.

It is important to note that the proportional odds assumption was violated for this analysis. Specifically, the relation between bridging and vocabulary may not be stable across different levels of bridging. Here, it is argued that the dependent variable (i.e., bridging) is an ordered, categorical variable. As such, ordinal regression is the most appropriate analysis. However, future research may explore other types of models, including partial proportional odds

models that treat problematic variables as nominal and non-problematic variables as ordinal (Peterson & Harrell, 1990; Sasidharan & Menendez, 2014).

With respect to elaboration, results suggested that vocabulary was a significant predictor of elaboration, such that increasing vocabulary scores were associated with an increase in the log odds of producing elaborations (RQ3). This is consistent with prior research that suggests that vocabulary knowledge is related to one's ability to generate elaborative inferences that go beyond explicitly stated text content (Barnes et al., 2015; Calvo, 2005). Additionally, Feller et al. (2020) found that lexical knowledge positively predicted computationally derived elaboration scores (via RSAT) in a 2-year institution. The present study replicates this finding with hand-coded elaboration scores in a 4-year institution.

With respect to DE status, DE enrollment was a significant, negative predictor of elaborating (RQ4). This study found that the odds of having a lower rather than higher elaboration score (0 rather than 1 or 2) were 43% higher for DE students than non-DE students, which is a substantial difference. This is an important finding because theories of comprehension assume that elaboration involves incorporating prior knowledge into one's mental representation of a text (McNamara, 2004; McNamara & Magliano, 2009a) and elaboration has been shown to be positively related to performance on standardized tests of comprehension (e.g., Magliano et al., 2011). As such, DE readers, who were less likely to produce quality elaborations, may be limited in terms of comprehension.

This finding replicated Magliano, Lampi, et al. (2020), who conducted a studying using constructed responses on a small sample of DE and non-DE students. That study was conducted at the same four-year institution as the present study. The present results indicated that differences in elaboration could not be explained in terms of differences in the foundational skills

of reading, which suggests that there were other factors not measured in this study that may account for this difference. Magliano, Lampi et al., (2020) explained these results in terms of differences in primary and secondary educational experiences. Given that DE students may come from underperforming schools, it may be that DE readers have less exposure to a variety of topics (Seery, 2009). Limited prior knowledge has been shown to weaken comprehension performance (e.g., McKeown et al., 1992; O'Reilly & McNamara, 2007; Ozuru et al., 2009; Tarchi, 2010) and background knowledge is strongly related to vocabulary knowledge (Johnson, 1982; Murphy et al., 2021; Sidek & Rahim, 2015). Given that vocabulary was predictive of elaboration, it is plausible that this finding is related to vocabulary knowledge; however, the interaction between DE status and vocabulary was non-significant (see Appendix C). This replicated finding warrants further research to understand the reasons why this difference exists.

Lastly, in terms of overall quality scores, results indicated that both word recognition/decoding and vocabulary were positive predictors of overall quality scores (RQ3). Many assume that college readers have sufficient word reading skills but lack the ability to understand texts on a deeper level (e.g., Gough, Hoover, & Peterson, 1996). However, the present results suggest that variability in word reading skill matters at the college level. This result is consistent with prior research suggesting that, while the relation between decoding processes and reading comprehension weakens over grade levels (e.g., Abbott et al., 2010; García & Cain, 2014; Keenan et al., 2008), these processes are still found to be related to reading comprehension, even at the college level (Bell & Perfetti, 1994; Cunningham et al., 1990; Holmes, 2009; Martino & Hoffman, 2002).

With respect to vocabulary, the present analysis suggested that the log odds of producing high quality constructed responses was related to proficiency in vocabulary. The magnitude of

this relation was such that each unit increase in vocabulary was associated with a 13% increase in the odds of receiving a higher rather than lower overall quality score (e.g., 1 or 2 rather than 0). As seen previously, vocabulary was significantly predictive of both bridging and elaboration scores. Given that overall quality ratings for constructed responses were based on evidence of successful bridging and elaboration (see Appendix A), it is unsurprising that vocabulary was related to overall quality scores that targeted these very strategies. Moreover, this result is consistent with other research suggesting that vocabulary is related to reading strategy use (Cromley et al., 2010; Feller et al., 2020; Kopatich et al., 2019).

