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Functionally Illiterate Adults Resolve Reading Difficulties

Presented by Lexically Ambiguous Words: An Investigation of the Ability of

the Lexical Quality Hypothesis to Describe Differential Reading Skill

by

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ABSTRACT

The present study examined the characteristics of functionally illiterate adult readers' reading skill using the Lexical Quality Hypothesis (Perfetti & Hart, 2001). The quality of less skilled adult readers' word representations was expected to affect reading time differentially when compared with two control populations (skilled adult readers and children). Three populations were presented with balanced or biased lexically ambiguous words embedded into sentences that manipulated the location of disambiguating context. Participants' reading times were recorded for two regions: the target word and post-target region. Results were not completely consistent with the set of predictions. Location of context affected reading time. Target word meaning frequency affected readers' post-access processing of lexically ambiguous words. A stronger manipulation and increased sample size are likely to yield more significant effects and interactions among variables.

Functionally Illiterate Adults Resolve Reading Difficulties

Presented by Lexically Ambiguous Words: An Investigation of the Lexical

Quality Hypothesis' Ability to Describe Differential Reading Skill

Reading is a complex cognitive skill essential to one's social and

economic success. Typically, one perfects basic literacy skills in childhood, but

low literacy skills impair millions of adults' abilities to participate fully in society

worldwide. The United Nations Scientific, Educational and Cultural Organization

(UNESCO) estimates that 862 million adults worldwide are illiterate (UNESCO,

n.d.). The majority of the world's illiterate adult population is congregated in

South and West Asia, but illiteracy remains a pressing concern of first world

nations (Linnakylä, Malin, & Taube, 2004; National Center for Education

Statistics, 1993; Rassool, 1999).

In 1992, the United States Department of Education surveyed 26,000

adults in their performance on basic literacy skills. The National Adult Literacy

Survey (1992) estimated that over one third of American adults are functionally

illiterate. Functionally illiterate adults are individuals who are unable to use

reading, speaking, writing and computational skills in everyday life situations (A

more detailed discussion of the term "functional illiteracy" follows in the

Definitions of Literacy section). For example, functionally illiterate adults may be

unable to follow posted instructions or fill out an employment application

(Literacy Volunteers of Broome/Tioga Counties, 2005).

The manner in which low literacy skills interfere most markedly with

functionally illiterate adults' lives is by severely limiting their employment

options (Addis, 2003). Even for employed individuals, illiteracy comes at a high

personal cost. Adults with low literacy skills are faced several times a day with

the challenges of navigating a print-rich environment. At best, confronting this

obstacle can be embarrassing. At worst, it may be dangerous to lack literacy

skills. Looking up the local hospital's phone number in an emergency, or using

street signs to orient oneself in an unfamiliar neighborhood may be stressful for

literate adults. However, for adults with low literacy skills, these tasks may be

impossible (Purcell-Gates, 1995; Quigley, 1995). In consequence, a twofold stress

burdens low literate adults: they must anticipate the same inconveniences and

emergencies as literate adults, and cope with the additional stress that they may

not be able to resolve these situations easily or at all.

Functionally illiterate adults who are unable to overcome emergencies are

also limited in their abilities to look after their children. Further, these parents

may be unable to assist their children with schoolwork or read to them before

bedtime. Fortunately, parents' functional illiteracy does not compromise their

children's safety in these activities as it could during a medical emergency; it is

not imperative that parents provide their children with homework help and read

bedtime stories. However, there are many other motivating factors insisting that

adults acquire general literacy skills in order to survive in a society that presumes literacy.

Generational Illiteracy

Low literacy rates among parents present another significant, albeit less immediate, danger. Parents who have not mastered basic literacy skills are unable to reinforce effectively at home the reading skills to which their children are introduced in school. Elementary and middle school educators rely on parents to bolster the skills they introduce in the classroom. The growing body of research on family literacy concludes that there exists a critical need for parents to reinforce their children's literacy skills at home (Goin, Nordquist, & Twardosz, 2004; Gonzalez & Nelson, 2004; Weikle & Hadadian, 2004).

In a study by Haney and Hill (2004), parents were asked to report on the types of literacy activities in which they engaged at home with their preschool children. Children whose parents reported directly or indirectly teaching literacy skills at home performed better on tests of early literacy skills. Specifically, children who received some type of practice with writing at home scored significantly higher on tests of alphabet knowledge (letter identification) and beginning decoding skills (matching letter strings to spoken sounds) than children who lacked instruction writing written words (Haney & Hill, 2004).

Importantly, early reading success is a predictor of continued educational achievement. When parents read to their children, the children fare better in early reading instruction (Haney & Hill, 2004; Lee, 1986). According to a 2004 survey,

an estimated thirty- to forty-percent of preschoolers enrolled in a pre-elementary program at a community development center who experienced language delays had parents who were functionally illiterate (Primavera, 2004). The process of becoming literate begins before a child enters formal schooling. In particular, studies with low-income (Dearing, McCartney, Weiss, Kreider, & Simpkins, 2004) and Latino (see Ortiz, 2004 for review) families revealed that parental attitude toward literacy was positively associated with children's literacy performance.

If parents do not find literacy to be an important skill, or if they are unable to provide their children with the practice necessary to develop a satisfactory set of literacy skills, their children are disadvantaged in the classroom. Further, these children are likely to fall behind their peers in their reading skill in early grades. Small differences in children's reading ability in the early grades are magnified every subsequent school year, and they become much larger deficits by the time these children reach middle school (Cunningham & Stanovich, 1997; Maughan, Hagell, Rutter, & Yule 1994; Stanovich, 1986). This phenomenon has been termed the "Matthew effect," and identifies the tendency of children who experience early and continued reading difficulties to fall further behind their peers (Stanovich, 1986). Less skilled child readers have fewer experiences with reading, and thus have fewer opportunities to gain familiarity with printed text and practice reading. Children who fall significantly behind their peers in reading

skill are more likely to drop out of school in middle or high school (Denti & Guerin, 2004).

This pattern of generational illiteracy in American society must be broken. In an attempt to combat this cycle, several programs have been developed to promote family literacy as a whole. The Even Start program allows entire families to attend literacy classes together (C. Babkiewicz, personal communication, January 28, 2005; NCSALL, 2001). For a section of each class, adults learn with other adults and children with other children. Importantly, these programs integrate learning within a family, thereby enabling families to more conveniently reinforce at home the skills they learn in these programs (Garcia & Hasson, 2004).

Limitations of Adult Basic Education Programs

Low literate adults who decide to return to school are channeled through Adult Basic Education (ABE) programs. ABE programs provide a variety of instruction, ranging from English classes for students learning English as a second language through higher-level classes structured specifically to assist students in obtaining a General Education Diploma (GED) certificate. The GED is generally considered equivalent to completing a high school course load. Regrettably, these programs frequently fail adults with low basic skills in the most crucial aspects of literacy skill development. ABE instructors are presented with a diverse group of students with various needs (Amstutz & Sheared, 2000). In this sense, every ABE

classroom in western Massachusetts and nationwide is an aggregate of students' different ambitions and needs.

One student, for example, may have an extensive oral vocabulary, but poor spelling skills. Another student may quickly recognize and pronounce printed words, but she may be unable to write an organized paragraph. Some students are native English speakers; many more have learned English as a second language or simultaneously with another language. Many of the adult students enrolled in an ABE program after dropping out of middle or high school. These adults may enroll in ABE classes a few months after leaving high school, or several years may have passed before they return to school. Similarly, students range from age 16 to their mid-60s. As a result, in any given class, the students vary in several ways that inform the type of instruction that would best facilitate their learning (Amstutz & Sheared, 2000; L. Bay, personal communication, April 1, 2005; Quigley, 1995).

