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Distinguishing Effects of Domain Knowledge and General Knowledge on Passage Fluency, Oral Reading Errors, and Comprehension

Abstract

The goal of this dissertation was to understand the relationship between prior domain knowledge, general world knowledge, word identification, and comprehension. Previous research (Priebe, Keenan, & Miller, in press) showed that prior knowledge can facilitate both word identification and fluency, and this dissertation asked whether the effects of prior knowledge also extend to general world knowledge. Three studies aimed at clarifying the distinction between prior domain knowledge and general world knowledge were conducted. Study 1 used a within-subjects design to control for differences in general world knowledge by examining the effects of different levels of prior domain knowledge within the same participant. Poor readers made fewer errors on the passage for which they had prior knowledge, compared to the passage for which they did not have prior knowledge. In addition, both good and poor readers made fewer substitutions that were based solely on graphic information, and made more substitutions that made use of both graphic and semantic information. Study 2 examined whether greater general world knowledge might also affect word identification by using a reading-age match design to create differences in general world knowledge without creating decoding differences. Older readers, regardless of reading ability, read passages more fluently, and a similar effect on error types as observed with prior domain knowledge was obtained as well. The third study examined whether differences in general world knowledge still affected word identification and comprehension when all participants had prior domain knowledge. No significant difference in the overall rate of errors, passage fluency, or comprehension, was observed. These studies suggest that that prior domain knowledge and general world knowledge are similar but separable in their effects on word identification. Implications for remediation and instruction are discussed.

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DISTINGUISHING EFFECTS OF DOMAIN KNOWLEDGE AND GENERAL
KNOWLEDGE ON PASSAGE FLUENCY, ORAL READING ERRORS, AND
COMPREHENSION

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The goal of this dissertation was to understand the relationship between prior domain knowledge, general world knowledge, word identification, and comprehension. Previous research (Priebe, Keenan, & Miller, in press) showed that prior knowledge can facilitate both word identification and fluency, and this dissertation asked whether the effects of prior knowledge also extend to general world knowledge. Three studies aimed at clarifying the distinction between prior domain knowledge and general world knowledge were conducted. Study 1 used a within-subjects design to control for differences in general world knowledge by examining the effects of different levels of prior domain knowledge within the same participant. Poor readers made fewer errors on the passage for which they had prior knowledge, compared to the passage for which they did not have prior knowledge. In addition, both good and poor readers made fewer substitutions that were based solely on graphic information, and made more substitutions that made use of both graphic and semantic information. Study 2 examined whether greater general world knowledge might also affect word identification by using a reading-age match design to create differences in general world knowledge without creating decoding differences. Older readers, regardless of reading ability, read passages more fluently, and a similar effect on error types as observed with prior domain knowledge was obtained as well. The third study examined whether differences in general world knowledge still affected word

identification and comprehension when all participants had prior domain knowledge. No significant difference in the overall rate of errors, passage fluency, or comprehension, was observed. These studies suggest that that prior domain knowledge and general world knowledge are similar but separable in their effects on word identification. Implications for remediation and instruction are discussed.

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Chapter 1: Introduction

Distinguishing Effects of Domain Knowledge and General Knowledge on Passage Fluency, Oral Reading Errors, and Comprehension

Fluency, or the ability to read words accurately and quickly, is an important skill necessary for successful reading. Accordingly, a large body of research shows that fast and accurate word identification predicts comprehension (Fuchs, Fuchs, & Compton, 2004; Pinnell et al., 1995), and deficits in fluency are cited as one possible reason for comprehension problems for many students (Duke, Pressley, & Hilden, 2004). Indeed, several studies have shown that interventions aimed at targeting fluency in word identification can improve comprehension for struggling readers (Chard, Vaughn, & Tyler, 2002; National Institute of Child Health and Human Development, 2000; Nicholson & Tan, 1999; Stahl & Heubach, 2006; Tan & Nicholson, 1997).

While the prevailing wisdom is that fluency leads to better comprehension, there is also the possibility that the causal relationship is bidirectional: perhaps better *comprehension* also leads to better *fluency*. Comprehension is a dynamic process, involving the integration of a reader's knowledge with the text they encounter, and familiarity with the topic of a passage is known to lead to greater comprehension (McNamara & Kintsch, 1996; Miller & Keenan, 2009). Accordingly, Priebe, Keenan, and Miller (in press) showed that when poor readers had prior knowledge of a passage, and thus had a better idea of what the passage was about, they read the text more fluently and

tended to make fewer errors that detracted from the meaning of the text, compared to when poor readers did not have prior knowledge of the same passage. The goal of this dissertation is to continue to investigate the findings of Priebe et al. that suggest that comprehension does in fact affect fluency, by investigating prior domain knowledge differences within the same participant, and by clarifying what type of prior knowledge leads to more fluent reading. We do that through three studies that examine oral reading accuracy as a function of both prior knowledge and general world knowledge. The hope is that by understanding how knowledge affects word identification, we may uncover additional avenues for reading instruction and remediation.

Knowledge Effects on Word Identification

A rich body of research shows that having prior knowledge about the topic of a passage enables both greater comprehension of the text and better memory for it (McNamara & Kintsch, 1996; Rawson & Van Overschelde, 2008; Recht & Leslie, 1988; Spilich, Vesonder, Chiesi, & Voss, 1979). In contrast, there has been very little research investigating whether prior domain knowledge might also improve word identification. Taft and Leslie (1985), however, examined the effects of prior domain knowledge on oral reading accuracy by examining oral reading errors produced by a group of 3rd graders, half of whom had completed a lesson plan on food chains, and half of whom had not. The authors asked the children a series of questions related to the food chain to ensure that all the children in the high prior knowledge group had successfully learned about the food chain. The children then read a passage about food chains out loud and answered comprehension questions.

Taft and Leslie (1985) found that the children who had prior domain knowledge answered more comprehension questions correctly, but more interestingly, their patterns of miscues, or errors made while reading a text out loud, were also affected by their prior domain knowledge. Compared to children without prior domain knowledge, children with prior knowledge made fewer miscues that resulted in meaning loss, and they made fewer graphically similar miscues. Taft and Leslie interpreted this finding as suggesting that due to their greater semantic knowledge of concepts in the passage, children with prior domain knowledge were less reliant on graphic cues from the text, and better able to substitute words that did not change the authors' intended meaning for the passage.

Taft and Leslie (1985) demonstrated that having prior knowledge led to fewer errors that detracted from the meaning of the passage, results partially corroborated by Malik (1990)'s study of adult second language learners. Taft and Leslie, however, did not control for decoding in their study, and since decoding has been shown to correlate as highly as .75 with knowledge (Best, Floyd, and McNamara, 2008), we extended their findings by examining oral reading errors in a sample where the knowledge groups were matched on decoding (Priebe et al., in press).

The goal of the Priebe et al. (in press) study was to not only determine whether prior knowledge affects word identification, but how. Like Taft and Leslie (1985), we employed miscue analysis, a method of analyzing the qualitative nature of oral reading errors that was popularized by Goodman (1969). We categorized oral reading substitutions in terms of their graphic and semantic similarity, such that an error was simultaneously classified in terms of both dimensions. Table 1 shows examples of each type of substitution.

Table 1

Examples of the Types of Graphic and Semantic Errors

Type of Substitution	Example (target word = plane):
Graphically and Semantically similar (G+S+)	airplane
Semantically similar but graphically dissimilar (G-S+)	jet
Graphically similar but semantically dissimilar (G+S-)	plant
Neither graphically nor semantically similar (G-S-)	rock

We then examined the substitutions to determine the locus of prior knowledge effects on word identification, and proposed two models that we thought could be operating. The first was the bypass model, in which we hypothesized that readers would bypass the graphic information due to highly activated semantic information, leading to more substitutions that were graphically dissimilar, but semantically similar to the target word (G-S+). The second model we examined was a constraint satisfaction model, in which the activation from semantics would lead to fewer substitutions that were based solely on graphic information and were semantically dissimilar to the target word (G+S-).

We found effects of knowledge on oral reading only for poor readers. The results provided strong support for the constraint satisfaction model in poor readers: poor readers with prior knowledge made fewer substitutions based solely on graphic information, and their errors also tended to preserve the meaning of the text. In addition, poor readers with

prior knowledge made fewer errors overall, and had significant gains in fluency compared to poor readers without prior knowledge.

While our results showed that prior knowledge facilitated word identification, independent of the contributions of decoding, the possibility remains that readers who had prior knowledge of our passage differed on some other characteristic that affected their reading behavior. Perhaps, for example, readers who had prior knowledge of our passage topic also had greater prior knowledge across many domains. We do not know how our participants would have performed on other passages. One way to address this limitation is to examine prior knowledge effects within the same participant: by examining the pattern of errors across two passages, one in which the reader does not have prior knowledge, and one in which they do, we can see if topic knowledge still facilitates oral reading and comprehension, yielding the pattern of results observed in Priebe et al. (in press). Although this design involves comparing across passages that might have many differences, such as vocabulary and syntax, if we see the same pattern of results, i.e. fewer errors, and lower rates of errors based solely on graphic information, when a reader who previously had no prior knowledge now does, this will strengthen our finding that prior domain knowledge leads to better fluency. If, however, we find that readers make similar rates of errors across the two passages, it may be that differences in the passages overshadow prior knowledge effects, or that the prior knowledge effects we observed in Priebe et al. were due to some other characteristic.

Defining Prior Knowledge

As Kamalski, Sanders, and Lentz (2005) point out, there has been much methodological variation in how prior knowledge has been operationalized, from

employing an expert-novice paradigm, to simply assessing pre-existing knowledge via concept questions. Each method has benefits and problems associated with it.

The expert-novice paradigm involves finding two groups of readers: people who are considered experts in a given field, and people who have little to no experience with that field. This technique has been used with academic subjects, such as Birkmire (1985) who selected physics and music students who then read a text on laser techniques. This technique has also been used with non-academic subjects, such as chess (Chase & Simon, 1973), bridge (Charness, 1979), and baseball (Chiesi, Spilich, & Voss, 1979). While creating these groups undoubtedly creates knowledge differences between groups, it may also introduce other differences, such as motivation. A reader who knows a lot about chess, for example, may find such a passage more enjoyable to read. Similarly, a physics student may find a passage about lasers more engaging compared to music students.

Other researchers vary the materials, using topics that are presumed to be familiar and unfamiliar to readers (Blanc & Tapiero, 2001). For example, Malik(1990) gave Iranian English-language learners a passage about Iranian mythology for the familiar topic, and a passage about Japanese mythology for the unfamiliar topic. Participants that read a presumably unfamiliar text are classified as having no prior knowledge, whereas participants who read a familiar text are classified as having prior knowledge. Implicit in this technique is the assumption that such materials are familiar or unfamiliar to readers; however, this way of defining prior knowledge is open to the criticism that without doing an assessment, it is possible that some readers presumed to not have prior knowledge of the text, may in fact have it and vice versa.