The overall quality of constructed responses is also intended to reflect one's ability to effectively combine reading strategies (i.e., paraphrasing, bridging, and elaboration; Best et al., 2005; McCarthy et al., 2021; McNamara, 2004). The quality of constructed responses has been linked to comprehension outcomes (Magliano et al., 2011; Magliano & Millis, 2003; McNamara et al., 2006). As such, the present study suggests that word recognition/decoding and vocabulary may support one's ability to effectively use multiple strategies when thinking aloud, which should support comprehension.

DE status did not significantly predict overall quality scores after controlling for proficiency in foundational skills (RQ4). This suggests that differences in overall quality scores were likely driven by differences in the foundational skills of reading, rather than extraneous factors. Overall quality scores appeared to be particularly related to word recognition/decoding and vocabulary, as discussed above.

The results assessing the relations among foundational skills of reading, bridging, and elaboration did not replicate those of Feller et al. (2020) and, as such, hypotheses derived from Feller et al. were not confirmed. Feller et al. (2020) found that sentence processing was the only

foundational skill that significantly predicted bridging, whereas the present study found a relationship between word recognition/decoding and vocabulary knowledge. With respect to elaboration, Feller et al. (2020) found that word recognition/decoding and morphological knowledge were predictive of elaboration, but the present study indicated that only vocabulary knowledge was a significant predictor. It is important to acknowledge, however, that both studies indicated that proficiencies in word processing (word recognition and lexical processes) were associated with elaboration.

There are a few important differences between studies worth noting. First, Feller et al. (2020) used computational algorithms to detect bridging from constructed responses, as opposed to hand-coding. Second, it is possible that there are institutional differences in terms of proficiency and strategy use (Magliano et al., 2022). As will be discussed in the section exploring the implications of the results for theory below, the analyses across both studies are consistent with the Lexical Quality Hypothesis and suggest that proficiency in lexical processing have important implications on the extent that college readers engage in bridging and elaboration strategies.

Relations Among Strategies

The correlations among strategies (and overall quality scores) are worth noting. Paraphrasing and bridging scores were positively correlated with each other but negatively correlated with elaboration scores. First it is important to note that bridging involves establishing how the current sentence is related to the prior discourse context (McNamara, 2004) and, in the context of thinking aloud, paraphrasing and bridging strategies co-occur (e.g., Trabasso & Magliano, 1996). Specifically, an effective bridge may often require one to restate content form the sentence that was just read. The negative correlations between paraphrasing and bridging

with elaboration are consistent with a study conducted by Todaro, Magliano, and McNamara (reported in McNamara & Magliano, 2009b). They showed that features of text that are positively predictive of bridging (i.e., presence of causal antecedents in the prior discourse) are negatively correlated with elaboration, whereas features that are positively correlated with elaboration (number of new arguments) were negatively bridging. When the text requires establishing coherence across the text, readers are more likely to paraphrase and bridge than elaborate, whereas when the texts introduces new topic, readers are more likely to elaborate based on relevant background knowledge than engage in bridging and paraphrasing. Future research should explore the extent to which strategies are used in combination and the extent to which different combinations of strategies predict comprehension outcomes.

Consideration of Text Effects

Results indicated that text type was a significant predictor in multiple analyses. While text type was not of primary interest in the present study, serving largely as a control variable, there were a few results worth noting. Specifically, the odds of paraphrasing were significantly lower for participants when thinking aloud to the history text than the science text. However, the odds of elaborating and producing higher overall quality scores were significantly higher for participants when thinking aloud to the history text than the science text.