Unlike children enrolled in formal schooling, adult students in ABE classes attend class for only a few hours a day (Hoffman, 1980). Frequently, ABE classes instruct students only one day a week. Additionally, students may remain in classes that instruct at a level below their true capability if no vacancies exist in more advanced classes; ABE students may flounder in classes that are not challenging enough and lose interest in school altogether (Quigley, 1995). This is especially troubling in light of evidence that the success of ABE learners in particular is contingent upon instructors' ceaseless recognition and integration of

students' motivational level and self-concept of learning (Apel & Swank, 1999). Lastly, the instructional methods employed are perhaps the most troubling of the ways the current structure of ABE fails its learners: ABE students are instructed in methods developed for children (Hoffman, 1980; Quigley, 1995).

Definitions of Literacy

ABE class instructors are charged with the task of teaching their adult students "basic literacy skills." What is the nature of the task these men and women undertake daily? What, precisely, does it mean to be "literate"? To best develop instructional techniques to remedy the problem of illiteracy, a consensus definition of what it means to be "literate" in America would be useful. If we may visualize clearly a picture of the functionally literate adult reader, we will, in effect, catalog the skills and abilities considered essential for one's integration as a member of society.

Literacy itself is a socially constructed concept, and its definition varies according to historical and cultural contexts (Roman, 2004). The traditional definition of literacy required that "literate" individuals merely be able to sign their own names, read printed words, and perform simple mathematical calculations (Rassool, 1999). By this definition, literate individuals are not required to understand the material they read.

The former definition of literacy, now referred to as "basic literacy," was previously confined to basic reading and writing ability for pragmatic reasons: Historically, literacy has been the exception among Americans. The definition of

literacy has evolved in tandem with broad economic changes (CERI, 1992). Years ago, much of the American labor force held industrial and agricultural occupations. These professions had no literacy requirement to be completed satisfactorily (CERI, 1992; Rassool, 1999; Rush, Moe, & Storlie, 1986).

The United States recently has witnessed quick and broad technological advances nationwide. These recent developments appeared in many workplace environments as specific technologies to assist with labor-intensive duties. Employers frequently require their employees to master these technologies. Employees are often required to learn the required skills by consulting the accompanying manuals or other on-the-job materials. Researchers who have evaluated several of these manuals discovered that most are written at a high school reading level (Diehl & Mikulecky, 1980 as cited in Rush, et al., 1986).

Innovations in communication systems have remade American customs and increased the demand for a wholly literate America. The emergence of electronic mail, for example, has transformed the communication habits of families and businesses. The emergence of electronic mail and the World Wide Web place new demands on employees: employees are now required to engage in more complex communications with clients and coworkers. These technological changes contribute, overall, to making jobs more demanding (CERI, 1992; Rassool, 1999).

As a result of sweeping technological change, the former definition of literacy has matured into a set of criteria that more adequately captures the

complex set of behaviors associated with being "literate." The term "functional

literacy" was first coined by the US Army to distinguish servicemen who could

understand military commands at a basic level. This typically required a fifth

grade reading level (Sharon, 1973). In the following definition of "functional

literacy," the United Nations Education, Scientific and Cultural Organization

attempts to capture the complexity of this skill set:

> A person is functionally literate who can engage in all those activities in
> which literacy is required for effective functioning of his/her group and
> community and also for enabling him/her to continue reading, writing and
> calculation for his/her own and the communities' development (UNESCO,
> 1980).

Another definition of functional literacy, developed by the National Center

for Education Statistics (1993), identifies the characteristics required for young

adults to be considered literate. By this definition, literate people "[use] printed

and written information to function in society, to achieve one's goals, and to

develop one's knowledge and potential."

 As employer demands continue to evolve, so we must continually revise

the consensus definition of what it means to be literate in American society. The

term "functional literacy" captures the diverse array of skills an individual must

exploit in different combinations (Roman, 2004). In this sense, the notion of

literacy emerges as more of a continuum than a specific skill set one acquires. No

consensus definition of "literacy" exists, but most of the present definitions

converge on one fact: reading acquisition is an essential component of developing

literacy skills. An individual's ability to read and understand printed text must precede the development of any other associated literacy skills.

When adult students enrolled in ABE classes are asked what made them decide to return to school, their answers varied (Amstutz & Sheared 2000; Belzer, 2004). Some students cited the tangible goal of obtaining a GED certificate. Other individuals reported more abstract ambitions, such as a desire to improve the quality of life for oneself and one's children, to improve English skills, to hone one's mathematical skills, or to find a better job. ABE students pursue varying goals, but share a hallmark trait: these individuals are less skilled at reading than is expected of a functionally literate adult. Thus, it is the primary and fundamental obligation of ABE classes to provide these students with remediation in this basic skill (Thompkins & Binder, 2003).

Importantly, ABE classes and jobs place a high demand on students' and employees' reading skills. A 2004 study investigating at what level poor reading skills interfere with educational achievement revealed that poor reading skills have a strong negative impact on the lowest-performing quarter of all adults surveyed (Arnbak, 2004). I have hereto referred to ABE students as "functionally illiterate," but the basis for these individuals' discrepant overall literacy skills is insufficient basic reading abilities. Inclusion of the term "functionally illiterate adults" in the title of this paper purports an evaluation of these students' skills at large. However, the only blanket assumption we may make about the ABE student participants is that they possess lower basic decoding and comprehension

skills than adults considered "functionally literate." Acknowledging the varied individual strengths and weaknesses within this group on other literacy measures, I shall collectively refer to this group as "less skilled adult readers" from this point forward.

In order to develop effective, age-appropriate materials for ABE programs, we must first identify what instructional approaches succeed in adult education. For this reason, it is important to understand what differentiates less skilled from skilled adult readers. Further, we must assess in what ways children and adult beginning readers converge and differ in early reading skill acquisition. Nonetheless, this appraisal will be an onerous undertaking, since research on reading acquisition in adults is scarce. Until recently, investigations into each rudimentary reading skill's relative contribution to overall reading ability have focused almost exclusively on children.

Distinguishing Skilled from Less Skilled Readers

Acquisition of reading skill occurs through a combination of instructional support and practice. Skillful reading incorporates three elements: orthographic, phonological, and semantic representations of words (See Adams, 1990 for review). Orthographic representation refers to the specific spelling of a word, or the way a word appears in print. The phonological component of a word is the way it is spoken or pronounced. Lastly, the meaning of a word is its semantic component. For example, consider the word "apple" according to these three components. The orthographic representation of the word is as we just saw: apple.

Phonologically, "apple" is composed of three smaller sound units (termed phonemes), and represented as /æ/ /p/ /l/. The semantic element of "apple" is its real word representation and includes general details; it is a round, sweet fruit that grows on trees and may be red, yellow, or green.

The goal of reading is to extract meaning from text. As the first step in learning to read an alphabetic orthography such as English, an individual must master foundational ideas about the connection between printed text and speech (Juel, 1988; see Perfetti, 1986 and Rayner, Foorman, Perfetti, Pesetsky, & Seindenberg, 2001 for review;). First, one must understand that the letters present in printed text are symbols that correspond to spoken sounds. This component is termed "alphabetic understanding." Next, one must recognize that specific combinations of these spoken sounds amount to words. "Phonological recoding" refers to a reader's ability to use systematic relationships between letters and the sounds they represent either to retrieve the pronunciation of an unknown string of text, or to spell words he or she has heard spoken. Collectively, these two features are termed the "alphabetic principle" (Perfetti, 1984; 1986). Letter-sound knowledge is a prerequisite to effective word identification. Importantly, readers must master the alphabetic principle before developing any of the other skills associated with reading.

The definition of reading acquisition offered above should not present any controversy. The cumulative results of multiple reading studies spanning over forty years have confirmed this explanation. Several research teams have inquired

regarding how children learn to read (see Adams, 1990, and Rayner, et al., 2001 for review). Most research teams have approached the question of reading acquisition by exploring the differences between skilled and less skilled child readers. Indeed, many research teams have attempted to explain the nature of the differences between good and poor child readers within the same grade (Perfetti, Finger, & Hogaboam, 1978; West, Stanovich, Feeman, & Cunningham, 1983).