Instead of just assuming what topics should be familiar or unfamiliar, some researchers have investigated knowledge effects by teaching some readers but not others a knowledge base, using techniques varying from a simple instruction booklet (McNamara & Kintsch, 1996) to highly interactive lessons that take from 30 to 60 minutes to administer (Gilbert et al., 2005; McKeown et al., 1992), to more lengthy instruction administered as part of an existing curriculum, as Taft and Leslie (1985) did in their study. The success of teaching the knowledge base is then assessed by asking the reader questions about what they have learned. Such a technique is quite time and labor intensive, and may lack external validity. Learning a knowledge base over a short amount of time may not mirror pre-existing prior knowledge representations, which may have been accumulated over many years and multiple exposures. In addition, while researchers recommend that the knowledge base consist of major concepts and ideas needed to construct a representation, and not just information from the text to be read, there may be some overlap in terms of the ideas presented in the knowledge base and the text. Thus, when a child reads a text after learning a knowledge base, and then answers questions about the ideas presented in that knowledge base, they may be primed to certain concepts in a way that would not happen with normal exposure to ideas over time.

One way to assess prior knowledge and avoid priming the text information is by limiting the assessment of prior knowledge about the material to be read to a single question. While this may seem a meager estimate of the complexity that undoubtedly underlies the rich representations that constitute prior knowledge, we have shown that this technique is a reliable and valid way of assessing knowledge differences which are

manifested in both oral reading and comprehension differences between knowledge groups (Miller & Keenan, 2009; Priebe, Keenan, & Miller, in press).

As shown above, prior knowledge is defined in many different ways, and yet, no matter how prior knowledge is defined, studies converge on similar findings, especially with regard to comprehension. This convergence raises the question of how specific prior knowledge is. Is prior knowledge specific to each domain, or could it reflect something else, for example general world knowledge? Many of the concepts in the Amelia Earhart passage used in the Priebe et al. (in press) study, could be argued to be not specific to the representation of “Amelia Earhart”, but reflect general world knowledge. For example, much of the passage deals with dangers Amelia Earhart faced when flying planes, due to things like mechanical problems and flying alone (see Appendix A for the full Amelia Earhart passage). While these concepts may have been encountered by a child reading or hearing about Amelia Earhart, they are also familiar concepts that a child may encounter when reading about planes or watching a television show. It is therefore unclear whether the increases in fluency observed in Priebe et al. were due to specific prior domain knowledge, or whether they could reflect more general world knowledge.

Related, prior domain knowledge on academic topics, such as Amelia Earhart, the topic of the passage used in Priebe et al. (in press), can correlate highly with IQ, as opposed to non-academic topics such as baseball. Miller and Keenan (2009) point out that IQ is a construct related very strongly to general knowledge, and that several IQ tests (e.g. Wechsler Intelligence Scale for Children; Wechsler, 1974) assess general knowledge as part of their battery. This gives support to the idea that some prior

knowledge effects may be more related to general world knowledge, and underscores the importance of distinguishing between prior domain knowledge and world knowledge.

World Knowledge and Word Identification

A second goal of this dissertation, then, is to investigate how specific prior knowledge needs to be to facilitate word identification; in other words, can greater world knowledge help word identification? In contrast to prior domain knowledge, which refers to specific, in-depth knowledge about a particular topic, world knowledge involves more widespread knowledge about how the world operates. This can include facts about places or things, such as ‘The weather in Alaska is cold’ or ‘Almost all professors have a PhD degree’, featural information, such as ‘Cats have fur and four legs’ and information about scripts, or a list of steps that need to be taken to accomplish a task, such as ordering food in a restaurant (Cook & Guerard, 2005; Schank, 1986). While prior knowledge of a passage topic may largely depend on a reader’s exposure to a specific topic, world knowledge may be expected to accumulate in a similar fashion with age among all readers, as they gain more experience with the world around them.

But how should one assess world knowledge? In contrast to prior domain knowledge, which revolves around a specific concept or idea, world knowledge reflects widespread experience with the world. Several attempts have been made to design tests that can assess a reader’s level of general world knowledge. The Woodcock Johnson III Academic Knowledge Test, for example, consists of orally administered questions about science, social studies, and humanities, and the Woodcock Johnson III General Information subtest similarly consists of orally administered questions that ask children to identify where objects are found and what people typically do with an object, and is

thought to reflect semantic activation and access to declarative general knowledge (Woodcock, McGrew, & Mather, 2001). Both of these tests, and similar subtests of IQ tests have been found to predict reading comprehension performance (Best, Floyd, & McNamara, 2008), lending support to the idea that general knowledge predicts reading comprehension.

While the concepts assessed in these tests undoubtedly tap general world knowledge, they also tap components of comprehension itself. Specifically, orally administered questions require listening comprehension skills, and, in fact, the technical manual of the Woodcock Johnson-III lists both of these subtests designed to assess general world knowledge as belonging to a general comprehension cluster (Schrank, McGrew, & Woodcock, 2001). Tests such as these, therefore, are confounded with comprehension skill and may lead to lower estimates of knowledge for poor readers with lower comprehension skill. An alternate way to create differences in general world knowledge could be to compare reading behavior across different ages because as readers get older and gain more experience with the world around them, they gain more world knowledge.

Along these lines, several studies have compared word identification across different ages, by looking at how miscues change as a function of age. The general finding is that the percentage of graphically similar miscues tends to increase until up to around third grade, when it plateaus (Biemiller, 1970; Goodman, 1965). A similar trend is seen for contextually appropriate, or semantically and syntactically appropriate miscues. These patterns could be due to differences in world knowledge associated with age. Prior knowledge, after all, has been associated with less reliance on graphic cues,

and more on semantic cues (Priebe et al., in press; Taft & Leslie, 1985). However, decoding skill also increases with age. Good readers tend to make a smaller percentage of graphically similar miscues compared to poor readers (Au, 1977; Goodman & Goodman, 1977; Priebe, Miller, & Keenan, 2008; Weber, 1970) and a larger percentage of contextually appropriate miscues compared to poor readers (Schlieper, 1977; Wixson, 1975). It is therefore unclear whether developmental changes in miscue patterns are due to increased decoding proficiency, or gains in world knowledge associated with age.

A few studies have looked at the interaction between grade level and reading ability on miscue patterns. Christie(1981) analyzed the oral reading behavior of good and poor readers in 2nd, 4th, and 6th grade, and found no difference in percentage of graphic similarity across age, but instead, an interaction between ability and grade level, such that for poor readers, the percentage of graphically similar miscues increased steadily with age, whereas it decreased for good readers. In terms of contextually appropriate miscues, the percentage of contextually acceptable miscues did increase with grade for all readers, regardless of reading ability. Coupled with the research showing effects on miscues due to reading skill, it is possible that age effects on miscues may be at least partially due to decoding proficiency.

Reading-Age Match Designs

One way to disentangle the effects of decoding skill and general world knowledge on word identification is to employ a reading-age match design, which is one goal of this dissertation. Reading-age match designs have been used to investigate a variety of research questions. In a reading-age match design, readers are matched to a younger group on some reading skill, and then measured on some task. The idea is that if readers

and their reading-age-matched counterparts differ on their performance on that task, it cannot be due to the reading skill they were matched on. Alternate explanations usually point to another skill that is thought to contribute to deficient reading, but it is also possible that differences on a task reflect developmental differences.

For example, Snowling (1981) matched a group of dyslexic readers whose mean age was 12.5 years on a reading task and on verbal IQ to a younger group, with a mean age of 9.5. Children then participated in a grapheme-phoneme correspondence discrimination task, and when the dyslexic group performed worse than the reading-age match group, the researchers concluded that dyslexic children had a deficit in grapheme-correspondence and had adopted alternative ways to identify words compared to their younger, normally reading peers.

Reading-age match designs are often used to ask causal questions about the nature of component skills in reading. While longitudinal and training studies are best suited for such questions, as Cain, Oakhill, and Bryant (2000) point out, such methods are time consuming and expensive. Reading-age match designs therefore represent another way to ask causal questions, and have been used to identify possible deficits in poor readers' comprehension (Cain, Oakhill, & Bryant, 2000) and word-reading skills (Frith, & Snowling, 1983; Siegel & Ryan, 1988; Stanovich, Nathan, & Vala-Rossi, 1986).

Reading-age match designs, similarly, may be useful for creating knowledge differences in readers due to age, without also creating concomitant differences in decoding that also may be due to age. This dissertation will therefore use a reading-age match design in Studies 2 and 3 to examine the role of general world knowledge on oral reading accuracy, by examining the miscues that are produced during oral reading of

several passages. If prior knowledge effects on word identification extend beyond specific domain knowledge, then we should see similar patterns in the reading-age-match design as we did in previous work (Priebe et al.). Specifically, we should see gains in fluency, and a reduction in total number of errors and errors solely based on graphic information when poor readers are matched to a younger group on decoding skill, due to larger amounts of general world knowledge. The same pattern may be obtained when good readers are matched to older readers on decoding skill. If, however, prior knowledge effects are only domain specific, we should see no difference in fluency, the number of errors, or the quality of those errors when comparing older readers to their younger reading-age match.

Chapter 2

Study 1: Examining Prior Domain Knowledge Effects on Word Identification and Comprehension Within the Same Reader

Study 1 continues the investigation of prior topic knowledge started in Priebe et al. (in press) by comparing word identification as a function of prior knowledge, within the same participant. We examine both good and poor readers from the Colorado Learning Disabilities Research Center whose reading comprehension is assessed by a set of tests (see Keenan, Betjemann, & Olson, 2008), one of which is the Qualitative Reading Inventory (QRI; Leslie & Caldwell, 2001). In Priebe et al. (in press), the analyses concerned performance on one passage, “Amelia Earhart”. This passage was selected because it had sufficient variability in prior topic knowledge to form two prior topic knowledge groups- those with some prior knowledge of the topic, and those with no prior knowledge of the topic. Knowledge groups were constructed for each of two levels of reading ability – typical and poor readers. The current Study 1 extends that study by examining all the children who had no prior knowledge on the Amelia Earhart passage when reading a different passage for which they have prior knowledge, “The Octopus”. As in Priebe et al., children’s oral reading errors made during reading this passage are scored in terms of both their graphic and semantic similarity. We then analyze these oral reading errors as a function of reading ability and prior knowledge on each passage.

By comparing the performance of the same reader across two passages, one where they have no prior domain knowledge, and one where they do, we can be confident that any effects we observe are not due to differences in general knowledge because that is controlled by having the same person in both levels of the prior knowledge variable. We expect to see gains in fluency, and a reduction in total number of all errors, and G+S-substitutions in particular, on the Octopus passage for which readers have prior knowledge compared to the Amelia Earhart passage for which they have no prior knowledge.

There are two ways in which this prediction of knowledge facilitation may not be supported. One is that it is possible that we will only see this effect for poor readers. As in Priebe et al., we may find that prior domain knowledge only facilitates word identification in poor readers; good readers showed no effect of prior domain knowledge due to their already adequate word decoding skills (Priebe et al., in press). Another factor that could affect the prediction is passage differences. Passage differences in length or difficulty may overshadow potential prior domain knowledge effects on word identification.

We also examine the effects of prior knowledge on comprehension. We analyze recall performance as a function of prior knowledge, and expect gains in comprehension performance when readers have prior knowledge of the passage topic, compared to the passage for which they did not have prior knowledge. As above, we may only see effects for poor readers, as prior domain knowledge has been demonstrated to be particularly facilitative for poor readers, and good readers may already show adequate comprehension of the passages (Miller & Keenan, 2009).

Method

Participants

Data for this dissertation were drawn from the language comprehension assessment battery (cf. Keenan et al., 2006) in a larger ongoing research project associated with the Colorado Learning Disabilities Research Center (c.f. Olson, 2004). Data from 30 4th graders were used in this study, with 15 poor readers and 15 good readers (defined below). The 30 participants selected have no prior knowledge of “Amelia Earhart” but have prior knowledge of “The Octopus”. Thus, knowledge is a within subjects variable, with the same child serving in both the prior knowledge (PK) group and the no prior knowledge (NPK) group, depending on the passage.