Prior research suggests that readers may be more or less likely to engage different reading strategies depending on the difficulty (Sun, 2012) or genre of the text (narrative vs. expository; Best et al., 2008). Texts in the present study differed slightly in terms of readability (Flesch-Kincaid grade level of 11.7 for history, 9.9 for science). As such, differences in readability may have contributed to text effects. Prior research has shown that successful paraphrases are associated with less difficult sentences (Best et al., 2004). In the present study, the science text

was less difficult than the history text (i.e., in terms of Flesch-Kincaid level), which may have led to an increase in successful paraphrases.

The genre of the texts also differed. While both were expository texts, the history text was an account of Louis the XVI and, as such, read more like a narrative than the science text. The text discussed Louis the XVI as someone who was unfairly judged due to being caught in the wrong place at the wrong time. As such, participants may have been more likely to relate this to their own personal experiences, engaging in elaborative inferencing and increasing the likelihood of producing higher quality responses; however, caution is advised when interpreting these results, given that only one history and one science text were used.

Consideration of Trial Order

Trial order was also a significant predictor of strategy use in multiple analyses. As participants progressed from the beginning of the text toward the end, the odds of paraphrasing increased and the odds of producing bridges, elaborations, and higher overall quality responses decreased. While different strategies may be more or less useful as readers move through a text (McNamara & Magliano, 2009b), the present results may be attributed to a fatigue effect. Prior research using RSAT suggests that individuals tend to decrease the amount of words they use over the course of the task (Kurby et al., 2012; Millis & Magliano, 2012). In this study, it is possible that students became less engaged toward the end of the task and began relying on easier strategies (i.e., paraphrasing) rather than more effortful strategies (i.e., bridging, elaboration). Less bridging and elaborating (as well as less effort in general) would also have contributed to lower overall quality scores. Future research may seek to explore this issue further, as will be discussed in the future directions section.

Consideration of Sex Effect

Results for RQ1 showed that sex was a positive predictor of DE enrollment, with the odds of participants who identified as female being 2.16 times greater than that of participants who identified as male. One may wonder why self-identified females were more likely to be enrolled in DE courses, even when controlling for foundational skills. One thing to consider is that there were more self-identified females (n = 159) than males (n = 93) in the study in general (see Table 2.1). Moreover, there were 98 self-identified females enrolled in DE compared to 43 males (with 5 who chose not to respond), which was disproportionately high compared to the rest of the non-DE sample (61 female, 50 male, 1 unknown). There were no data collected to elucidate this trend. However, prior research suggests that DE screening procedures may influence the composition of DE courses in terms of gender and race (Scott-Clayton et al., 2012). This may reflect a systemic bias in the higher educational system, but more research is needed to assess the prevalence of this bias and the underlying causes of it.

Implications for Research and Theory

The RSF motivated the present study, and the results are consistent with the lexical quality hypotheses proposed by it (Perfetti, 2007; Perfetti & Stafura, 2014). Vocabulary was found to be a significant, positive predictor of bridging and elaborating. According to the RSF, high-quality lexical representations allow readers to quickly integrate words into their mental representations (Perfetti, 2007; Perfetti & Stafura, 2014). This, in turn, facilitates one's ability to generate inferences, in part by freeing up mental resources (Perfetti & Stafura, 2014; Singer et al., 1992). Moreover, the ease and speed at which integration occurs has been shown to be related to vocabulary knowledge, even when this integration occurs across sentence boundaries (as is the case with bridging; Guerra & Kronmüller, 2020). Similarly, unfamiliar words may

place a high demand on working memory, which constrains a reader's ability to think beyond the text content (Calvo, 2005; Perfetti, 2007; Singer et al., 1992). Consistent with the present study and the RSF, vocabulary knowledge has been found to be a limiting factor both in terms of the speed and ability to generate elaborative inferences (Barnes et al., 2015; Calvo et al., 2003; Calvo, 2005; Monzó & Calvo, 2002).