The results of the many studies with children indicated that the primary difference between skilled and less skilled readers is how well they are able to use letter-sound correspondence to identify words (e.g. Duncan & Johnston, 1999; Shankweiler & Fowler, 2004). Children identified as skilled and poor readers were presented with alphabetic (common words) or non-alphabetic stimuli (colors and digits), and instructed to name the stimuli with which they were presented as quickly and accurately as possible. No differences in response latency were found to exist between skilled and poor child readers when presented with non-alphabetic stimuli. For the alphabetic stimuli, children differed in vocalization latency: Skilled readers vocalized the words faster than the pictures, and less skilled readers took more time to vocalize words than pictures. Researchers concluded that these results eliminated the possibility that differences between skilled and poor readers are strictly the result of vocalization components. In sum, these results indicate that it is not word retrieval that is the main problem of the less skilled reader. Rather, the difficulty lies in accessing words from print (Perfetti, et al., 1978).

In another study, researchers explored vocalization latencies in skilled and less skilled child readers when they were presented with English words or pseudowords consisting of one or two syllables (Hogaboam & Perfetti, 1978). In one stage of the study, participants were given practice with the pseudoword stimulus set before the vocalization task; otherwise, no experience with the pseudowords was granted. Participants were given one of two types of practice: aural and printed experience with the pseudoword, or meaning assignment. For both skilled and less skilled child readers, vocalization latency decreased when the aural and printed experience with the pseudoword was provided, but giving meaning to the words did not have any effect on the amount of time participants took to respond. These results indicated that some difference in print-to-word decoding ability separates skilled from less skilled readers, and that these differences may not be explained entirely by skilled reader's prior experience with specific word units.

Indeed, there is ample evidence suggesting that a link exists between awareness of speech segments and successfully learning to read (see Liberman & Shankweiler, 1979 for a review). To distinguish the effects of age on phonemic decoding ability, children were administered a set of phonemic awareness tests several times in the course of a two year longitudinal study of first and second graders (Juel, et al., 1986). Children with poor phonemic awareness were disadvantaged in learning to read. Phonemic awareness scores at the beginning of the school year strongly predicted children's reading performance at the end of

the school year. In particular, children's abilities in spelling, word recognition, writing, and reading comprehension were affected.

Further, many students that were rated as having poor phonemic awareness were unable to read any nonsense words. These results suggest that it is necessary for children to develop phonemic awareness before they may adequately decode printed text (Juel, Griffith & Gough, 1986). If children have poor decoding skills, they have fewer opportunities to practice reading in school and outside of school. Consequently, as skilled readers sharpen reading skill through practice, already poor readers fall further behind (Juel, 1988). Additionally, in a recent study with fourth grade poor readers, a high level of phonological awareness was found to make a great contribution to readers' decoding ability (Betourne & Friel-Patti, 2003).

Calfee and his research team (1973) assessed children's phonemic awareness. Researchers asked children in kindergarten through twelfth grade to perform a series of tests in which they were required to manipulate the order of separate colored blocks that represented individual or combinations of sound sequences. The results indicated that from first through fifth grade, mastery of basic phonological skills differentiate skilled from poor readers. That is, poor readers at nearly every grade in elementary and secondary school have failed to master phonological skills (Booth, Perfetti, & MacWhinney, 1999; Calfee, Lindamood & Lindamood, 1973).

A great deal of evidence indicates how phonemic decoding ability largely distinguishes skilled from less skilled child readers. Does this pattern also describe the differences between skilled and less skilled adult readers? A 1994 study with college students explored the ways in which skilled readers at the college level differed from their classmates who did not read as well (Bell & Perfetti, 1994). College students were tested on a number of information processing and language comprehension tasks, including a lexical decision task, a spelling task, and several reading comprehension measures. During the lexical decision task, researchers presented participants with two variants of the task. One task required the participant to select the real English word from a pair including a homophone (to test orthographic skill), and the second task asked participants to decide which of two pseudowords could be pronounced as a real word (to test phonemic skill).

Skilled readers were better than less skilled readers at decoding real English words and pseudowords, especially on the orthographic decision task. The same differences were not observed between participant groups on the phonemic decision task. Although basic reading difficulties may arise from adult skilled readers' poor phonemic processing skills, this is not the only deficiency in their general word representation system. Instead, Bell and Perfetti (1994) asserted that less skilled adult readers have a lower-quality word representation system in general, with fewer good connections between spelling patterns and phoneme sequences.

Distinguishing the differences between skilled and less skilled college-aged readers has been the focus of several studies. The results of these studies are useful in distinguishing the differences between children's and adult's reading behaviors. However, the typical "less skilled" adult reader participant in these studies is truly a skilled college-level reader who reads at a lesser proficiency than his or her classmates. Unfortunately, the results of these studies are of little use to those who wish to uncover how functionally illiterate adults read.

Low Literate Adults' Performance on Reading Tasks

The vast majority of experimental research on reading acquisition has focused on children. Until recently, reading researchers have largely ignored adults learning to read. Consequently, there exists in the reading literature a significant deficit of studies in which researchers focus on adult beginning readers. A small, but growing, body of research with less skilled adult readers exists. The main purpose behind research teams' exploration of less skilled adults' reading skill has been to compare this population's reading behaviors to those with children.

Two adult populations were compared on their performance on a phoneme segmentation task originally tested with child participants (Liberman, Shankweiler, Fischer & Carter, 1974). Adults who had not learned to read failed at this task, while adults who were recently enrolled in some literacy education program succeeded (Morais, Cary, Alegria, & Bertelson, 1974). Each of these studies' results reinforced researchers' conclusion that poor adult and child

readers differed from skilled readers in their age group in the same way: phonemic decoding difficulties.

A recent study with Spanish-speaking low literate adults (Jiménez & Venegas, 2004) replicated a 1994 study with children (Stahl & Murray, 1994). Low literate adults were administered four tests of phonemic awareness: blending, isolation, segmentation and deletion. Of these tasks, the phonemic blending task seemed to provide the best determinant of adults' reading ability. That is, most adults who scored low on the phonemic blending task also scored low on a test of basic decoding skill (Jiménez & Venegas, 2004). Similarly, the results of another study with low literate inmates indicated that adults' performance was satisfactory on speech and listening tasks. However, adults performed poorly when asked to segment words into phonemes (Read & Ruyter, 1985).

A study by Pratt and Brady (1988) divided adult students enrolled in ABE classes into two groups: more skilled and less skilled readers. These students were tested on several measures of reading skill. These groups were found to differ on two levels of phonological awareness: Less skilled readers performed more poorly on these tests of phonological awareness than more skilled readers (Pratt & Brady, 1988). Researchers concluded that phonological awareness is related to reading skill in adults. This corresponds with the results of studies focusing on phonological awareness in children.

It is imperative that we establish an accurate and exhaustive profile of functionally illiterate adults' reading behaviors if we are to resolve the crisis adult

illiteracy presents in American society. To create a portrait of low literate adults'

reading skill, we cannot adhere exclusively to evidence displaying the similarities

between low literate adults' and children's reading behaviors. There are many

ways in which adult beginning readers differ from children. Differences in

cognitive ability, age, and experience in formal schooling may differentially affect

adults' reading skill development and strategies in resolving difficulties. Indeed,

some studies have compared low literate adults to children, explicitly to establish

the ways in which these factors affect reading skills. In fact, these studies have

uncovered some differences between the two groups' reading strategies

(Greenberg, Ehri, & Perin, 1997; 2002; Thompkins & Binder, 2003).

Several research teams have focused on comparing adult low literate

readers directly with children who read at the same grade level (Greenberg, et al.,

1997; 2002; Thompkins & Binder, 2003). A 1997 study by Greenberg and

colleagues compared the performance of low literate adults to children matched

for reading grade level on phonologically complex tasks and orthographically

complex tasks. Phonologically complex tasks are those in which participants were

asked to read pseudowords aloud, pronounce a common word omitting one

phoneme, and segment words into individual phonemes. Tasks in which

participants were asked to read atypically spelled words aloud, select the "more

world-like" of a printed pair of nonwords, or select the more frequent position of

a letter within a word served as the orthographically complex tasks. Adults

performed more poorly than children on phonologically complex tasks. The two

populations' performance did not differ as greatly on the orthographically complex tasks.