Table 2 presents descriptive statistics on age and word decoding skill for the two reading ability groups. Decoding skill was measured by a composite z-score of word recognition ability when reading words in a list using the Timed Oral Reading of Single Words (Olson, Forsberg, Wise, & Rack, 1994) and the Peabody Individual Achievement Test (PIAT) word recognition subtest (Dunn & Markwardt, 1970). The poor readers have an age-adjusted composite decoding z-score of -1 or below. The controls all have word decoding composite z-scores above zero, indicating above average word decoding skills.

Table 2

Average Age and Word Decoding Skill for Participants

	Poor Readers (<i>n</i> = 15)	Controls (<i>n</i> = 15)
Age (years)	9.62 (.23)	9.8 (.33)
Word Decoding (composite z- score)	-1.54 (.56)	.49 (.36)

Measures

Qualitative Reading Inventory. This study used two expository passages, “The Octopus” and “Amelia Earhart” from the Qualitative Reading Inventory (QRI; Leslie & Caldwell, 2001). The passages were chosen because they have approximately equal length (254 words for “The Octopus”, and 263 words for “Amelia Earhart”) and because there were sufficient number of children who had no knowledge of Amelia Earhart but had knowledge of octopuses, allowing for a within-subject comparison of the prior domain knowledge variable. Unfortunately, “The Octopus” is a harder passage than “Amelia Earhart”, as rated by the Flesch-Kincaid Grade Level index (4.1 for “Amelia Earhart”, compared to 5.3 for “The Octopus”). The Flesch-Kincaid Grade Level index takes average sentence length and the average number of syllables per word into account to roughly approximate the grade level generally required to understand a given text. This index is thus a measure of both syntax and word factors such as frequency, as low-frequency words tend to have more syllables. The benefit of including a more difficult passage is that it may allow us to see effects of prior knowledge even for good readers. It

is also possible, however, that the factors that make a passage more complex and more difficult to read might outweigh the potential benefits of prior knowledge.

Procedure

Before the child read the passage, the tester asked the child a background knowledge question to gauge how much the child knew about the topic of the passage. For the “Amelia Earhart” passage, the concept question is “Who is Amelia Earhart?”. Answers such as “A pilot” or “The first woman to fly around the world” would be scored as demonstrating prior knowledge, whereas incorrect responses or “I don’t know” would be scored as demonstrating no prior knowledge. The concept question for “The Octopus” is “What is an octopus?” and is scored in a similar way. The child then read the passage orally, while the examiner scored the passage online for rate and accuracy. The readings were transcribed and coded according to the taxonomy described below in the “Substitution Error Scoring” section. After reading the passage, the child provided a free recall of the passage. The transcripts were transcribed and coded according to the procedure described below in the “Comprehension Scoring” section.

Substitution Error Scoring

Oral reading errors for all three studies were coded using the following procedure. Any substitution that was fully sounded out was counted as a substitution error for the error type analyses. In addition, both self-corrections and uncorrected errors were included in the analyses of total number of errors. The taxonomy of error types was based on the one used by Taft and Leslie (1985), which was demonstrated to have high inter-rater reliability (Priebe et al., in press). The author coded all substitutions for graphic and semantic similarity, and two trained graduate students coded 10% of the

transcripts to obtain reliability, as seen below. Table 1 gives examples of each type of substitution.

Graphically similar (G+). Substitutions were classified to the degree to which they were graphically similar to the target word by assigning 1 point for each letter shared by the substitution and the target word, and in the same relative order in both words. After totaling the points, they were divided by the number of letters in the target word. Results greater than .5 were judged to be graphically similar, and results less than .5 were judged graphically dissimilar¹.

For example, if a child encounters the word “*mechanical*” and produces “*michinical*”, the substitution would be assigned a graphic similarity score of .80 (8 shared letters, divided by the total number of letters in the word). A substitution of “*machine*”, in contrast, would receive a score of .40 and would not be judged graphically similar because .4 falls below the .5 cutoff.

Semantically similar (S+). While a quantitative measure of semantic similarity would be preferable, previous attempts to do so by using latent semantic analysis(LSA; Landauer, 2002) resulted in very low agreement with human ratings of semantic similarity (Priebe & Keenan, 2009). Therefore, as in previous work (Priebe et al., in press), we relied on human ratings of semantic similarity for this study. Substitutions were categorized according to the degree to which they changed the intended meaning of

¹ Exceptions to the above rules concern substitutions for 2-letter words. Because these words are so short, applying the same rules resulted in many substitutions being classified as graphically similar when they only shared one letter and did not really seem to be retaining much graphical similarity (e.g. the substitution of *that* for *an*). In the case of 2-letter words, only miscues that share the initial letter of the target word were counted as graphically similar.

the author of the passage, by reading the sentence up to the substitution and determining if the resulting sentence retained the author's intended meaning for the passage. For example, if a child substituted "*inventor*" in the sentence "Amelia Earhart was an *adventurer*", the substitution would be judged as semantically dissimilar since it changed the intended meaning. A substitution of "*adventuresome*", in contrast, would be judged semantically similar.

Total Errors

The number of substitutions, omissions, insertions, repetitions, and skipped lines was summed to create a total number of errors for each subject. Although the passages were of similar length, proportions were used to account for the slight difference in word length between the two passages. These were calculated for each participant by dividing the overall number of errors made by the number of words in the passage.

Substitutions

To compare the rate of each type of substitution across passages, all error types were converted into proportions by dividing them by the total number of errors for each participant.

Rate

Rate (words per minute; WPM) was calculated for each child by dividing the number of words in each passage by the time it took each child to read the passage. In this way, the rate of reading the passage was not influenced by the number of words in each passage.

Passage Fluency

Passage fluency was calculated for each child by dividing the total number of words read correctly by the time it took to read the passage.

Comprehension Scoring

After the testing session, the recalls were scored according to the number of idea units recalled from the idea checklist that accompanies the test. See Appendix B for the recall checklists for both passages.

Reliability of Error Scoring

Intra-rater reliability was assessed through use of BBEDIT, a text-editing software that allows multi-file searches. Each coded word in a transcript was checked against all other occurrences of that word in the remaining transcripts, ensuring that all miscues were categorized in the same way. Inter-rater reliability was obtained by having a trained second observer code 10% of the transcripts for the above categories. As with previous work with this taxonomy (Priebe et al., in press) reliability between observers was high for all categories, with Cronbach's alphas of .9 for all categories except for substitutions that were semantically dissimilar (Cronbach's alpha = .85).

Results

Total Oral Reading Errors

A total accuracy score was created by dividing the number of errors each participant made while reading the passage by the number of words in each passage. Table 3 shows the averages and standard deviations for the total proportions of all errors for each passage and for each group. An ANOVA with one within subject variable (passage) and one between subjects variable (reading ability), and proportion of errors as

the dependent variable, showed that good readers made fewer errors than poor readers ($F(1,28) = 8.83, p < .05$). More interestingly, there was a main effect of passage, such that all children made fewer errors when reading the Octopus passage for which they had prior knowledge ($F(1, 28) = 5.36, p < .05$). The interaction between passage and reading ability did not reach statistical significance ($F(1,28) = 2.61, p = .12$); however, paired t -tests revealed that while good readers showed no difference in oral reading errors across passages ($t(14) = .64, p = .53$), poor readers made significantly fewer errors when they had prior knowledge compared to when they did not ($t(14) = 2.34, p < .05$). These results replicate the finding of Priebe et al. (in press) that prior knowledge facilitates word recognition accuracy only for poor readers.

Table 3

Average Performance on Comprehension and Fluency Measures

	Poor readers		Good Readers	
	Amelia Earhart (No prior knowledge)	The Octopus (Prior knowledge)	Amelia Earhart (No prior knowledge)	The Octopus (Prior knowledge)
Total Errors (proportion)	0.09 (.04)	0.07 (.04)	0.05 (.03)	0.04 (.03)
Rate (Words per Minute)	83.49 (16.10)	81.18 (16.32)	120.48 (17.10)	124.14 (18.82)
Passage Fluency (Words correct per minute)	75.88 (14.56)	75.45 (13.90)	114.81 (18.50)	111.81 (17.93)
Idea Units recalled (proportion)	.32 (.13)	.27 (.11)	.45 (.08)	.37 (.14)

Rate

The time to read each passage was converted into a rate (words per minute) by dividing the number of words in the passage by the time it took to read the passage. An ANOVA was then conducted with one within subject variable (passage) and one between subjects variable (reading ability), with the words read per minute as the dependent variable. The only significant effect was for reading ability, with good readers reading both passages more quickly compared to poor readers ($F(1, 28)=44.91, p<.05$). Although the interaction between passage and reading ability was not significant ($F(1, 28)=2.55, p=.12$), as Table 3 shows, poor readers showed no difference in rate across the two passages ($t(14)=.84, p=.42$), whereas good readers showed a trend to be faster on the Octopus passage, ($t(14)=1.45, p=.09$).

Passage Fluency²

Fluency was calculated for each passage by dividing the number of words read *correctly* over the time taken to read the passage. An ANOVA was then conducted with one within subject variable (passage) and one between subjects variable (reading ability), with the words read correctly per minute as the dependent variable. As expected, good readers read both passages more fluently than poor readers ($F(1, 28)=40.12, p<.05$). The main effect of passage was significant ($F(1, 28)=9.39, p<.05$), but it was qualified by an interaction between passage and reading ability ($F(1, 28)=5.29, p<.05$). Good readers, but not poor readers, had lower fluency on the Octopus passage ($t(14)=3.68, p<.05$). Because good readers had shown faster rate on this same passage, it suggests there

² Because the passages are of different lengths, we replicated these fluency analyses by taking the words read correctly per minute and dividing it by the number of words in each passage. The same pattern of results emerged, and the results are presented here in raw numbers for clarity of reading.

was a speed/accuracy tradeoff not visible when comparing raw proportions of total errors, and points to the complications of measuring fluency.

Types of Oral Reading Substitution Errors

Each substitution type (G+S+, G+S-, G-S+, and G-S-) was converted into a proportion for each participant by dividing the number of each type of substitution by the total number of all errors (including substitutions, omissions, insertions, repetitions, and skipped lines) the participant made for each passage. A mixed ANOVA with three within subjects factors (Semantic, Graphic, Passage) and one between subjects factor (reading ability) was conducted to examine the effect of prior knowledge and reading ability on each type of substitution error.

As Table 4 shows, poor readers made proportionally more substitutions across the two passages on average compared to good readers ($F(1, 28) = 5.50, p < .05$). In addition, all readers made proportionally more substitutions on the more difficult Octopus passage for which they had prior knowledge compared to the Amelia Earhart passage ($F(1, 28) = 14.68, p < .05$). This is interesting because poor readers made fewer errors overall for the Octopus passage, and suggests that prior knowledge or passage difficulty may lead readers to make more attempts to sound out words in lieu of making other types of errors.