Results also suggested that word recognition and decoding were significantly related to bridging and the quality of constructed responses. The RSF underscores the importance of rapid, automatic word-level processing as a limiting factor in comprehension (Perfetti, 2007; Perfetti & Stafura, 2014). As such, one's word reading ability may influence their ability to create deeper meaning from text. Given that the quality of constructed responses is related to comprehension outcomes (Magliano et al., 2011; Magliano & Millis, 2003; McNamara et al., 2006), it is possible that there are both direct and indirect effects of foundational skills on comprehension. That is, one's ability quickly decode words and activate strong lexical representations is directly related to reading comprehension (Kopatich et al., 2019; Feller et al., 2020), and may be indirectly related to comprehension through one's ability to use reading strategies, as evidenced by the quality of constructed responses (Cromley et al., 2010; Kopatich et al., 2019; Magliano, Higgs, et al., 2020). While this mediational pathway is never explicitly discussed in the RSF, it is a testable hypothesis that is consistent with the RSF, which emphasizes the interactive nature of comprehension processes and proposes that integration processes occur on multiple levels.

Lastly, in chapter one of this dissertation, it was argued that the RSF provides a valuable lens to explore the literacy skills of postsecondary readers. The present study is one such application of this framework and demonstrates how the RSF can be used to examine the strengths and challenges of struggling readers. Specifically, the present study used the RSF to

show how foundational skills were differentially related to comprehension strategies. Addressing these sorts of questions would not be difficult through other theories of comprehension that combine multiple components reading skills into a single factor (e.g., Gough & Tunmer, 1986; Hoover & Gough, 1990). Understanding how various literacy skills relate from a theoretical and empirical standpoint is of importance to researchers and educators and the present study informs future research about the utility of the RSF in college populations.

Implications for Practice

Developmental education has been the source of much debate over the past 10-20 years, with many DE programs being modified or eliminated altogether (Bailey, 2009; Cormier & Bickerstaff, 2020; Crisp & Delgado, 2014). Moreover, research suggests that many DE programs targeting reading have limited success, especially regarding degree attainment (Bailey, 2009; Jaggars & Stacey, 2014). What can be learned about struggling college readers through the present study that might have implications for supporting underprepared college readers?

First, in terms of assessment, the standardized tests commonly used for placement in DE programs (e.g., ACCUPLACER®, ACT COMPASS®, SAT) typically rely on a global assessment of student's reading comprehension skill (Hu & Hu, 2021; Hughes & Scott-Clayton, 2011). Students read short passages, answer multiple-choice questions, and receive a single score meant to reflect their comprehension ability. There are several criticisms of these assessments (e.g., Barnett & Reddy, 2017; Hu & Hu, 2021; Rupp et al., 2006); however, here it is argued that assessing comprehension at a more fine-tuned level may have value, as it affords identifying where specific challenges arise (see also Jaggars & Hodara, 2013). Moreover, although having a theoretically grounded assessment of comprehension is of importance, many reading assessments are not theoretically motivated (Pellegrino et al., 2001). SARA was developed to be conceptually

aligned with the RSF (Sabatini et al., 2013; Sabatini et al., 2019) and, as such, could be beneficial in terms of identifying areas where students struggle and informing institution-specific programs.

The results of this study suggest that DE students may have strengths and challenges. Consistent with Magliano, Lampi et al. (2020), DE and non-DE students did not differ in paraphrasing but did differ in terms of elaboration. More research is needed to understand the nature and reasons for these replicated findings, but they suggest that assuming DE students broadly struggle with literacy skills may be somewhat misplaced.

The results of this study present a challenge in terms of supporting struggling readers who may have challenges with foundational skills of reading. Supporting a diverse group of learners with a wide range of reading challenges is difficult. In recent years, many DE programs have begun to allow students to complete credit bearing courses while concurrently receiving support through DE courses (Complete College America, 2013; Cormier & Bickerstaff, 2020). While this may benefit some students (Jaggars et al., 2015), others with particularly low foundational skills may have difficulties rectifying these issues and will likely struggle in credit bearing courses. As a result, an increasing number of reforms to DE programs are beginning to involve Adult Basic Education programs housed in continuing education departments (ABE; Cormier & Bickerstaff, 2020; Senserrich, 2014). ABE programs may be better able to meet the needs of low-skill readers (Cormier & Bickerstaff, 2020), which allows DE programs to eliminate instruction on foundational skills from the curriculum and instead focus on content that aligns with preparing students for college-level course content (Bailey et al., 2015; Edgecombe et al., 2013).