In a more recent study by the same research team, researchers performed an error analysis of their 1997 data (Greenberg et al., 2002). Instead of examining less skilled adult readers' and children's performance differences on a battery of tests that focused on a number of skills associated with reading, in this study, researchers focused on the nature of the mistakes these two populations made when trying to develop the correct answer. This analysis revealed that the adults were less likely than children to use phonological strategies when confronted with reading difficulty. When they made reading mistakes, adults were more likely to substitute another real word for the one they misread. On the contrary, children's mistakes were the result of decoding errors. These results support the notion that adults were more likely to rely on orthographic or visual processes to guide them out of the difficulty (Greenberg, et al., 2002).

Despite evidence that these groups differ in their reading strategies, specific aspects of reading skill acquisition present similar challenges for both children and adults learning to read. In children, reading problems frequently arise because children have difficulty comprehending that the orthography of English represents phonological elements in speech (see Adams, 1990 and Stanovich, 1986 for review). Recent research with adult learners illustrated that adults also have difficulty decoding the printed word. Additionally, this difficulty is sometimes complicated by general word comprehension difficulties (Thompkins

& Binder, 2003). Perfetti and Marron (1995) have further suggested researchers have previously underestimated the extent to which adult learners' word recognition and decoding skills are deficient. This area warrants more research to tease out their precise nature, and the relationship of phonological and orthographic ability to general reading skill.

Generally, adults have greater general world knowledge and more experience with the spoken language than children. Moreover, children may have a more pronounced redundancy between spoken language and orthographic-to-phonological mappings as a result of recent phonics mapping. Though both groups may have poor lexical representations, the sources may differ. Therefore, the experience of learning to read might be different for children and adults. If we apply knowledge of these differences between adults and children learning to read, we may begin to develop an alternative model of reading acquisition that accommodates these important differences.

To Learn How Adults Acquire Reading Skill, Study Adults

The preceding review delineates and attempts to characterize the precise differences between skilled and less skilled child readers. Further, the similarities and differences between children and adult beginning readers were explored. Several studies have pointed to well-developed phonological awareness as the chief contributor to skilled reading. Although research on phonological awareness highlights an important difference between skilled and less skilled readers, these data are correlational. They serve to illuminate a consistent connection between a

specific aspect of reading and overall individual reading skill, but do not successfully inform any supplementary explanation of this reliable effect.

Simply put, empirical evidence alone cannot address or explain the intricate manner in which individuals of various reading ability differ, even when such evidence outlines specific performance differences on certain reading tasks between skilled and less skilled readers. However, this evidence provides a framework from which researchers may conceive an integrated theoretical model to explain reader groups' differential strengths and weaknesses in reading skill. Importantly, if such a theoretical model is supported, this may elucidate a method by which individual discrepancies in reading skill within one population of readers may be eliminated. Further, such a model should provide an explanation for skill differences that exist across different age groups. Studies on differentially skilled elementary school and college level readers ignore such differences. This paucity of experimental research in this area begs the question: how do children differ from adults when both are learning to read?

There are many potentially significant distinctions between the life experiences of adults and children that may contribute considerably to each group's acquisition and improvement of reading skill. Adults and children vary in their levels of language experience, print exposure and cognitive development. Readers' discrepant life experiences may necessitate different approaches to reading instruction. Unlike children, adults have had extensive exposure to print in advertisements, business and street signs, television, clothing, packaging, and a

number of other sources (Purcell-Gates, 1995). Adults have also developed several important cognitive functions permitting them to employ logic, to develop arguments, and to troubleshoot and strategize (Hoffman, 1978). Through conversation with others and consumption of mass media outlets, such as radio and television, adults amass a considerable amount of experience with spoken language and assemble a sizable vocabulary. These experiences also serve to promote adults' acquaintance with syntax and language patterns, which could conceivably facilitate better reading comprehension.

Although age affords adults more experience with printed text and spoken language, they lack the formal reading instruction children receive in the classroom daily. Teachers instruct children in reading acquisition largely through phonics. Unlike adults, children are drilled on the phonics skills they learn in class, and are provided frequent opportunities to practice these and other reading skills (Adams, 1990; Juel, 1991). Children spend much more time in a learning-centered environment than adults do in ABE classes. Elementary school classes typically last for six or seven hours, five days a week, while ABE classes last at most only three or four hours. In several regions of the country, ABE students receive only one day of instruction a week. Required benchmark testing and holidays further diminish the amount of time ABE students spend in class (L. Bay, personal communication, April 1, 2005; Hoffman, 1980).

As illustrated, there are differences in the quantity and nature of reading instruction that children and adults receive. However, we should not ignore a

more basic difference between these groups: neural development. Recent neurocognitive research has addressed the ways in which neurological developmental differences affect adults' and children's lexical processing (Booth, Burman, Meyer, Gitelman, Parrish, & Mesulam, 2004). In one study, adults and children were presented with spelling and rhyming tasks, which were designed to test orthographic and phonological knowledge, respectively. As they completed these lexical tasks, their brain activity in specific regions were monitored. Greater activation was observed in adults than children when they performed a task requiring them to convert orthography to phonology, and adults tended to activate both systems even while they completed a task that did not require conversion. These results suggest that adults experience more interaction between these two systems during reading than children (Booth et al., 2004).

The ways in which adults and children vary greatly in their cognitive functions and life experiences are relatively easy to discern: Readers at different ages have different levels of exposure to word meaning and vocabulary, printed text, and immersion in phonics training. In these ways, reader groups' skills vary; legitimately, these distinctions may contribute differentially to reading acquisition in adults and children. Presently, programs intended to help low literate adults acquire reading skill are designed based on evidence from studies with children. These dissimilarities of life experience between these two populations are observable and specific, and thereby warrant further investigation to determine

the precise ways in which they differentially affect reading acquisition, and how instruction can cater to each population's needs.

The Lexical Quality Hypothesis

For reading to occur, an individual must skillfully incorporate all three elements of word representation: orthographic, phonological, and semantic. Perfetti and Hart (2001) use this construction to propose a model, termed the lexical quality hypothesis, to explain differential reading ability. They suggest that a reader's skill can be explained by the quality of his or her word representations. The level of success a reader has in associating the three constituents informs the quality of his or her representation for that word. Importantly, Perfetti and Hart (2001) assert that the term "constituent" better illustrates the non-hierarchical relationship among its components that each word represents: an unordered triple of its orthographic, phonological and semantic constituents.

High quality lexical representations facilitate skilled reading. What constitutes a high quality word representation? Perfetti and Hart contend that in order for a word's representation to be high quality, this representation must be "specific" and "redundant." Specificity is marked by a reader's ability to recognize a word's particular spelling. Notably, words' phonological representations serve as a bridge between the orthographic and semantic constituents. Word meaning should be uncovered from spoken language. In addition, meaning may be understood by mapping a word's orthography to its pronunciation. Spoken language and orthographic-to-phonological mapping

provide redundant phonological representations for a word. Taken together, these two comprise the "redundant" requirement of a high quality word representation.

Specific and redundant representations serve readers best. Simultaneous activation of the orthographic, phonological, and semantic elements of a word thereby minimize the chance that its individual constituents will co-activate elements shared with other words and word forms. For example, when a reader encounters a word in a sentence with two meanings, both are activated, but they do not reach consciousness at the same time. This is termed asynchronous co-activation. The resulting effect for the reader is confusion and a slower identification time for the word. Over time, the semantic constituent of the word is strengthened through exposure in relation to specific contexts of the text.