Substitutions tended to be graphically similar ($F(1, 28) = 83.57, p < .05$), and poor readers trended toward making proportionally more graphically similar substitutions ($F(1, 28) = 4.09, p = .053$), while good readers made more semantically similar substitutions ($F(1, 28) = 14.31, p < .05$). The interaction between semantic similarity and passage was also significant ($F(1, 28) = 16.09, p < .05$), showing that all readers made more semantically similar substitutions on the Octopus passage where they had prior

knowledge than the Amelia Earhart passage. Finally, the interaction between graphic similarity, semantic similarity, and reading ability was significant ($F(1, 28) = 4.57, p < .05$), indicating that the pattern of errors differed by reading ability. As Table 4 shows, poor readers were more likely to make G+S- errors across both passages compared to good readers, replicating results from Priebe et al. (in press) and demonstrating that poor readers are more likely to make errors based solely on graphic information.

Based on Priebe et al. (in press), we expected that participants would make fewer G+S- errors when they had prior knowledge. As Table 4 shows, poor readers did make fewer G+S- errors on the Octopus passage than on the Amelia Earhart passage ($t(14) = 1.81, p < .05$). Interestingly, whereas Priebe et al. (in press) found that the reduction in G+S- errors only occurred for poor readers, in the current study, good readers also showed a significant decrease in G+S- errors ($t(14) = 2.61, p < .05$).

G+S+ errors, in contrast, were greater on the Octopus passage for both good readers ($t(14) = 3.02, p < .05$) and poor readers ($t(14) = 3.08, p < .05$). Prior knowledge seems to be facilitating word recognition for both good and poor readers by constraining the possible choices for a word in terms of both graphic and semantic similarity. These constraints may both decrease the number of errors based only on graphic information, and also increase errors that are based on both graphic *and* semantic information, indicating that readers with prior knowledge are making use of both graphic and semantic cues when attempting to decode words.

Table 4

Average Proportions of Each Type of Substitution Error

	Poor Readers		Good Readers	
	Amelia Earhart (No prior knowledge)	The Octopus (Prior knowledge)	Amelia Earhart (No prior knowledge)	The Octopus (Prior knowledge)
Total Substitutions (proportion)	.66 (.11)	.83 (.17)	.48 (.21)	.71 (.35)
G+S+ (proportion)	.16 (.08)	.28 (.15)	0.17 (.10)	.34 (.23)
G+S- (proportion)	.38 (.17)	.33 (.14)	.20 (.15)	.14 (.20)
G-S+ (proportion)	.05 (.04)	.15 (.16)	.07 (.10)	.16 (.16)
G-S- (proportion)	.08 (.08)	.06 (.08)	.04 (.05)	.07 (.12)

Comprehension

An ANOVA was conducted with one within subject variable (passage) and one between subjects variable (reading ability) with the proportion of idea units recalled as the dependent variable. As expected, good readers recalled more idea units on average across the two passages compared to poor readers ($F(1, 28) = 8.89, p < .05$). There was also a main effect of passage ($F(1, 28) = 10.42, p < .05$). As Table 3 shows, good and poor readers both recalled fewer idea units on the Octopus passage than the Amelia Earhart passage. Thus, the main effect of passage on comprehension was opposite of the predicted direction for prior knowledge, but was in the direction predicted by Flesh-Kincaid difficulty. That is, we would expect that comprehension would be lower on the Octopus passage because it is more difficult. It is interesting that prior domain knowledge can overcome passage difficulty in terms of word identification, but not for

comprehension. As we will discuss later, this may occur because of increased demands placed on decoding due to the more difficult text. The interaction between passage and reading ability was not significant ($F(1, 28) < 1$).

Predicting Comprehension with Error Types

To see how the total proportion of errors and the different types of errors predicted comprehension, averages were calculated for all variables across both passages. Table 5 shows the correlations between the average overall proportion of errors, the four types of substitution errors, and comprehension across both passages. What is interesting is that the most commonly used measure of oral reading, overall proportion of errors, did not significantly predict comprehension. One might also expect that the G-S- errors, because they are unrelated to either graphic or semantic information, might be the strongest predictor of poor comprehension. As seen in Table 5, however, the rate of this type of error was very low, which may have led to the low correlation observed. However, two types of errors did have a significant relation with comprehension, with greater numbers of these types of errors associated with lower comprehension: G+S- ($r=-.50$) and G-S- ($r=-.43$). Comparing the correlations with a z-transformation revealed that the average proportion of G+S- errors predicted recall more strongly than the proportion of G-S- errors ($Z=2.43, p < .05$). As in Priebe et al. (in press), making more semantically dissimilar errors, and in particular, those based solely on graphic information, was again diagnostic of the lowest comprehenders in the sample.

Table 5

Correlations Between Comprehension and each type of Substitution Error

	Total Errors	G+S+	G+S-	G-S+	G-S-
Recall	-0.21	-0.28	-.50*	0.12	-0.43*
Total Errors		-0.07	0.30	0.06	0.10
G+S+			-0.13	-0.13	0.21
G+S-				-0.13	-0.04
G-S+					-0.04

* $p < .05$

Effects of Passage Difficulty

Two of the above findings were contrary to our hypotheses, and previous work showing that prior domain knowledge is associated with gains in fluency and comprehension (Miller & Keenan, 2010; Priebe et al., in press). To explore whether the difficulty of the Octopus passage might be obscuring potential prior knowledge effects, we repeated the comprehension and fluency analyses with another sample: 30 fourth graders children who had prior knowledge of *both* Amelia Earhart and octopuses. We expected to find no difference in comprehension and fluency across the two passages among these children who had prior knowledge of both passages; however, as Table 6 shows, there was a significant decrease in comprehension ($t(29) = 2.33, p < .05$), and a

trend towards a decrease in fluency ($t(29) = 1.64, p = .11$), suggesting that the difficulty of the Octopus passage leads to decreases in recall for all children, regardless of prior domain knowledge.

Table 6

Comprehension and Fluency on Amelia and The Octopus for all Prior Knowledge Groups

	Recall		Fluency	
	Amelia	Octopus	Amelia	Octopus
No PK of <i>Amelia Earhart</i> , PK of <i>The Octopus</i>	0.39	0.32	95.86	96.86
PK on both <i>Amelia Earhart</i> and <i>The Octopus</i>	0.41	0.30	96.73	93.13

Additional exploratory analyses were conducted comparing fluency and comprehension for all 5th and 6th graders, who also had “The Octopus” as the second reading passage, but differed in the first reading passage (5th graders first read a passage about Martin Luther King, and 6th graders first read a passage about Andrew Carnegie). Because these children were older than the children in the current sample, the grade level index of the Octopus passage was either at or above grade level, and should therefore not lead to the same decreases seen in the above analyses. As Table 7 shows, an increase in fluency from the first passage to “The Octopus” was observed for both the 5th graders ($t(159) = 18.43, p < .05$) and the 6th graders ($t(160) = 19.98, p < .05$). In contrast, examining

the fluency among all fourth graders revealed a trend towards the same drop in fluency observed in the above analyses ($t(152)=1.60, p=.11$).

A similar pattern was observed with comprehension, where an increase in comprehension from the first passage to “The Octopus” was seen for both the 5th graders ($t(155)= 5.66, p <.05$) and the 6th graders ($t(158) =8.44, p<.05$). Again, the entire sample of 4th graders showed the same decrease in comprehension ($t(149) =5.56, p <.05$) we observed in the current study. Taken together these results suggest that passage factors such as syntax and passage difficulty may be more important than prior domain knowledge in predicting reading behavior.

Table 7

Average Comprehension and Fluency for Grades 4, 5, and 6

	Recall		Fluency	
	Amelia	Octopus	Amelia	Octopus
4th grade	0.40	0.34	97.46	95.88
5th grade	MLK	Octopus	MLK	Octopus
	0.29	0.36	101.65	115.11
6th grade	Carnegie	Octopus	Carnegie	Octopus
	0.32	0.41	114.14	128.24

Discussion

Study 1 sought to extend the results of Priebe et al. (in press), and assess whether prior domain knowledge effects are still evident when controlling for general knowledge differences, due to having the same person read passages both where they knew the topic (Octopus), and did not (Amelia Earhart). When we thus controlled for general knowledge differences in this way, we found several indications that prior domain knowledge facilitates reading within the same reader, even when the passage for which they had prior domain knowledge was more difficult. The results from this study illustrate how powerful prior knowledge effects can be: even when readers encounter a difficult passage, prior domain knowledge still facilitates word identification.

As in Priebe et al. (in press) we found that prior domain knowledge reduced the overall number of errors, again only for poor readers. Interestingly, whereas prior domain knowledge led to a decrease in the overall number of errors made, we found that prior domain knowledge actually led to proportionally *more* substitutions compared to other types of errors (omissions, insertions, skipped lines, and repetitions). This may indicate that the increased semantic facilitation due to having prior knowledge leads a reader to pay more attention to the text, and is thus less likely to omit and insert words. Alternatively, because the Octopus passage is also the more difficult passage, it may be that the difficulty of the passage leads readers to pay more attention to the text, and make more attempts to sound out words instead of making other kinds of errors.

In addition to effects on the number of errors, we also found that prior domain knowledge affected the types of errors made. Both good *and* poor readers made fewer G+S- errors when they had prior knowledge compared to when they did not. In addition,

good and poor readers made more G+S+ errors: errors which can be thought of as the best possible type of error to make as they indicate making use of all available graphic and semantic information to identify a word. Just as a decrease in semantically dissimilar errors might indicate prior domain knowledge facilitation, so too, the increase in these semantically similar errors is supportive of additional semantic activation that comes with having prior domain knowledge, and was seen in both good and poor readers.

The rate of G+S- errors was also, as in Priebe et al. (in press) the type of error that predicted poor comprehension performance the most strongly. Importantly, the overall rate of errors, a measure often used by reading researchers and diagnosticians, did not significantly predict comprehension at all. This finding lends credence to the utility of miscue analysis in predicting reading behavior, despite the time and labor-intensive nature of miscue analysis.

One interesting theme from Study 1 is that we observed knowledge effects for both good *and* poor readers. This may be because the Octopus passage was more difficult, allowing more room for prior domain knowledge to exert its effects. The increased difficulty, however, also might have been responsible for our finding that prior domain knowledge did not facilitate fluency, although we observed fluency effects in Priebe et al. (in press). It is also possible that what we observed was a speed-accuracy tradeoff among good readers, wherein prior knowledge increased the overall rate of reading, but was not able to compensate for the difficulty of the text, resulting in lower fluency for good readers.

Despite many studies showing that prior domain knowledge facilitates comprehension (c.f. McNamara & Kintsch, 1996; Miller & Keenan, 2009), in the current

study, prior domain knowledge did not lead to greater comprehension on the recall measure for either good or poor readers. We attribute this to the increased difficulty of the Octopus passage, which may have overshadowed prior domain knowledge effects; however, we still saw prior domain knowledge effects on word identification that overcame these differences in passage difficulty. Why might prior domain knowledge be able to overcome passage difficulty for word identification, and not comprehension? Reading comprehension is a dynamic process, in which the reader must integrate the information from the text with their background information. Since attentional resources are limited (LaBerge & Samuels, 1974), there is often a tradeoff between allocating these resources to decoding and comprehension (Perfetti, 1985). When a text is difficult to read, readers may have to focus more on decoding, and might devote more of their resources to identifying the words in the text. They therefore may have fewer resources available to devote to forming a coherent representation of the ideas presented. Prior knowledge may be able to compensate for some of these increased attentional demands, as seen with the results showing that prior knowledge reduced the overall rate of oral reading errors for poor readers; however, it may be the case that this compensation was not powerful enough to allow additional resources to be devoted to comprehension.