Another important implication from the current study relates to the role of vocabulary. Results of the present study suggests that struggling college readers may need support in terms of acquiring enriched vocabulary knowledge (Willingham & Price, 2009). A few interventions among DE readers have targeted vocabulary, providing students with strategies for identifying and learning new words (García-Navarrete et al., 2012; Robson, 2009; Willingham & Price, 2009). The majority of programs target vocabulary indirectly through "contextualized" DE instruction, wherein instructors use authentic, college-level reading tasks to scaffold reading skills like vocabulary and background (Cormier & Bickerstaff, 2020; Perin, 2013). The results of this study lend credence to this practice.

An additional implication concerns the relation between elaboration and DE status. The present study replicates a finding that suggests that DE readers may need additional support in terms of generating elaborative inferences (Magliano, Lampi, et al., 2020). Interventions that target self-explanation and, in particular, the use of elaboration may be beneficial to DE readers. These interventions typically encourage readers to activate whatever domain-related knowledge they have when reading difficult or unfamiliar texts (McNamara, 2004). When readers think about what they know in relation to a text, they are better able to bring in outside knowledge to fill in missing information and create a more coherent mental representation of the text (Cain & Oakhill, 2014; McNamara, 2004; McNamara & Magliano, 2009b). Self-explanation training has been applied among adolescent and college populations with some success (McNamara, 2007; McNamara, 2017; McNamara et al., 2006; O'Reilly et al., 2006). For example, McNamara (2017) found that low-knowledge students who received self-explanation training were able to perform as well as their high-knowledge counterparts on science course exams. It is possible that

self-explanation training may benefit struggling readers and help rectify issues surrounding prior knowledge and elaboration.

Finally, in the present study, it was argued that understanding the strengths and challenges of DE readers is of importance given that 1) it tells us something about readers at the lower-end of the college spectrum and 2) it may be useful in informing policy, curriculum, and interventions. Indeed, the present study suggests that a more diagnostic measure of proficiency could be useful in understanding and helping struggling college readers and that DE designation may capture more than differences in basic reading proficiency. However, it is worth questioning the utility of "DE" as a label in educational research. While the DE label has significant consequences for students and institutions (e.g., Crisp & Delgado, 2013), the label is relatively arbitrary as it varies from institution to institution. Moreover, research suggests that many students are mis-assigned to DE courses, that cutoff points are arbitrary, and that students just above and just below typical DE cutoff scores are equally responsive to remediation (see Scott-Clayton et al., 2012). An individual's literacy skill lies on a continuum that ranges from low to high (Cormier & Bickerstaff, 2020; Greenberg, 2008). Research targeted at understanding why readers struggle in general, regardless of labels (i.e., DE vs. non-DE), may be of importance in terms of informing models of comprehension and scaffolding interventions.

Limitations & Future Directions

A few potential limitations to the current study should be noted. Findings from this study emphasize the importance of vocabulary among struggling college readers; however, to address the issues related to vocabulary, a deeper understanding of the vocabulary-specific challenges faced by these readers is necessary. Literature examining vocabulary typically makes a distinction between breadth and depth (Anderson & Freebody, 1981; Nagy & Scott, 2000;

Wallace, 2007). Vocabulary *breadth* refers broadly to the number of words an individual knows. Vocabulary *depth*, on the other hand, refers to the amount of knowledge an individual has for a particular word—both in terms of knowing the different contexts in which a word is used (Stahl & Fairbanks, 1986; Wallace, 2007) and having high-quality lexical representations with well-specified meanings (Cain & Oakhill, 2014; Perfetti, 2007; Perfetti & Hart, 2001). SARA was designed to assess aspects of both vocabulary breadth (e.g., the meaning of academic or domain-specific words) and depth (e.g., secondary meanings for polysemous words (i.e., words with multiple meanings); Sabatini et al., 2019). However, it may be valuable to have more detailed measures that examine aspects of vocabulary individually (i.e., academic words, specialized content area words, secondary meanings, etc.) rather than collectively (Beck et al., 2008). Ideally, this would include measures that do not rely on word reading processes (e.g., picture naming), as doing so would allow one to control for the influence of word identification processes (Garcia & Cain, 2014). Understanding the vocabulary needs of struggling readers presents a challenge for future researchers but may be valuable in terms of intervention.