The Lexical Quality Hypothesis explains individual differences in reading skill by way of the varied quality of readers' lexical representations. That is, skilled readers have many specific and redundant, high quality word representations. Less skilled readers have fewer high quality word representations. However, Perfetti and Hart (2001) advise against the deterministic application of this standard; even skilled readers have low quality representations for some words. Skilled readers' better foundational resources in reading, such as decoding, spelling and grammatical skills allow them more opportunities to practice and develop their reading skill. This contributes to the divergence between skilled and less skilled readers' ability to resolve difficulty presented by a word for which they have a low quality lexical representation.

Even among skilled adult readers, individual differences in reading ability exist. A reader's particular level of experience with printed text, spoken language, and instructional support (specifically, phonics training) may correspond to his or her reading skill. That is to say, readers with a great deal of experience with printed text may perform better on tests of orthographic skill than readers who lack that experience. Similarly, readers who have recently received a great deal of phonics training are likely to possess a greater aptitude for phonological decoding. Age may influence the differences in readers' constituent strength: adults' print exposure may afford them a better orthographic constituent, while children's phonological constituent may be strong as the result of recent phonics instruction.

Typically, children have overall lower quality word representations, while adults have more of higher quality. However, it is not useful to use age as an exclusive predictor of readers' relative constituent strengths; differences in reader skill level exist for groups of readers at the same age. The lexical quality hypothesis may be useful to uncover differences between readers of different skill levels within the same age range. Specifically, this theoretical model may be useful to uncover the ways in which adult less skilled readers differ from children learning to read, and to determine their similarities with adult skilled adult readers.

The lexical quality hypothesis provides a novel perspective on the difficult endeavor of determining the ways in which skilled and less skilled readers vary. This model explains differences in reader skill more richly than the more

simplistic models of "garden variety" (Bell & Perfetti, 1994) poor readers. In these models, less skilled readers' limited reading abilities are explained by the idea that they have poorer cognitive function across the board (Palladino, Cornoldi, DeBeni, & Pazzaglia, 2001; Perfetti & Goldman, 1976). On the contrary, this model creates scaffolding that enables us to more completely and elegantly inquire about reading skill differences. The lexical quality hypothesis provides the framework within which to investigate the ways in which two sets of readers differ: skilled and poor readers in general, or, more interestingly, between groups of less skilled readers.

One approach used to explore the relative contributions of each lexical representation element (orthographic, phonological, and semantic) is to manipulate their relationships. Perfetti and Hart (2001) explained that for lexically ambiguous words, the qualities of these words' representations are compromised because there is a lack of one-to-one mapping between orthographic and semantic elements. These words have a single orthographic and phonological form with two or more semantic constituents. Lexically ambiguous words emerge as a useful tool to explore the validity of the lexical quality hypothesis, especially when we consider the differential development of constituents among different groups of readers.

Factors Affecting Ambiguity Resolution

American English is punctuated with ambiguity. A series of words may have multiple possible interpretations, or a single word may have more than one

meaning (see Simpson, 1984; 1994 for a review). Since linguistic ambiguity is ubiquitous in speech and print, it typically goes unnoticed by a listener or reader. Language ambiguity creates difficulty in selecting the correct meaning or interpretation of a sentence or word, despite the fact that we are oblivious to it in speech.

In particular, resolving lexically ambiguous words presents unique processing difficulties for readers, because they compromise the exclusive orthographic-to-semantic constituent inherent in unambiguous words. Lexically ambiguous words are those that share a spelling and pronunciation, but have two or more meanings. For example, the word "pitcher" is lexically ambiguous. For both meanings of the word (a container for liquids and player on a baseball team), "pitcher" has only one spelling and pronunciation. It was assumed that individuals used context to determine the appropriate meaning of lexically ambiguous words (Simpson, 1984), but other factors affecting meaning selection have since been revealed.

Several experimental studies have illustrated that meaning selection presents difficulties for skilled readers (Holmes, Arwas & Garrett, 1977; Olson & MacKay, 1974). When presented with two sentence fragments, participants take more time to complete reading the fragment that contains an ambiguous word than a fragment that does not (Olson & MacKay, 1974). Researchers assert that the increased response time associated with reading sentences that contain lexically ambiguous words indicates increased processing load.

In addition to lengthened processing time, Holmes and his research team (1977) suggested that an individual's recall ability is hindered when he or she must elect one of two or more meanings of a lexically ambiguous word. In this study, participants read sentences sequentially as they were presented at a high rate. When asked to recall as much of each sentence as possible, participants recalled sentences with ambiguous words consistently more poorly than they recalled sentences that did not contain ambiguous words. These results provide evidence for the idea that selecting meaning is an attention-demanding task; while one is determining which meaning of two is appropriate, an individual's attention is diverted from other tasks.

In the past three decades, researchers have proposed several comprehensive models and experimental support to elucidate the particular processes that govern resolution of lexically ambiguous words (Simpson, 1984; 1994). Numerous investigators and research teams have concluded that two factors bear significant influence on how meaning selection is resolved: the word's relative meaning frequency and the sentence's contextually biasing information (Binder & Morris, 1995; Duffy, Morris & Rayner, 1988; Rayner, Pacht & Duffy, 1994).

A lexically ambiguous word's relative meaning frequency refers to how likely each of its meanings is to occur (Dopkins, Morris & Rayner, 1992). The term balanced means that a lexically ambiguous word has two or more equally likely meanings. Lexically ambiguous words are termed biased if one meaning is

significantly more likely than the other(s). In a study using eye fixation patterns, Rayner and Duffy (1986) noted that readers fixated on balanced ambiguous words for more time than they fixated on biased ambiguous words when the biasing context followed the target word. This prolonged fixation indicates more processing is necessary when one reads an ambiguous word in a sentence than when one reads an unambiguous word. Furthermore, they posited that the extra processing was necessary to select the proper meaning of the word in that specific context, out of all the meanings activated. Other studies tracking readers' eye movements illustrate that resolution of a lexically ambiguous word takes more time.

Duffy and colleagues (1988) illustrated that relative meaning frequency interacts with context. Participants' eye fixation patterns were recorded as they read a sentence that contained one lexically ambiguous target word or an unambiguous control word. In addition to the type of target word present, each ambiguous word was either balanced or biased, and disambiguating context came before or after the target word. Participants read sentences that varied in three ways: type of target word (ambiguous or control), type of ambiguous word (balanced or biased), and location of disambiguating context (before or after target word). The present study replicates this design.

Researchers noted the duration of a reader's gaze on the target word in a sentence. Additionally, total reading times were calculated for the lexically ambiguous target word, the disambiguating region, and from the end of the target

word to the clause boundary. The results of this study imply that sentence context

plays an important role in the meaning selection in lexically ambiguous words.

Readers looked at the disambiguating region of the sentence longer when the

target word was ambiguous, especially if it was a biased ambiguous word. If the

ambiguous word was balanced, participants read it as fast as the corresponding

control word, as long as context came before (Duffy, et al., 1988).

Rayner and Frazier (1989) conducted a study similar to that of Duffy and

her research team (1988). These researchers also explored how readers process

ambiguous words when they are preceded by a neutral or disambiguating context.

Instead of substituting unambiguous control words for ambiguous target words,

however, researchers compared participants' fixation times on ambiguous words

when either the word's dominant or subordinate meaning was instantiated in the

sentence frame. For preceding neutral context, readers looked at balanced

ambiguous words for more time than their unambiguous biased counterparts.

Furthermore, participants spent longer looking at the disambiguating region of the

sentence when it instantiated the subordinate meaning of a biased lexically

ambiguous word (Rayner & Frazier, 1989).

When presented with a lexically ambiguous word after a neutral context,

readers access all meanings of the word. These meanings compete for selection,

which inflates a reader's processing time (Onifer & Swinney, 1981). Further,

readers' processing time of the disambiguating region was prolonged. This can be

explained by the chance that some proportion of readers selected the incorrect

meaning of the lexically ambiguous word and they had to revise their initial interpretation of that word's meaning (see Morris & Binder, 2001 for a review).