It is also possible that prior domain knowledge might have actually interfered with recall performance. Anecdotally, when asked ‘What is an Octopus?’ before they read the passage, many readers supply facts about octopuses that are not in the actual passage (e.g. can open jars, are cephalopods). We often find that many of these facts make it into the recall of the passage, often preceded by a statement like “I know this wasn’t in the passage, but...”. Their prior knowledge of the topic, coupled with the

difficulty of the text and resources that are being consumed by decoding, therefore might cause interference when they turn to recalling the ideas presented in the text, due to overlapping representations between the ideas presented in the text and the facts they already know about the topic. This may result in participants reporting everything they know about the topic of the passage itself, rather than just the ideas presented in the passage itself.

Related, the results from this study point to the importance of making sure passages are equivalent when exploring individual difference factors such as prior domain knowledge. As we saw, all readers in 4th grade, regardless of prior domain knowledge, showed a decrease in fluency and comprehension on the Octopus passage, whereas older readers showed an increase in fluency and comprehension on this passage. While we would have liked to have had passages that were equivalent in difficulty, this was not possible with our current data, as there are no other passages that have sufficient variability in prior domain knowledge. Future studies should take care to equate passage difficulty when attempting to gauge the effects of prior domain knowledge.

The results from Study 1 support previous research showing that prior domain knowledge can facilitate oral reading. The design of Study 1 allowed us to examine the effect of prior knowledge when general knowledge was controlled for by examining what happened when the same reader had both prior knowledge and no prior knowledge. When we controlled for general knowledge, prior knowledge still facilitated oral reading in terms of a reduction in total errors for poor readers, and in the types of substitutions made. In this way, we can be confident that the results we obtained in Priebe et al. (in press) were not due to general knowledge differences. Study 2 continues this line of

inquiry by exploring general knowledge differences themselves, to see if general world knowledge can also facilitate word identification.

Chapter 3

Study 2: General World Knowledge and Word Identification

Study 2 examines the effects of general world knowledge on word identification in good and poor readers, by way of a reading-age match design. A reading-age match design can be used to create knowledge differences that are assumed to accrue with age, while controlling for other factors that might also increase with age, such as word decoding skill. In Study 2, we match poor readers to younger readers on raw word decoding skill and performance IQ, and good readers to older readers on raw word decoding skill and performance IQ. In this way, knowledge differences can be established for both good and poor readers, without creating decoding differences. We then examined their word identification across age and reading ability for the same passages. Namely, by examining the reading rate, number of oral reading errors, the quality of those oral reading errors, and the fluency of which a passage is read, we can see whether general world knowledge facilitates word identification in a similar way as prior domain knowledge.

While Study 1 used passages from the QRI, they are not appropriate to use in this study because different age groups read different passages in the QRI. Instead, we will use passages from the Gray Oral Reading Test-3 (GORT; Wiederholt & Bryant, 1992). A total of 13 passages are included in the GORT battery, and most children read some passages below grade level, and some above. This allows us to have data from younger

and older children reading the same passages, making comparisons across age groups easier and not confounded by differences in passages.

All participants read a series of passages, and errors were tabulated and scored in terms of graphic and semantic similarity. If world knowledge, like prior domain knowledge, facilitates passage fluency, then when readers of different ages are matched on decoding skill, we should see that world knowledge, as defined as differences in age, should lead to greater passage fluency scores. The predicted pattern is somewhat counterintuitive in that poor readers are predicted to do better than their reading-age matched controls, whereas good readers are expected to do worse than their reading-age matched controls. This prediction stems from the fact that poor reader 6th graders are matched to controls in 4th grade in the reading-age match design; in contrast, good reader 6th graders are matched to older 8th graders on decoding skill. Thus, if world knowledge is controlling performance when decoding skill is matched, then older children should do better than their decoding matched controls. Specifically, for poor readers, we should see greater fluency, fewer errors overall, and fewer G+S- miscues in particular, compared to their younger, reading-age matched counterparts, whereas for good readers, we should see lower fluency scores, more errors overall, and more G+S- miscues compared to their older, reading-age matched peers. In addition, we might see an *increase* in G+S+ miscues associated with age and more general world knowledge, indicating increased attention to graphic and semantic cues based on the facilitation due to general world knowledge. While comparing comprehension would also be an interesting avenue, the GORT has demonstrated problems with passage independence, in that most of the questions on the GORT can be answered without reading the passage (Keenan & Betjemann, 2006) and is

therefore not appropriate for testing for the effects of general world knowledge on reading comprehension.

Method

Participants

As with Study 1, participants for this study were drawn from the larger pool of subjects from the CLDRC database. The target participants were 40 6th graders, half of whom were good readers and half who were poor readers defined as a reading disability (RD) in reading words. Decoding skill was again measured by a composite z-score of word recognition ability when reading words in a list using the Timed Oral Reading of Single Words (Olson et al., 1994) and the Peabody Individual Achievement Test (PIAT) word recognition subtest (Dunn & Markwardt, 1970). The poor readers have an age-adjusted composite decoding z-score of -1 or below. The controls all have word decoding composite z-scores above zero, indicating above average word decoding skills.

Twenty 4th grade reading-age controls were matched to the 20 poor 6th grade readers, and 20 8th grade reading-age controls were matched to the good 6th grade readers. Matching was done on PIAT Word Recognition Raw Scores and on WISC Performance IQ Raw scores. In addition, matched participants were selected so that the older group always had higher scores on the WISC Information subtest than their matched counterparts, to ensure that the older member of the matched pair had higher general world knowledge. *T*-tests were conducted to ensure that the matching was successful; as Table 8 shows, there were no significant differences among the target groups and their reading-age matches on decoding or performance IQ; however, the older group always had significantly higher WISC Information scores. Because processing speed is known to

increase with age, and is also known to affect many cognitive skills (c.f. Kail, 2007), *t*-tests were also conducted comparing a standardized speed composite of WISC Symbol Search and Coding. As Table 8 shows, there were no significant differences between the groups on the speed composite.

Table 8

Matching Statistics for Study 2

	6 th Grade Poor Readers			6 th Grade Good Readers		
	Reading			Reading		
	Poor Readers (<i>n</i> =20)	Age Match (<i>n</i> =20)	<i>t</i> Statistic	Good Readers (<i>n</i> =20)	Age Match (<i>n</i> =20)	<i>t</i> Statistic
Grade	6.00	4.00		6.00	8.00	
Age	12.00 (.33)	9.91 (.47)		11.76 (.52)	13.81 (.41)	
PIAT Word Recognition	44.10 (5.23)	44.35 (4.72)	<i>t</i> (38)=.21, <i>p</i> =.84	62.45 (4.75)	62.15 (4.45)	<i>t</i> (38)=.16, <i>p</i> =.88
WISC Performance IQ	50.10 (5.51)	50.30 (6.75)	<i>t</i> (38)=.40, <i>p</i> =.69	53.25 (7.92)	54.25 (7.72)	<i>t</i> (38)=.10, <i>p</i> =.92
WISC Information Subtest	12.65 (1.87)	18.20 (2.44)	<i>t</i> (38)=10.0, <i>p</i> <.05	17.00 (2.20)	23.55 (1.93)	<i>t</i> (38)=8.07, <i>p</i> <.05
WISC Speed Composite	-.16 (.50)	-.18 (.96)	<i>t</i> (38)=.13, <i>p</i> =.90	.32 (.97)	.36 (.88)	<i>t</i> (38)=.15, <i>p</i> =.88

Measures

Gray Oral Reading Test-3: This study used passages from Form A of the Gray Oral Reading Test-3 (GORT; Wiederholt & Bryant, 1992). This test requires participants to read aloud a series of expository and narrative passages (ranging from 80 to 150 words in length). After the passages are read, the examiner reads a set of multiple choice comprehension questions to the participant.

Procedure

Participants started on the passage that was the appropriate level for their given grade. Before the child read the passage, the examiner told them a sentence that supplied basic information about the passage (e.g. *This story is about a bird having a problem*). The child then read the passage orally, while the examiner scored the passage online for rate and accuracy. The GORT requires children to reach basals and ceilings for both fluency and comprehension; thus, passages are read until both are reached. All oral readings for the GORT were transcribed, and errors were analyzed according to the taxonomy given in Study 1.

Researchers recommend only analyzing data where a minimum of 20 errors are made (e.g. Laing, 2002). Because the GORT passages are relatively short, we might not see 20 errors made in a single passage. Our previous research showed that even poor readers read passages at approximately 90% accuracy (Priebe et al., 2008). Thus, to ensure a good number of errors, and to allow comparisons across the same passages among the age groups, we focused on three passages for each group.

Because children start at the passage for their grade level and continue upward until they have made enough errors on both comprehension and fluency, we selected

passages that they were likely to encounter. For the 6th grade poor readers and their 4th grade reading-age matches, we examined passages 5, 6, and 7. For the 6th grade good readers and their 8th grade reading-age matches, we examined passages 7, 8, and 9. (See Appendix C for the passages used for this study.) These passages are assumed to correspond roughly with grade level, however, analyzing the readability of these passages revealed that this was not necessarily the case, especially for the higher-level passages. The passages used for the 6th grade good readers and their 8th grade reading match are substantially harder, as measured by the Flesch-Kincaid Grade Level index (average grade level index for passages 7, 8, and 9 = 11.1) compared to the passages used for the 6th grade poor readers and their 4th grade reading-age matches (average grade level index for passages 5, 6, and 7 = 7.6). The inclusion of difficult passages, however, may be a benefit because as we saw in Study 1, more difficult passages allow for knowledge effects to be observed on oral reading errors for good readers as well. Subjects were only included if they read these three passages. In addition, finding children who made at least 20 errors across all three passages and still satisfied the matching criteria proved to be very hard in practice, so we relaxed this criteria slightly and allowed inclusion if children made at least 15 errors across all three passages.

Results

Because the 6th grade poor readers and their 4th grade reading-age matches read different passages than the 6th grade good readers and their 8th grade reading-age matches, it was not appropriate to combine analyses. Therefore, all analyses were conducted separately for the 6th grade poor readers and their 4th grade reading-age matches, and for the 6th grade good readers and their 8th grade reading-age matches. In

this way, each comparison can be considered a replication of the other: by comparing both age groups we can see if the effects replicate and if a general pattern holds when comparing younger and older readers in both directions. Because the same passages were used for all readers within a comparison, raw numbers were used for all calculations.

Total Errors

A total accuracy score was created by summing the number of errors for each participant across the three passages. There was no significant difference in total errors for the 6th grade poor readers and their 4th grade reading-age matches ($t(38) = .33$, $p = .37$). However, consistent with the view that older readers' greater knowledge might facilitate their oral reading of words in context, the 8th graders made fewer errors compared to the 6th grade good readers, and this difference was almost significant ($t(38) = 1.50$, $p = .07$); Table 9 shows the average number of errors for each group.

Rate

As in Study 1, the time to read each passage was converted into a rate by dividing the time by the number of words in the passage. T-tests were conducted separately for the good and poor readers to compare average words read per minute across grade.

Consistent with the idea that general world knowledge might facilitate fast word recognition in the same way prior domain knowledge does, 6th grade poor readers read significantly faster than their 4th grade reading-age matches ($t(38) = 1.91$, $p < .05$).

Similarly, the 6th grade good readers read fewer words per minute compared to their 8th grade reading-age matches, although this difference was not quite statistically significant ($t(38) = 1.55$, $p = .07$). See Table 4 for the average word reading rate for each group.