Relatedly, a second limitation pertains to the relation between vocabulary and prior knowledge. Vocabulary represents an intersection between foundational reading skills and prior knowledge (Murphy et al., 2021; Sidek & Rahim, 2015). As discussed above, vocabulary was a robust predictor in several analyses. However, prior knowledge was not assessed in this study. As such, it is impossible to determine whether differences related to vocabulary scores were associated with vocabulary knowledge, prior knowledge, or a combination of the two. Given the important role background knowledge plays in comprehension (e.g., McCarthy et al., 2018; Smith et al., 2021), future research should seek to examine its role in relation to DE status, proficiency, strategy use, and comprehension outcomes.

The present study relied on the hand-coding of constructed responses in determining the presence and quality of strategies. While there is a long history of using expert judgments to hand-code constructed responses (e.g., Chi, 1997; Pressley & Afflerbach, 1995), with advances in natural language processing tools (NLP), there has been a growing interest in using computational text analysis tools to assess the linguistic features of constructed responses (Allen et al., 2016; Flynn et al., 2022; Magliano et al., 2011). Computational text analysis tools provide a nuanced approach to assessing constructed responses and provide a potential advantage to hand-coding as they allow researchers to detect subtle features of language that may otherwise be difficult to assess. Research suggests that these tools can be used to predict individual differences in comprehension (e.g., Allen et al., 2015; Millis et al., 2006). Future research should continue to explore what features of constructed responses differ between skilled and less-skilled readers as doing so may aid the development of automated reading assessments and interventions (Magliano & Graesser, 2012).

The present study indicated that strategy use varied over the course of the text. Paraphrasing appeared to increase from prompt to prompt while bridging, elaboration, and the overall quality of constructed responses decreased. As mentioned, one possibility is that these effects are related to fatigue or motivation. While not tested here, one simple way to assess this claim would be to add the length of constructed responses (i.e., number of words) or text order to the analytic models. One would suspect that constructed responses would get shorter over the course of the task. As such, responses produced at the beginning of texts should be longer than those produced at the end and responses produced during the first text should be longer than those produced during the second text (i.e., order effect). If participants paraphrase more (and use other strategies less) when they’re fatigued or less motivated, one would expect this to be

related to the length of protocols or text order. Future research should explore these relations and the extent to which changes in strategy use are related to prompt location, proficiency, and motivation.

Another limitation to the current study is that only two texts were used in the think-aloud activity. As such, it is difficult to say whether differences found between texts were related to text difficulty, text genre, or features of the texts themselves (e.g., cohesion of the text; O'Reilly & McNamara, 2007). Relatedly, the present study did not explore any interaction involving text type. It is possible that DE and non-DE students utilized different strategies for the different texts. Or it is possible that foundational component skills could be differentially predictive of strategy scores, depending on the text type. For example, scientific writing may be more likely to contain more technical vocabulary than history texts (Shanahan, 2009). As such, one's vocabulary knowledge may affect their ability to engage specific strategies, depending on the text. Additional research is needed to explore genre differences, the extent to which findings from the present study replicate across multiple texts, and whether there are genre-related interactions.