The experimental results delineated above and their implications for processing demonstrate the difficulty facing skilled readers as they select the proper meaning of a lexically ambiguous word. In their presentation of the lexical quality hypothesis, Perfetti and Hart (2001) acknowledged that if it is possible for meaning selection to confuse skilled readers, less-skilled readers are at an even higher risk for confusion. When readers are presented with many difficulties in reading, the opportunities to practice and improve reading skills are thereby limited. Perfetti and Hart (2001) suggested a view of the interconnected nature of reading skill acquisition: Lexical skills facilitate reading comprehension, comprehension encourages reading practice, and reading practice reinforces lexical skills and word recognition. According to this model, each component of reading skill is closely associated with another skill or set of skills.

Applying the Lexical Quality Hypothesis Across Age and Skill Level

In the present study, I employed Perfetti and Hart's (2001) lexical quality hypothesis to develop assumptions about how differential reading skills among three groups of readers would affect performance when reading sentences containing lexically ambiguous words. The lexical quality hypothesis posits that a reader's skill level results from the quality of his or her word representations. A high quality representation is the consequence of a close association among the three constituents of which word representations consist: orthographic,

phonological, and semantic. Importantly, each constituent plays an equal role in a word representation's quality. Perfetti and Hart predicted that if one constituent weak, an individual's reading behavior is impaired. However, the pattern of this impairment will vary depending on which constituent's quality is diminished.

In an earlier discussion, I briefly outlined the manner in which age and experience with formal reading instruction differentially affect less skilled readers' ability. We may use the lexical quality hypothesis to explain the individual differences between skilled adult readers. Importantly, we also use this hypothesis to explain overall differences between reader groups of differing skill. In this interpretation, differential life experience affects lexical constituent strength. The comparison of interest is between less skilled adult readers and children.

An explanation of the ways in which a reader's age influences the relative strength of each of the three constituents is offered above. Adult readers have more experience with spoken language and a larger vocabulary than children. Additionally, older individuals have been presented with more opportunities to improve their vocabulary and become familiar with rules of syntax and grammar. These experiences serve to bolster older readers' command of word meanings, and impart adults with an overall better-developed semantic constituent. Additionally, adult readers have greater exposure to the printed word than children, which likely contributes to an overall stronger orthographic constituent.

Children have had fewer opportunities to strengthen their semantic constituents. Although they are disadvantaged by their comparatively minimal experience with spoken language and opportunity for vocabulary acquisition, children benefit from the formal reading instruction they receive in school. Since they have more recently received phonics training, children likely have a better-developed phonological constituent than adults. They have been given ample opportunity to hone these skills through recent formal phonics instruction in the classroom. Upon encountering an unfamiliar word, children should be able to employ the skills they have acquired through phonics instruction to determine its pronunciation. Although they have had relatively limited opportunity to develop their semantic constituents, children have likely developed strong phonological constituents for many words.

On the other hand, adults are more likely than children to have a better-developed orthographic constituent. Printed text is ubiquitous in an adult's daily life: Adults must survey advertisements, written instructions, and street signs to navigate themselves, even when they cannot understand the words that these print sources present.

I examined participants' reading time on lexically ambiguous words, recording how long each participant spent reading the target word in a sentence, and the region of the sentence following that target word. The target word time served as a measure of the difficulty participants had initially accessing a word's meaning. The post-target region time measured post-access difficulties with

meaning reconciliation. Since they assess reading difficulties associated with initial meaning access, and post-access processing, together, these two measures provide a more thorough examination of the ways that readers' with differential skills resolve difficulties presented by the lexically ambiguous word in the sentence.

Hypotheses

Participants in this study consisted of adult beginning readers, adult skilled readers, and children of varying reading levels. I drew upon the lexical quality hypothesis' concept of differential constituent strength to make several predictions about the relative speed of each reader group's performance within four different experimental conditions.

Hypothesis 1: Sentences in which a balanced lexically ambiguous word appears after disambiguating context. Since skilled readers have a high quality representation for the balanced word, both meanings will be simultaneously and efficiently activated. Longer reading times on the target word in a sentence would indicate that the reader experienced difficulty initially accessing the meanings of the word, while shorter times indicate little meaning access difficulty. Since processing difficulties presented by specific words in a sentence are not resolved immediately, the effects of readers' processing often "spill over" beyond the time spent reading that word alone, as a reader selects the appropriate meaning of the target word and integrates this meaning into the context of the sentence. For this condition, because the word is preceded by disambiguating context, the correct

meaning should be selected almost immediately, and we would observe few spillover effects of processing into the post-target region. I expected that skilled readers would not process the balanced target word differently than a control word preceded by neutral context. Thus, reading time on the target word and post-target region should be relatively short.

For less skilled adult readers and children, processing times should be inflated because both groups possess a low quality lexical representation of the balanced word. I did not predict significant differences between these two groups' reading time on the target word and post-target region.

Hypothesis 2: Sentences in which a balanced lexically ambiguous word appears after neutral context. Skilled readers' high quality representation of the balanced word permits activation of both meanings of the word. Despite the quick activation, the correct meaning may not be selected until the reader reads the post-target region. Thus, I anticipated that for skilled readers, time spent reading the balanced lexically ambiguous target word in a sentence would be inflated when the disambiguating context followed, rather than preceded, the balanced word. Further, I predicted an inflated reading time for skilled readers reading the post-target region of the sentence when neutral context preceded the balanced word.

Since less skilled adult readers and children have low quality lexical representations, access to word meanings are delayed. As a consequence, the difficulty presented by selecting the appropriate meaning of a balanced lexically ambiguous word meaning selection takes longer to surface, especially when it is

preceded by neutral context. Therefore, I did not predict an inflated reading time for either group when they read the target word in a sentence.

Less skilled readers, regardless of age, are expected to have a slower processing time on selecting the appropriate meaning of a balanced word. These readers' processing difficulty is likely to emerge in the post-target region, as they struggle to select the appropriate word meaning. Importantly, less skilled adult readers have a better-developed semantic constituent than children. This likely allows less skilled adults to use the context of the sentence more efficiently to select the appropriate meaning. As a result, I expected to see longer processing times in the post-target region of the sentence for both less skilled reader groups, but that adults might be able to resolve this difficulty more quickly.

Hypothesis 3: Sentences in which a biased lexically ambiguous word appears after context instantiating its subordinate meaning. There is evidence revealing that, when presented with a biased word after context that instantiates the subordinate meaning of that word, skilled readers spend more time reading that biased lexically ambiguous word. The inflated processing time is thought to be due to the competition between the two meanings. I anticipated that both populations of less skilled readers (children and less skilled adults) would have an inflated reading time on the biased lexically ambiguous word in the sentence, since they must select between the activated meanings.

Low quality lexical representations prohibit less skilled readers from experiencing the same difficulty when reading the target word, since they do not

access both meanings as efficiently as do skilled readers. For this reason, less skilled readers are more likely to be influenced by the preceding context when selecting the appropriate meaning of a biased word. When less skilled readers read a biased word after context that instantiates the subordinate meaning, the processing difficulty presented by initial meaning access should spill over into the post-target region of the sentence, even though readers have been alerted to the appropriate meaning. Less skilled readers should have spent less time on the target word, but more time on the post-target region, than skilled adult readers.

Hypothesis 4: Sentences in which a biased lexically ambiguous word appears after neutral context. In the absence of biasing context, readers automatically retrieve the dominant meaning of biased lexically ambiguous words, and spend longer reading disambiguating context instantiating the subordinate meaning of the word when it follows that word in a sentence. Researchers believe that this is an indication of readers' revision of their original meaning selection. Less skilled adult readers' cognitive abilities are better developed than children's. I predicted that application of these cognitive mechanisms would permit them to use context more efficiently, and doing so would assist their release from confusion about which is the correct meaning.