Passage Fluency

As in Study 1, passage fluency scores were calculated by dividing the number of words read correctly across the three passages by the time taken to read all three passages. *T*-tests were conducted separately for the good and poor readers to compare average words read correctly per minute across grade. Table 9 shows the average words read correctly per minute for all groups. 6th grade poor readers read more fluently compared to their 4th grade reading-age matches ($t(38)=1.69, p<.05$), and similarly, 8th graders read more fluently compared to their 6th grade reading-age matches ($t(38)=1.74, p<.05$). These results mirror the gains in fluency due to prior domain knowledge seen in Priebe et al. (in press) and suggest that the greater world knowledge that accumulates with age leads to more fluent word recognition in context.

Table 9

Average Fluency Measures

	Poor Readers		Good Readers	
	4th Grade	6th Grade	6th Grade	8th Grade
Total Errors (raw)	33.65 (16.03)	35.25 (14.17)	33.00 (16.36)	26.7 (9.12)
Rate (Words per Minute)	94.12 (22.49)	111.23 (33.21)	117.77 (15.76)	126.54 (19.89)
Passage Fluency (Words correct per minute)	85.46 (23.15)	100.47 (32.36)	108.83 (16.17)	118.78 (19.81)

Types of Oral Reading Substitution Errors

To investigate the pattern of substitutions as a function of world knowledge, mixed ANOVAs with 2 crossed repeated measures factors (Graphic, Semantic) and one between-subjects factors (grade) were conducted separately for the 6th grade poor readers and their reading-age matches, and for the 6th grade good readers and their 8th grade reading-age match.

6th grade poor readers versus 4th grade reading-age match. There was no main effect of grade, indicating that the 6th grade poor readers made roughly equivalent numbers of substitutions compared to their younger reading-age matches. Table 10 shows the number of substitutions for each group. There were more graphically similar than graphically dissimilar substitutions ($F(1, 38)=107.28, p <.05$), but in contrast to Study 1 there were more semantically dissimilar than semantically similar substitutions overall ($F(1, 38) =39.48, p <.05$), perhaps because GORT texts are more difficult than QRI texts. This effect was qualified, however, by a significant interaction between semantic similarity and grade, whereby 6th grade poor readers made more S+ errors compared to their 4th grade reading-age matches ($F(1,38) =4.92, p <.05$). This suggests that the older readers had additional semantic facilitation through having greater general world knowledge.

The interaction between graphic and semantic similarity was significant ($F(1, 38)=65.15, p<.05$), indicating that the level of semantic similarity was different for the 2 levels of graphic similarity. As Table 10 shows, whereas graphically dissimilar miscues (G-) were almost equally likely to be semantically similar or semantically dissimilar, graphically similar miscues (G+) were more likely to be semantically dissimilar than

semantically similar. Because the graphically similar miscues made up the bulk of the miscues that were made by all readers, this tendency most likely reflects the general tendency to make more semantically dissimilar miscues, again due to the difficulty of the texts. The predicted three-way interaction between graphic similarity, semantic similarity, and grade was almost significant ($F(1, 38) = 3.32, p = .08$).

Table 10 shows the average number of each type of substitution. Based on Priebe et al (in press), we expected to find lower rates of G+S- errors among the 6th grade poor readers compared to their younger reading-age match; however, as shown in Table 5, while 6th grade poor readers did make fewer G+S- errors, this difference was not significant ($t(38) = 1.03, p = .16$). One type of error differed significantly by grade: 6th grade poor readers showed a higher rate of G+S+ errors compared to their 4th grade reading-age matches ($t(38) = 3.05, p < .05$), suggesting that, due to greater general world knowledge, they were making more use of both graphic and semantic information compared to the 4th graders. There were no significant differences for the other types of errors.

Table 10

Average Number of each type of Substitution Error

	Poor Readers		Good Readers	
	4th Grade	6th Grade	6th Grade	8th Grade
Number of substitutions	23.85 (12.86)	23.85 (11.14)	24.80 (11.30)	20.00 (7.36)
G+S+ (raw)	4.00 (2.29)	6.5 (2.86)	5.30 (3.10)	2.14 (.48)
G+S- (raw)	16.30 (10.53)	13.30 (7.71)	16.8 (8.74)	12.85 (5.62)
G-S+ (raw)	1.60 (1.76)	2.4 (1.88)	1.5 (1.43)	1.8 (1.4)
G-S- (raw)	1.95 (1.39)	1.65 (1.69)	1.2 (1.47)	1.4 (1.35)

6th grade good readers versus 8th grade reading-age match. 6th grade good readers made more total number of substitution errors than their 8th grade reading-age matches, but the difference was not significant ($F(1, 38) = 2.53, p = .12$). Table 10 shows the number of substitutions for each error type. As with the 6th grade poor readers and their 4th grade reading-age matches, errors were more graphically similar than dissimilar ($F(1, 38) = 219.70, p < .05$). Interestingly, the 6th grade good readers made more graphically similar miscues compared to the 8th grade reading-age matches ($F(1, 38) = 6.79, p < .05$), indicating that younger readers were paying more attention to graphic cues. Coupled with the finding that there was no significant difference in the rate of graphically similar miscues between the 6th grade poor readers and their 4th grade poor reading-age matches, this may support the finding that younger readers are more reliant

on graphic cues (c.f. Biemiller, 1970; Goodman, 1965), but may also interact with text difficulty.

The same main effect of semantic similarity that was observed with the 6th grade poor readers and their 4th grade reading-age matches, was seen here, with more miscues being semantically dissimilar than semantically similar ($F(1, 38) = 58.33, p < .05$). The interaction between graphic and semantic similarity was also again significant ($F(1, 38) = 83.61, p < .05$), indicating that the level of semantic similarity was different for the 2 levels of graphic similarity. As with the 6th grade poor readers and their 4th grade reading-age matches, graphically similar miscues were more likely to be semantically dissimilar, whereas the rate of semantically similar and semantically dissimilar miscues was roughly equivalent among the graphically dissimilar miscues. The predicted three-way interaction between graphic similarity, semantic similarity, and grade, however, was not significant ($F(1, 38) = 1.17, p = .29$).

Again, we expected to find lower rates of G+S- errors among the older group due to more general world knowledge, and this hypothesis was borne out: 6th grade good readers showed a higher rate of G+S- errors compared to their 8th grade reading-age matches ($t(38) = 1.7, p < .05$). We also expected to see more G+S+ errors among the older readers due to larger stores of general world knowledge; however, 6th grade good readers made *more* G+S+ errors compared to the 8th grade reading-age matches, and this comparison was marginally significant ($t(38) = 1.6, p = .06$). It is possible that this increase was seen because the 6th graders made significantly more errors compared to the 8th graders, and G+S+ errors are the most reasonable errors for 6th graders to make.

Discussion

Study 2 explored whether the effects of general world knowledge on word identification were similar to the effects of prior domain knowledge on word identification. We did this by matching younger and older readers on word decoding and performance IQ, resulting in two groups for comparison: poor 6th grade readers matched to 4th grade readers, and good 6th grade readers to older 8th grade readers. This allowed us to see if the increase in general world knowledge that typically increases with age would lead to an increase in fluency, and a decrease in errors based solely on graphic information. The results from Study 2 suggest that the effects of world knowledge on word identification are very similar to the effects of prior domain knowledge on word identification. When matched on decoding, older readers read the passages more fluently compared to their younger reading-age matches, regardless of reading ability. The 6th grade poor readers read the passage *more* fluently than their 4th grade reading-age matches, and likewise, 6th grade good readers read the passage *less* fluently compared to their 8th grade reading-age matches. These findings mirror those from Priebe et al (in press), where readers with prior domain knowledge read the passage more fluently compared to readers without prior domain knowledge. Interestingly, while the effects in Priebe et al were confined to poor readers, in Study 2 we see that the effects also extend to good readers.

Study 2 also examined the effect of general world knowledge on the types of errors made. We expected to find that older readers made fewer G+S- substitutions, based on the findings from Priebe et al. This hypothesis was supported with the 6th grade good readers and their 8th grade reading-age matches, where the 6th grade good readers

made more of this kind of substitution compared to their older 8th grade counterparts. As with prior domain knowledge, having more general world knowledge decreased the tendency to substitute words that were solely based on graphic information and detracted from the meaning for the passage. A similar pattern was seen for the 6th grade poor readers, where the 6th grade poor readers made fewer of this kind of substitution compared to their 4th grade reading-age matches, but that difference was not significant.

The other type of substitution that we were interested in was the substitution based on both graphic and semantic information (G+S+), as they might demonstrate a reader making full use of all the information available. We hypothesized that if general world knowledge operates in a similar way as prior domain knowledge, we might see a greater rate of this kind of error with age. This hypothesis was supported by the finding that 6th grade poor readers made more G+S+ errors compared to their 4th grade reading-age matches, however, we also found that 6th grade good readers made more G+S+ errors compared to their older 8th grade reading-age matches. This may be reflective of the fact that the 6th grade good readers made more errors compared to the 8th graders, but may also reflect a developmental trend in the types of errors made. The miscues of all younger children (the 4th graders and both the 6th grade good and poor readers) were more graphically similar compared to the older 8th graders. Miscues of younger children tend to be more graphically similar, with semantically similar miscues following the same general trajectory and plateau; however, this trend is generally not observed past third grade (Biemiller, 1970; Goodman, 1965). A contribution of this dissertation, however, is the simultaneous classification of miscues on both graphic and semantic dimensions, whereas previous research did not do so. It is unclear, therefore, whether

reclassifying these errors in the same way would lead to an extension of this trajectory beyond the third grade. It could be that younger readers, with relatively less experience and less well-developed word identification networks, have a general tendency to rely more heavily on graphic cues, and this increase in G+S+ errors is reflecting that.

As with Study 1, it is also possible that the difficulty of the passages affected the results, as text difficulty can affect the pattern of miscues observed (Christie & Alonso, 1980; Kibby, 1979; Leslie & Osol, 1978). For this reason, researchers often utilize passages that are near the reader's grade level. While we attempted to do this, the passages were actually much higher than grade level, but especially for the 6th grade good readers and their 8th grade reading-age matches. As shown in Table 10, substitutions that were G+S- made up the bulk of the substitutions that both groups made on these passages, a trend not observed in either Study 1 or in Priebe et al (in press). The texts used here were harder to decode, and may have led to an increased reliance on graphic cues. Importantly, even despite this tendency for all readers to make more G+S- substitutions, we still saw that older readers, with more general world knowledge made fewer G+S- errors compared to their younger reading-age matches. Future studies should look at the pattern of miscues for good and poor readers who differ in general world knowledge across a variety of texts ranging in difficulty.

This study was novel in that it represents the first time that general world knowledge has been assessed through a reading-age match design. Due to the problems associated with traditional measures of general world knowledge mentioned earlier, such as a focus on academic knowledge and confounds with verbal skills, this kind of design may prove useful in investigating general world knowledge effects. Along the same lines,

this study was the first to examine the effects of general world knowledge on word identification behavior. Importantly, we investigated these effects while controlling for other skills that might also increase with age. By matching our groups on word decoding and performance IQ, we can be confident that the results we observed were due to increases in general world knowledge. In addition, Kail (2007) showed that with age comes a general increase in processing speed; however, since our groups were equivalent on processing speed, what we observed is not a general increase in speed that comes with age. Rather, our results revealed a specific facilitation in passage fluency due to increased general world knowledge. The fact that we saw not only a reduction in the total number of errors, but also an effect on the types of errors made, also bolsters this claim.