One of the goals of the present study was to replicate Feller et al. (2020) in a 4-year institution. Given that the same measures were used in both studies, this study afforded a cross-study comparison. While it is encouraging that many of the findings replicated across institutions, some findings did not. One might speculate that some of these differences are related to how constructed responses were coded (i.e., hand coded vs. computational scoring). However, comparing mean RSAT scores from both studies makes this explanation less likely. Feller et al. (2020) reported mean bridging and elaboration scores of 1.80 (*SD* = 1.21) and 2.68 (*SD* = 1.74), respectively. While RSAT scoring was not used in the present study, mean RSAT scores were

somewhat similar (1.51 (*SD* = 0.88) and 3.01 (*SD* = 1.76) for bridging and elaboration, respectively). However, this pattern differs from the hand-coding used in the present study, which showed that bridging and elaboration scores were similar, albeit elaboration scores were slightly lower (see Table 2.2). Magliano, Lampi, et al. (2020) showed similar patterns of results for DE and non-DE participants across hand-coding and RSAT scores. In their hand-coding system, they parsed constructed responses into idea units and classified each idea unit with respect to the strategy it reflected. Thus, their hand-coding captured the propensity to engage in these strategies rather than the quality of the strategies. This may be one reason why the pattern of the results in that study was similar between RSAT and hand-coding. RSAT does not take into account the quality of responses, whereas the present study does. One possible explanation for differences across the present study and Feller et al. could, in part, be due to the fact that the present study used a coding system that was sensitive to both the presence and quality of the strategies. That said, the results of the linear mixed effects models in the present study that controlled for foundational skills of reading showed similar findings to Magliano, Lampi et al. with respect to both bridging and elaborative inferences across DE and non-DE participants. Given that the present study and Magliano, Lampi et al. took place in the same institution and had similar findings using RSAT and two different hand-coding systems, it can be concluded that the differences across the present study and Feller et al. cannot be solely based on differences in how the strategies were identified across the studies.

Another possibility is that there are important differences in readers across institutions, particularly when contrasting 2- and 4-year institutions. For example, it appears that there may be a greater discrepancy in foundational skills between DE and non-DE readers in 4-year institutions than there was in the 2-year institution (i.e., Feller et al., 2020). In light of such

differences, tailoring interventions to fit the needs of a particular institution may be an important means of improving student outcomes (Renick, 2020). While challenging, future research should seek to replicate these findings across multiple institutions at a large scale.

Conclusions

Struggling readers in this sample had difficulties with word knowledge that limited their use of important comprehension strategies. Moreover, DE readers appeared to struggle with elaboration, even when foundational reading skills were accounted for. Understanding these specific challenges may be an important first step in helping struggling postsecondary readers succeed. The present study illustrates one way in which the RSF can be successfully applied to struggling postsecondary populations.

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APPENDICES

Appendix A

Rubric for coding protocols for the presence of paraphrasing, bridging, and elaboration (Adapted from McCarthy et al., 2021).

Paraphrase	Paraphrase Presence	0 = not present 1= contains one full clause that overlaps; may include single words; contains some (about half) of the main idea units from the target sentence 2 = contains most (50% or more) of the main idea units from the target sentence
Bridging	Bridging Presence	0 = not present 1 = includes anaphoric reference or one or two words from prior text 2 = includes a complete idea that is from the prior text, but vaguely conveyed 3 = includes one or more complete ideas from pervious ideas in the text (an idea is not necessarily a sentence, but it is a complete idea unit)
Elaboration	Elaboration Presence	0 = not present 1 = includes one or two relevant words that were not present in the text and are not synonyms of words in the text. The words must be content-relevant and be a

		noun or verb (not an adjective or adverb) 2 = includes a relevant idea from outside of the text – this idea is not present at all with the text
Overall Quality	Overall Self-Explanation	0 = Poor: Self-explanations that contain unrelated or non-informative information or are very short or too similar to the target sentence 1 = Fair quality: Self-explanations that either 1) only focus on the target sentence (e.g., paraphrase, comprehension monitoring, brief but related idea, brief prediction) OR 2) has only unclear or incoherent connections to other parts of the text (e.g., weak connections to prior text, simple one-word anaphor resolution) 2 = Good quality: Self-explanations that include 1-2 ideas from text outside the target sentence (local bridging, brief elaboration, brief or weak distal bridges) 3 = Great: High quality self-explanations that incorporate information at a global level (e.g., high quality local bridges, distal bridging, or meaningful elaborations)