Summary

This study explored how three factors affect resolution of lexically ambiguous words: target word in sentence (lexically ambiguous or non-ambiguous word), type of ambiguity (balanced or biased lexically ambiguous

word), and location of context (before or after target word). Further, I investigated these variables across three demographic groups: adult less skilled readers enrolled in area ABE classes, adult skilled readers enrolled at Mount Holyoke College (to provide an age-matched control), and elementary school children in fourth through eighth grade (to provide a grade level-controlled match with adult less-skilled readers).

METHOD

Participants

Eighty-six adults and children participated in the present study. Participants were recruited from three different population groups: adult less skilled readers, adult skilled readers, and elementary or middle school aged children. The 25 adult skilled reader participants were Mount Holyoke College (MHC) students, while the 31 participating less skilled adult readers and 30 children were learners enrolled in Adult Basic Education (ABE) classes and public elementary and middle schools in Western Massachusetts, respectively.

MHC students were recruited by word of mouth and posted signs. The ABE and elementary and middle school students were recruited by contacting educators and administrators at area schools. Additionally, child participants were recruited through word of mouth by contacting their parents. Participants were offered an appropriate incentive to participate: MHC students received research participation credit; ABE learners received $5 cash; and children received a $5 gift certificate to a retail chain.

MHC student participants were of traditional college age (18-23 years) or Frances Perkins Scholars (24 years and above), with an average age of 22.2 years. The adult participants enrolled in ABE classes ranged in age from 18 to 54, with an average of about 31 years of age. Children who participated in this study

ranged from 8 to 14 years. The average age of children participants was 10.6 years.

Adult beginning readers' scores on the Tests of Adult Basic Education (TABE) assessment were obtained from their school. The TABE assessment contains four content areas (reading, language, spelling, and math), each of which generates an independent TABE score (CTB, 1994). The combined scores from these content areas are translated into a Grade-level Expectation (GLE) score. This GLE score indicates at what grade level an individual reads. For example, an ABE student with a 4.5 GLE score reads as well as a fourth grade student in the fifth month of school. ABE students' GLE scores ranged from 2.8 to 12.6, with an average score of 6.99. Elementary school-aged students were the approximately reading level-matched control group. These children participants were in third through eighth grade, and the average grade level was 5.6. MHC students provided an approximately age matched-control group for the less skilled adult readers.

Paired samples t-tests were performed to assess if the control populations were appropriately matched to the adult less skilled reader population. There was a significant age difference between the adult less skilled readers (M=29.8) and the skilled reader population (M=22.2), $t(25) = 4.12$, $p < 0.05$. Additionally, there was a significant difference between the children participants' grade level (M=5.04) and adult less skilled readers' GLE scores (M=7.25), $t(25) = 3.45$, $p <$

0.05. The children and adult skilled readers provided approximate matches for reading level and age.

The adult skilled readers were primarily native English speakers. Of the sample, 88% learned English as their first and only language or with another language simultaneously. Of the less skilled adult reader participants, 60% were native English speakers or learned English with another language simultaneously, while 40% learned English after their native language. Predominantly, the bilingual ABE participants learned English and Spanish as native languages. Of those ABE students who learned English after their native language, 90% were native Spanish speakers. Participants were not asked to rate their literacy skills in their native language.

Materials

Stimuli

Sixteen lexically ambiguous target words were used in this study (see Appendix A). Eight of these target words were balanced ambiguous words, and eight were biased ambiguous words. All target words were nouns.

Norming task. Two norming tasks were completed for all demographic groups included in this study. One task verified the identity of each ambiguous word as biased or balanced. The other task ensured that participants in all demographic groups knew both the dominant and subordinate meaning(s) of biased lexically ambiguous words. These tasks are described below.

Fifty adult skilled readers and 21 children completed both subtasks of the norming task: the word association task and the definition task. Participating adult less skilled readers completed either the first or second subtask. Sixty-nine ABE students participated in the norming task: 37 completed only the first task, and 32 completed only the second. Participants in each population were offered the same incentive to participate as previously described.

Adult skilled readers performed the word association task differently than adult beginning readers or children. Adult skilled readers completed the word association task in a web form online. Participants were directed to the form's URL, where they read the informed consent form (see Appendix B) and submitted their digital signature in a blank text box. They then proceeded to the word association task within the same form. The participant was presented with 90 lexically ambiguous and non-ambiguous target words (see Appendix C), and asked to report the first word that comes to mind in a blank text field. They were then asked to use the target word in a sentence and type it in another blank text field (see Appendix D).

The same task was administered to adult learners and children, but it was not online. Instead, the task was administered in an interview style. The researcher instructed the participant verbally and recorded their responses on an audiocassette tape. For example, I said, "I'm going to give you a word. Please say the first word that comes to mind, and then use the word I just gave you in a

sentence." The researcher then began to read 90 target or control words one at a time (see Appendix C).

Adult skilled readers have well-developed writing skills, which enabled them to respond to the word association task by typing their answers. However, if an adult beginning reader or elementary school-aged child had limited writing ability, this deficit may have interfered with their ability to respond in this way. Therefore, to eliminate potential confounds presented by limited writing ability, this task was conducted differently for adult beginning readers and children than for adult skilled readers. Further, children were asked to respond to a 54-word, abbreviated version of the 90-word list with which adult participants were presented (See Appendix E).

The word association norming task ensured that the selected biased and balanced target words are truly balanced or biased for each of the three participant groups (See Appendix F). Ordinarily, a biased word is one for which about 80% or more of participants in each demographic group initially report one meaning (termed the dominant meaning), while less than 20% report another meaning (termed the subordinate meaning). Usually, a balanced word is one for which approximately half the participants in each demographic group initially report one meaning of the lexically ambiguous word, while half report the other meaning.

Of the eight biased lexically ambiguous words selected for use in the study, 81% of participants, on average, initially reported the dominant meaning. On average, 55% of participants reported the more prevalent meaning of the

balanced lexically ambiguous words used in the present study, while 45% of participants gave the uncommon meaning (see Appendix G).

Participants also completed the definition norming task (see Appendix H). A researcher presented the adult participants with each of 90 target and control words, and children with 54 target and control words. Participants were asked to report all the meanings he or she knew for that word. This task was conducted in exactly the same manner for all participant groups. Participant responses were documented on an audiocassette tape recorder and also marked in the researcher's notes.

The definition norming task established that all demographic participant groups were familiar with the ambiguous target words, that is, that participants in all demographic groups had in their lexicons the subordinate meaning of the biased words used in the experimental procedure. To assess the disambiguating context's significance in resolution of lexically ambiguous word meaning, it was necessary to employ the subordinate meaning of a biased word. It follows that participants must understand the subordinate meaning of the word for the measure to be accurate.

Lexically ambiguous word selection. The results of the word association norming task generated sets of biased and balanced lexically ambiguous words for each population. Words for which the identity of balanced or biased was preserved across all three demographic populations were candidates for inclusion in the study. For biased lexically ambiguous words to be eligible for use in the

study, they must have had the same dominant and subordinate meanings across all three populations.

On average, 81% of participants initially reported the dominant meaning of the biased lexically ambiguous word selected for use in the study (see Appendix G). However, across all populations, the proportion of participants that initially reported the dominant meaning of the biased words ranged between 50 and 100%, while up to 50% of participants reported the other meaning (see Appendix F). Similarly, dominant and subordinate meanings emerged for each balanced word selected for use in the study. For balanced words, 55% of participants reported the more dominant meaning of the word and 45% reported the more subordinate meaning, on average (see Appendix G). The percentage of participants reporting each meaning of the selected balanced lexically ambiguous words ranged, much like participants' biased word responses. Across all populations, participants initially reported the dominant and subordinate meaning between 50 to 70% and between 30 and 50%, respectively (see Appendix F). For a word to be selected for use in the final study, about 60% or more of participants in the ABE and children population groups must have reported knowing all meanings of the ambiguous word in the definition norming task. Across all participant groups, there was a 73% comprehension rate for all meanings of the biased lexically ambiguous words, and 72% for the balanced words (See Appendix H)[1].