The results suggest that world knowledge acts in a similar way as prior domain knowledge, for both overall fluency and the types of errors made. Importantly, whereas the prior domain knowledge effects observed in Priebe et al (in press) were only seen for poor readers, effects were also seen here for good readers. This suggests that boosting general world knowledge, perhaps through curricula and interventions that emphasize building a knowledge base, may be beneficial for all readers.

Chapter 4

Study 3: Investigating General World Knowledge Effects When Prior Knowledge is Held Constant

Study 1 continued the investigation of Priebe et al (in press) by comparing word identification across the same participant, with and without prior knowledge. Study 2 compared different levels of general knowledge by employing a reading-age match design. In this chapter, Study 3 asks what happens when participants have equivalent levels of prior knowledge, and equivalent levels of word decoding skill, but differ only in the amount of world knowledge. By matching good readers in fourth grade to poor readers in sixth grade on decoding skill, with both groups of readers having prior knowledge of the topic of the passage, we examine whether general world knowledge adds anything, above and beyond the effects of prior domain knowledge and decoding.

One drawback of Study 2 was that, in order to have an adequate number of errors to analyze, and due to the shorter nature of the passages on the GORT, we had to sum up the number of errors across several different passages. In addition, we had no assessment of prior domain knowledge for each individual passage on the GORT. It is possible that some readers had prior domain knowledge for some of the passages used in Study 2. For example, one passage of the GORT is about Cesar Chavez, and another deals with the history of the cowboy in the United States. Differences in domain knowledge among the different passages of the GORT thus may have played some role in the results of Study 2.

For these reasons, Study 3 uses a passage from the QRI, “The Octopus”, and only includes participants who have prior knowledge of the topic.

Study 3 uses a reading-age match design to compare word identification between participants. 4th grade readers were matched to poor 6th grade readers on word decoding skill, and their word identification errors were tallied as they read a passage out loud. All readers have prior knowledge of one passage that was administered to both 4th and 6th graders (“The Octopus”), allowing for comparison across grades on the same passage.

We then compare reading rate, accuracy, fluency, error types, and comprehension between the 4th graders and the 6th graders, to ask if general knowledge adds any additional facilitation when word decoding skill is the same, and all readers have prior domain knowledge. If general world knowledge adds additional facilitation beyond prior domain knowledge, we should see that the 6th graders read the passage more fluently, perform better on comprehension, and make fewer G+S- errors than their 4th grade reading-age matches. If, however, general world knowledge does not add any additional facilitation, we should see no difference between the 6th graders and their 4th grade reading-age matches.

Method

Participants

Participants for Study 3 came from the CLDRC database, and consisted of 4th and 6th graders who have read and have prior knowledge of “The Octopus.” The sample for Study 3 was the same as the sample used for Study 2 (6th grade poor readers and their 4th grade reading-age match; refer back to Table 8 for descriptive statistics).

Measures

Study 3 used the same passage from the QRI that was used in Study 1, “The Octopus.”

Procedure

The same procedure for administration of the QRI employed in Study 1 was used here, with the child answering a concept question, reading aloud the passage, and then retelling the passage. The oral readings of the passages were transcribed, and errors were analyzed according to the taxonomy given in Study 1.

Results

Total Errors

Table 11 shows the mean number of errors for each group. To compare differences in accuracy as a function of prior knowledge, the total number of errors was summed for each participant. 4th and 6th graders did not differ on the number of errors made ($t(38) = .85, p = .40$).

Table 11

Mean Performance on Comprehension and Fluency Measures

	4th Grade Reading age Match	6th Grade Poor Readers
Total Errors	22.05 (13.03)	25.55 (13.06)
Rate (Words per Minute)	100.73 (23.61)	116.38 (29.70)
Passage Fluency (Words correct per minute)	92.56 (24.47)	105.60 (30.56)
Idea Units recalled	18.15 (7.91)	19.00 (8.1)

Rate

There was a trend towards 6th graders reading faster than 4th graders ($t(38) = 1.84, p=.07$). As Table 11 shows, 6th graders read around 15 more words a minute compared to the 4th graders.

Passage Fluency

Although there was a trend for 6th graders to read the passage more quickly, there was no significant difference in fluency between the 4th and 6th graders ($t(38)=1.49, p=.15$).

Types of Oral Reading Substitution Errors

To explore the patterns of error types, a mixed ANOVA was conducted with two within subjects factors (Graphic, Semantic) and one between subjects factor (grade), using the raw number of each type of substitution. There were only two significant effects: a main effect of semantic similarity, ($F(1, 38) = 28.50, p < .05$), with more substitutions being semantically similar than semantically dissimilar, and the usual significant interaction between graphic and semantic similarity ($F(1, 38) = 3.96, p < .05$), with the bulk of the semantically dissimilar miscues being graphically similar. No other main effects or interactions were significant.

If general knowledge added facilitation when prior knowledge was the same for both groups, then and only then would we expect to find differences in the rate of G+S- substitutions, with the older 6th graders making fewer G+S- substitutions compared to their 4th grade reading-age match; however, paired t-test comparisons revealed no significant differences in the rate of any of the types of substitutions between the 4th and 6th graders. Table 12 shows the mean number of each type of substitution.

Table 12

Average Number of Each Type of Substitution Error

	4th Graders	6th Graders
Number of substitutions	14.85 (10.51)	16.05 (8.20)
G+S+	4.7 (3.08)	5.45 (3.35)
G+S-	6.60 (7.74)	4.95 (3.60)
G-S+	2.25 (2.36)	3.7 (3.20)
G-S-	1.3 (2.18)	1.95 (2.11)

Comprehension

As Table 11 shows, 6th grade poor readers and their 4th grade reading-age matches recalled an equivalent number of idea units ($t(38) = .34, p = .74$).

Predicting Comprehension with Error Types

Neither the total number of errors, nor any individual type of error, correlated significantly with performance on the recall measure (see Table 13).

Table 13

Correlations Between Comprehension and Substitution Types

	Total Errors	G+S+	G+S-	G-S+	G-S-
Recall	-0.21	-0.14	-0.12	-0.21	-0.13
Total Errors		.61*	0.62*	.65*	.56*
G+S+			0.16	0.28	0.29
G+S-				0.04	0.20
G-S+					.49*

* $p < .05$

Discussion

The purpose of Study 3 was to see if general world knowledge adds any additional facilitation to word identification and comprehension beyond prior domain knowledge. We did this by using a sample of 6th grade poor readers, matched to younger 4th graders on word decoding and performance IQ, all of whom had prior domain knowledge. We hypothesized that if general world knowledge added benefits above and beyond prior domain knowledge, we would see gains in fluency and comprehension, whereas if general world knowledge did not add anything beyond prior domain knowledge, we would observe no differences between younger and older readers when they all had prior knowledge. We found no difference in comprehension between the younger and older readers, and no difference between the rate of errors between the 4th and 6th grade readers. We saw a trend towards 6th grade readers reading the passage faster compared to the 4th graders, and likewise, the 6th graders read the passage more fluently compared to the 4th graders, but this difference was not significant.

Based on the findings from Priebe et al, we were also interested in the types of errors that 4th and 6th graders made. Because there was no difference in total number of errors, it was not surprising that we also saw no difference between the 4th and 6th graders in the rate of G+S- errors, or any of the other types of substitutions.

With Study 3, we hoped to find evidence for the separability of general world knowledge and prior domain knowledge by comparing word identification and comprehension when prior domain knowledge was held constant, and readers only differed in general world knowledge. We hesitate to make strong conclusions about the current findings, however, given that we only examined one passage. In addition, any

conclusions we might make based on the findings from Study 3 would be based on completely null findings. In order to fully explore the relationship between general world knowledge and prior domain knowledge, it seems important to include another group: readers who differed on general world knowledge *and* prior domain knowledge. Including a comparison group where the readers differed on general world knowledge, and had no prior domain knowledge, would be an important way to clarify the findings from Study 3. In addition, including more passages, carefully selected for equivalent length and difficulty, would allow us to make firmer conclusions about how general world knowledge and prior domain knowledge interact. These comparisons were not possible with the current sample, as there were no passages where younger and older readers received the same passages and differed on prior knowledge, but they are important directions for future studies.

Chapter 5

Conclusions and Future Directions

This dissertation sought to explore prior knowledge and general world knowledge effects on word identification and comprehension. The major question of this dissertation concerned whether prior knowledge and general world knowledge are dissociable. We examined this question with three studies that approached the question from slightly different angles.

With Study 1, we controlled for differences in general world knowledge by examining what happened when a participant had no prior knowledge of one passage, and prior knowledge of another. As in Priebe et al. (in press), poor readers showed a reduction in the overall rate of errors made when they had prior knowledge, even though the passage for which they had prior knowledge was more difficult. Good readers showed a reduction in rate as well, indicating that prior domain knowledge can even help good readers read more difficult passages more quickly. We also found that prior knowledge affected the types of errors that both good and poor readers made: as in Priebe et al., we saw a reduction in substitutions based solely on graphic information that changed the meaning of the text (G+S-). We also saw an increase in substitutions based on both graphic and semantic information (G+S+) for both good and poor readers, indicating that prior domain knowledge helped readers make substitutions that made full use of graphic and semantic information. We did not replicate the facilitation of fluency

and comprehension observed in Priebe et al, results that we feel underscore the importance of equating texts for difficulty when attempting to compare knowledge effects across passages.

The purpose of Study 2 was to see if the effects of general world knowledge were similar to the effects of prior knowledge. Overall, we saw a strong indication that general world knowledge acts in a similar way to prior knowledge. With the assumption that with age comes more general world knowledge, we used a reading-age match design to create differences in general world knowledge while controlling for other skills that might also increase with age. Older readers, matched to younger readers on decoding and performance IQ, read the passages more fluently compared to younger readers. Mirroring the prior knowledge effects of Study 1, we saw that general world knowledge was associated with a reduction of G+S- errors, or errors based solely on graphic information, and an increase in G+S+ errors- errors that can be thought of as making full use of all information available.

The aim of Study 3 was to continue to investigate the contributions of general world knowledge and prior knowledge by examining fluency and comprehension when readers had equivalent decoding skills and prior knowledge of a topic, and only differed in the amount of general world knowledge. Unfortunately, interpretation of this study is limited due to both the null effects observed and the fact that we only examined one passage.

Taken together, these studies suggest that general world knowledge and prior knowledge are both similar and separable in their effects. The effects are similar, in that the effects of general world knowledge seen in Study 2 were very similar to the effects

seen for prior domain knowledge. The effects are also separable, in that we were able to see some of the effects we expected with prior domain knowledge when examining prior domain knowledge effects within the same participant, suggesting that the effects we saw in Priebe et al were not due to differences in general world knowledge that might be associated with having prior domain knowledge of a given topic. As acknowledged earlier, the selection of passages equivalent in difficulty, syntax, and word factors would strengthen this claim, but this study is an important first step in that direction.

This dissertation used different designs to approach the same question- are prior domain knowledge and general knowledge separable? We examined this question through different designs: comparing reading behavior both across participants and across passages. Priebe et al. (in press) and Study 2 compared reading across participants, and in both studies we found that knowledge conferred an advantage upon reading behavior. With Study 1, we compared word identification and comprehension across participants, and were able to replicate some, but not all, of the findings in Priebe et al., indicating that comparing passages across participants can introduce additional challenges. In addition, one problem with Study 3 was that we only examined one passage, and did not have sufficient variability to detect effects. Future studies should consider these factors when trying to elucidate the effects of prior and general world knowledge on reading.