Appendix B

Paraphrasing Interactions Model

Model Estimates for Ordinal Mixed Model Predicting the Likelihood of Paraphrasing

	Estimate	*SE*	*z-value*
Fixed Effects:			
DE Enrollment	2.28*	1.15	1.98
SARA Sentence	0.15***	0.05	3.33
DE*SARA Sentence	-0.11*	0.05	-2.23
Random Effects:		*SD*	
Subject	1.40	1.18	
Sentence Number	0.01	0.07	

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

Full Bridging Model

Model Estimates for Ordinal Mixed Model Predicting the Likelihood of Bridging

	Estimate	*SE*	*z-value*
Fixed Effects:			
DE Enrollment	0.10	0.16	0.59
SARA WRDC	0.02+	0.01	1.71
SARA Vocabulary	0.06**	0.02	2.87
SARA Morphology	-0.02	0.02	-1.07
SARA Sentence	0.03	0.03	1.00
Text Type	-0.22**	0.08	-2.68
Sex	-0.00	0.14	-0.01
Native English	-0.12	0.22	-0.53
Random Effects:		*SD*	
Subject	1.10	1.05	
Sentence Number	0.01	0.08	

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

Bridging Interactions Model

Model Estimates for Ordinal Mixed Model Predicting the Likelihood of Bridging

	Estimate	*SE*	*z-value*
Fixed Effects:			

DE Enrollment	2.31**	0.84	2.74
SARA WRDC	0.05**	0.02	3.00
SARA Vocabulary	0.07**	0.02	3.64
DE*SARA WRDC	-0.05**	0.02	-2.66
Random Effects:		*SD*	
Subject	1.29	1.14	
Sentence Number	0.01	0.09	

**$p < .001$, *$p < .05$

Full Elaboration Model

Model Estimates for Ordinal Mixed Model Predicting the Likelihood of Elaboration

	Estimate	*SE*	*z-value*
Fixed Effects:			
DE Enrollment	-0.47**	0.15	-3.16
SARA WRDC	-0.01	0.01	-0.31
SARA Vocabulary	0.05*	0.02	2.51
SARA Morphology	0.01	0.02	0.63
SARA Sentence	-0.06*	0.02	-2.36
Text Type	0.74***	0.10	7.71
Sex	0.03	0.13	0.22
Native English	-0.31	0.20	-1.50
Random Effects:		*SD*	
Subject	1.00	1.00	
Sentence Number	0.02	0.13	

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

Full Overall Quality Model

Model Estimates for Ordinal Mixed Model Predicting the Likelihood of Paraphrasing

	Estimate	*SE*	*z-value*
Fixed Effects:			
DE Enrollment	-0.19	0.19	-1.03
SARA WRDC	0.03*	0.01	2.35
SARA Vocabulary	0.13***	0.02	5.36
SARA Morphology	-0.03	0.02	-1.44
SARA Sentence	0.01	0.03	0.19
Text Type	0.34***	0.09	3.66
Sex	-0.09	0.16	-0.54
Native English	-0.04	0.26	-0.17

Random Effects:		*SD*
Subject	2.32	1.52
Sentence Number	0.02	0.14

**$p < .001$, *$p < .05$

Appendix C

Interactions

Coefficients and p-values for interaction terms, added one at a time to the existing model.

	Paraphrase B (p-value)	Bridging B (p-value)	Elaboration B (p-value)	Overall Quality B (p-value)
DE*WRDC	NS (p = .08)	-0.05 (p = .01)	NS (p = .33)	NS (p = .46)
DE*Vocabulary	No convergence	-0.07 (p = .05)	NS (p = .72)	NS (p = .19)
DE*Morphology	No convergence	NS (p = .12)	NS (p = .84)	NS (p = .30)
DE*Sentence	-0.10 (p = .04)	-0.13 (p = .02)	NS (p = .57)	NS (p = .30)

Note. NS = nonsignificant.