Related, the results from these studies show that the difficulty of the text can affect reading behavior, from fluency, to individual error types, to comprehension. Text factors are therefore critical to consider when designing studies to examine individual difference factors such as prior knowledge and general world knowledge. Future studies

could manipulate the difficulty of passages systematically to see what happens to passage fluency and comprehension when knowledge and text difficulty interact.

Another way that this dissertation contributes to the field of literacy research is by demonstrating that miscue analysis has benefits in predicting comprehension. As seen in Priebe et al (in press) and Study 1, the type of error, is often more predictive of comprehension than the overall number of errors. Substitutions based solely on graphic information predicted comprehension more strongly than the overall number of errors, which wasn't significantly predictive of comprehension at all. While miscue analysis is an extremely time consuming process, these results indicate that the effort may be worthwhile in terms of predicting reading behavior. In addition, two types of substitutions consistently are affected by both prior domain knowledge and general world knowledge. With knowledge, substitutions based solely on graphic information and not on semantic information decrease, and substitutions that are both graphically and semantically similar increase. This suggests that these two types of substitutions in particular are important in terms of knowledge effects.

The results of Study 2 show that knowledge effects are not necessarily specific to a given passage or topic. This may be good news for researchers like Hirsch (2006) who fear that our current educational system is actually creating what he calls a 'knowledge deficit'. Hirsch and others such as Neuman (2006) fear that increased pressure on test scores and school and teacher accountability has led to a narrowing of curriculum, in which important material is not covered. Indeed, a survey of 33 states found that instructional time for social studies had been reduced in 13 states (Rothman, 2005).

In addition, as Neuman (2006) points out, many basal readers tend to focus on fiction, instead of including informational texts in which a child can learn concepts while building reading skills at the same time. To address these concerns, Hirsch aims to establish a core knowledge base for all students. He calls for standardizing the curricula that different schools use with the aim of establishing a core knowledge base for all students, and for including non-fiction reading material that can introduce students to concepts as they master reading. Although Hirsch focuses on knowledge effects on comprehension to support his curriculum, the results from this dissertation show that general world knowledge can also lead to better word identification and fluency.

These findings also have implications for instruction and intervention. Several knowledge-based interventions have shown increases in comprehension (cf: Graves, Cooke, & LaBerge, 1979; McKeown, Beck, Sinatra, & Loxterman, 1992). McKeown, Beck, and Blake (2009) compared two types of instruction to build comprehension skills, strategy-based, and content-based. Strategy-based instruction involves teaching a reader general skills to use when reading and comprehending a text (e.g. how to summarize text, how to pick out main ideas). Content-based instruction involves open discussion between the teacher and student of the ideas presented in specific texts, where they connect that information with background knowledge. McKeown et al. found that the content-based instruction led to greater comprehension, suggesting that instruction that builds general world knowledge and how to connect that information with texts they encounter can help build reading comprehension skills. While they did not assess word identification, the results from this dissertation indicate that such instruction might also build word identification skills in addition to comprehension skills.

In the realm of education, educators are often faced with the daunting task of balancing explicit literacy instruction with other class curriculum. The results from this dissertation show that gaining knowledge may be another way to build literacy skills. Instruction in content areas should thus not be viewed as taking time away from literacy but as a potential addition to it (Hirsch, 2006; Kamhi, 2007).

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Appendix A
Passages for Study 1 and 3

Amelia Earhart

Amelia Earhart was an adventurer and a pioneer in the field of flying. She did things no other woman had ever done before.

During World War I, Earhart worked as a nurse. She cared for pilots who had been hurt in the war. Earhart listened to what they said about flying. She watched planes take off and land. She knew that she, too, must fly.

In 1928, Earhart was the first woman to cross the Atlantic in a plane. But someone else flew the plane. Earhart wanted to be more than just a passenger. She wanted to fly a plane across the ocean herself. For four years, Earhart trained to be a pilot. Then, in 1932, she flew alone across the Atlantic to Ireland. The trip took over fourteen hours.

Flying may seem easy today. However, Earhart faced many dangers. Airplanes had just been invented. They were much smaller than our planes today. Mechanical problems happened quite often. There were also no computers to help her. Flying across the ocean was as frightening as sailing across it had been years before. Earhart knew the dangers she faced. However, she said, “I want to do it because I want to do it. Women must try to do things as men have tried. When they fail, their failure must be a challenge to others.”

Earhart planned to fly around the world. She flew more than twenty thousand miles. Then, her plane disappeared somewhere over the huge Pacific Ocean. People searched for a long time. Finally they gave up. Earhart and her plane were never found.

Adapted from Scott, Foresman Social Studies, Grade 4: Regions of Our Country and Our World (Glenview, Ill.: Scott, Foresman and Co., 1983), p. 83.

The Octopus

Some people think of the octopus as a giant creature. They have seen this in science fiction movies. They think the octopus is a mean creature who attacks people and other animals. The octopus is really a shy animal. It is usually quite small.

The octopus has eight arms. Its name tells us this because “octo” means eight. The octopus uses its arms to walk on the ocean floor. Its arms are also used to capture crabs. Crabs are its favorite food. The octopus bites into the crab with its strong beak. This sends poison into the crab's body.

The octopus protects itself in three ways. First, when frightened, the octopus can push water from its body in a powerful stream. This action pushes the octopus forward very rapidly. This allows it to escape.

Second, the body of the octopus has a special sac or pouch that holds a dark, ink-like fluid. When an enemy comes close, the octopus squirts some of this fluid. It then swims away. All that the predator sees is a dark cloud in the water where the octopus was. Meanwhile, the octopus has escaped.

Finally, the octopus's body changes color when the octopus is excited or frightened. Suppose an octopus sees a crab. Patches of pink, purple, or blue will appear on the octopus's skin. Suppose the octopus sees an enemy. The octopus will completely change color. Then it seems to disappear into the background of its hiding place. It is hard for the predator to find the octopus.

Appendix B

Recall Checklists

Amelia Earhart

Setting/Background

- Amelia Earhart was an adventurer.
- During World War I she was a nurse.
- She cared for pilots who had been hurt.
- Earhart watched planes take off and land.

Goal

- She knew that she must fly.
- Earhart was the first woman to cross the Atlantic in a plane.
- Someone else flew the plane.
- Earhart wanted to be more than a passenger.
- She wanted to fly a plane across the ocean.

Events

- Earhart trained to be a pilot.
- In 1932 she flew alone across the Atlantic to Ireland.
- Earhart faced dangers.
- Airplanes were smaller.
- Problems happened often.
- There were no computers.

- Earhart said women must try to do things as men have tried.
- Earhart planned to fly around the world.

Resolution

- Her plane disappeared over the ocean the Pacific Ocean.
- People searched for a long time.
- They gave up.
- Earhart and her plane were never found.

Recall Score _____

The Octopus

Main Idea

- ___ Some people think
- ___ the octopus is a giant creature
- ___ and a mean creature.
- ___ They have seen this
- ___ in movies
- ___ science fiction movies.
- ___ The octopus is shy
- ___ and small.

Details

- ___ The octopus has eight arms.
- ___ Octo means "eight."
- ___ It uses its arms
- ___ to walk
- ___ and capture crabs.
- ___ Crabs are its food
- ___ its favorite food.
- ___ The octopus bites
- ___ into the crab.
- ___ This sends poison
- ___ into the crab's body.
- ___ The octopus protects itself
- ___ in three ways.
- ___ First,
- ___ when frightened,
- ___ the octopus can push water
- ___ from its body.
- ___ This action pushes the octopus
- ___ forward
- ___ very rapidly.
- ___ This allows it
- ___ to escape.
- ___ Second,
- ___ the octopus has a sac
- ___ that holds a liquid
- ___ an ink-like liquid.
- ___ When an enemy comes close,
- ___ the octopus squirts fluid.
- ___ It swims away.
- ___ The predator sees a cloud
- ___ a dark cloud.

- ___ The octopus has escaped.
- ___ Finally,
- ___ the octopus changes color
- ___ when it is excited
- ___ or scared.
- ___ Suppose the octopus sees a crab.
- ___ Pink patches,
- ___ purple patches,
- ___ or blue patches
- ___ appear.
- ___ If the octopus sees an enemy,
- ___ the octopus will change color
- ___ completely.
- ___ It seems to disappear
- ___ into the background.

Recall Score ____

Appendix C

Passages for Study 2

Passage 5

A blue jay was perched on a limb looking for water. Having just flown a great distance, she was very thirsty. At that moment she happened to spot a water jar on the ground, so she flew down and tried to get a drink from the jar. But there was so little water in the jar that she was unable to drink. Just as she felt that she would surely die of thirst, an idea struck her. The jay gathered a pile of stones and began dropping them in the jar. Little by little the water rose and at last the jay could drink her fill.

Passage 6

The era of the cowboy came to an end as a result of changes in the cattle business. When cows roamed the vast ranges of the Southwest, the herd could not be rounded up without skilled riders on horseback. But with the invention of barbed wire, great stretches of ranchland were fenced into smaller ranches. Then the roundup was no longer a major event and cowboys became less important. The long trail drives to the north, in which the cowboy's skill at herding cattle was essential, also became a thing of the past. With the coming of the railroad, cattle could be shipped directly to market.

Passage 7

Many American farm workers have been aided by the efforts of a shy, patient man named Cesar Chavez. As a youth Cesar traveled from one farm to another picking crops as they ripened. Since his family had no permanent home, Cesar had attended thirty-seven different schools by the time he reached the seventh grade. As he grew older,

he became increasingly concerned about the poverty and suffering of the farm workers. He began speaking to groups of workers about their need for safer housing and better health care. He convinced the grape pickers in California to join together and strike for better pay and working conditions. A strong believer in nonviolence, he led many peaceful protest marches and organized the first successful farm workers' union in the United States.

Passage 8

Mark was delighted to obtain his deputy sheriff's badge, but now he nervously pondered the difficult undertaking ahead. As his first assignment, he had been appointed to escort a prisoner to the authorities in Preston, the county seat and the site of the impending trial. The cunning prisoner had previously eluded the law and led state troopers in hot pursuit before finally surrendering. Experienced officers had cautioned Mark that this was a treacherous and possibly violent criminal who would stop at nothing. According to reliable testimony and other evidence, he was guilty of several ruthless attacks for which his victims could offer no clear motive. But when the prisoner was delivered to Mark's vehicle, the young deputy was struck by his sympathetic appearance and courteous manner. It seemed utterly incredible to Mark that physical form and conduct could so perfectly conceal the true nature of a human being.

Passage 9

The entomologist had contemplated the hazards of working with this lethal strain of honeybee. Imported from Africa, these bees were high-strung and aggressive, quick to incite the entire colony when antagonized. Their excitability often provoked them to mass attacks that resulted in fatalities. Yet they produced extravagant quantities of honey,

sometimes double that of their more docile European cousins. By crossing African queens with the local European drones, the entomologist planned to stimulate honey output. He had taken precautions to prevent catastrophes by locating the experimental hives in a sparsely populated area and erecting grids that curtailed the bees' range. But as the entomologist detached a grid for a routine check of his wards, he absentmindedly crushed a stray worker. Instantaneously the murmur from the hive was amplified. A few sentinels emerged, pelting against his veil in admonition. Then the torrent broke. In a furor the swarm converged on their keeper.