For example, over 80% of participants in all three populations reported that the first meaning that came to mind when presented with the lexically ambiguous word "ruler" was a wooden or plastic tool used for measuring twelve inches. Fewer than 20% in any population reported that the first thing that came to mind was a king or monarch. Additionally, over 60% of ABE and children participants reported knowing both meanings during the definition norming task. The other 15 words used in the present study conformed to the same criteria (See Appendices F & H).

Sentence frames. Once categorized as biased or balanced, 16 lexically ambiguous target words (8 biased, 8 balanced) were embedded into fitting sentence frames written by the principal researcher. Two sentence frames were written for each ambiguous word used, and each participant read a version of each sentence frame. In one version, the participant saw the ambiguous word, and in the other version, he or she saw the control word. Thus, the same word or sentence was not repeated for a given participant.

Each sentence was written according to two criteria: The target word must be replaced by a non-ambiguous control word[2], and the sentence content must be rearranged easily. The control word must have replaced the ambiguous target word without sacrificing the sentence's soundness. Furthermore, each control word was matched with its corresponding target word in word length and frequency of occurrence in printed text (Francis & Kucera, 1982).

The control word and the target word were matched in terms of length and frequency of usage per million words in printed text (See Appendix I). Differences in frequency ratings were obtained for the target and control words (Francis & Kucera, 1982). To ensure a frequency match between the two words, the difference between frequency ratings for the target and control word never exceeded a specified amount. The relative frequency of the target word determined the size of the difference permitted between a target and control word's frequency rating. When the target word had a low frequency rating, it was necessary to replace it with a control word with a similar frequency rating. It was less important to match closely the frequency rating between target and control word when the target word had a very high frequency.

For example, if the target word had a frequency rating less than 20 occurrences per million words in printed text, it was classified as a low frequency word. Low frequency ambiguous target words were matched with control words with similar frequency ratings. These control words' frequency scores differed, on average, from their target word's score by about fifteen. Medium frequency words were those with a frequency rating of 30 to 100 occurrences in printed text per million words. These words were matched with a control word that differed by about 25, on average. Ambiguous target words with a frequency of 100 occurrences per million in printed texts or above were classified as high frequency words. High frequency target words differed from control words by 85, on

average. Finally, target and control words never differed in length by more than two letters.

A paired samples *t*-test was performed and confirmed that there were no significant differences between the frequency rating of biased ambiguous target words (*M*=208) and replacement control words (*M*=167), $t(11) = -1.51, p > 0.05$. Another paired samples *t*-test was performed for the balanced ambiguous words to ensure that there were no significant frequency rating differences between target (*M*=101) and control words (*M*=88.7), $t(10) = -.794, p > 0.05$.

Target and control words were matched for letter length. A paired samples *t*-test was performed and confirmed that there were no significant differences between the number of characters in the ambiguous biased target word (*M*=5.00) and its replacement control word (*M*=4.83), $t(11) = -.518, p > 0.05$. Another paired samples *t*-test was performed for the balanced ambiguous words to ensure that there were no significant character length differences between target (*M*=5.18) and control words (*M*=5.18), $t(10) = .000, p > 0.05$.

Each sentence's clauses could be shifted easily, such that the disambiguating context could have appeared in the sentence before or after the lexically ambiguous word. Further, the ambiguous target word or the unambiguous control word never concluded sentences in which the disambiguating context preceded the target word. Sentence frames that included biased lexically ambiguous words were written to accommodate the lesser-known meaning of the lexically ambiguous word (See Appendix J). Both sentence frames

that contained balanced lexically ambiguous words were written for the same meaning of the word, but either meaning may have been featured.

Biased ambiguous words were embedded into two sentence frames appropriate for the subordinate meaning of the word (see Appendix K). In the following examples, the biased lexically ambiguous word "club" is italicized, and its control word, "gun," follows in parentheses. Only the ambiguous target word *or* the control word appeared when participants read the sentences below. Sentences 1 and 3 below exemplify sentences constructed such that the context comes after the lexically ambiguous biased word. The context comes before the lexically ambiguous word in sentences 2 and 4.

(1) The magazine article mentioned the *club* (*gun*) the criminal used in the bank robbery on Saturday.
    (Lexically ambiguous word, Context after)

(2) In the bank robbery on Saturday, the criminal used a *club* (*gun*) that was mentioned in the magazine article.
    (Lexically ambiguous word, Context first)

(3) There were many different types of *clubs* (*guns*) in the closet of the police station, so Officer O'Brady was disappointed to learn he could carry only one at a time.
    (Lexically ambiguous word, Context after)

(4) Officer O'Brady was disappointed to learn he could carry only one at a time since there were many different types of *clubs* (*guns*) in the closet of the police station.
    (Lexically ambiguous word, Context first)

Similarly, balanced ambiguous words had two sentence frames that corresponded to each ambiguous target word. Since balanced lexically ambiguous words have two meanings that participants recall equally well, either meaning of

the word may have been instantiated. Again, the same meaning was instantiated in both sentence frames (see Appendix K).

Exhibited below are two sentence frames that were used for the word "pitcher." The unambiguous control word, "catcher," follows in parentheses. Here, "pitcher" refers to the player on a baseball team. In both sentence frames, the same meaning is instantiated.

> (5) Her favorite *pitcher* (*catcher*) dropped the ball during the last baseball game of the season.
>   (Lexically ambiguous word, Context after)
>
> (6) During the last baseball game of the season, her favorite *pitcher* (*catcher*) dropped the ball.
>   (Lexically ambiguous word, Context first)
>
> (7) Aaron did not notice the *pitcher* (*catcher*) was new until the announcer said his name at the end of the baseball game.
>   (Lexically ambiguous word, Context after)
>
> (8) Until the announcer said his name at the end of the baseball game, Aaron did not notice the *pitcher* (*catcher*) was new.
>   (Lexically ambiguous word, Context first)

One sentence frame written for the lexically ambiguous word "pitcher" appears in sentences 5 and 6 above. In sentence 5, the disambiguating context follows the target word in the sentence, and precedes the target word in sentence 6. The second sentence frame appears in sentences 7 and 8. Similarly, context follows the target word in sentence 7, and comes before the target word in sentence 8.

In the example sentences above, the same unambiguous control word replaced the lexically ambiguous target word in both sentence frames. For some

lexically ambiguous words two different control words were used. However, each matched the target word they replace in terms of length and frequency.

Apparatus

These sentences were formatted specifically so that they were available for use by a program written in C++ and operated in DOS operating system. Bill Kaiser wrote this program, entitled "movrnd". This program displayed the sentences in random order on a computer screen. Initially, the sentence was displayed as a series of dashes. Several segments of dashes appeared separated by blank spaces to represent words. Each dash represented one letter in the word or neighboring punctuation. Sentence nine, written for the biased lexically ambiguous word "pitcher" first appeared as a series of dashes as illustrated below:

--- -------- ------- ------- --- ---- ------ --- ---- -------- ---- -- --- -------

After the sentence's initial presentation as a series of dashes, the program displayed one word of the sentence at a time. Every word in the sentence was presented in order by tapping the space bar key. Therefore, the participant controlled the rate at which the individual words were presented.

I will refer to the displayed word as our word of interest. After each word of interest was seen, it was replaced by the original dashes. After the initial presentation of dashes, a press of the spacebar presented the following on screen:

Her -------- ------- ------- --- ---- ------ --- ---- -------- ---- -- --- -------

Another press of the spacebar revealed the following.

--- favorite ------- ------- --- ---- ------ --- ---- -------- ---- -- --- -------

With one more press of the space bar, the following was revealed.

--- -------- pitcher ------- --- ---- ------ --- ---- -------- ---- -- --- -------

When the final word in the sentence was displayed, a press of the spacebar revealed either the entire sentence in its dashed form or a comprehension question. Intervals between each spacebar press were timed and recorded by the program.

Procedure

Experimental Procedure

After written consent was obtained, participants read 62 sentences on a computer screen in random order. Adult participants read the consent form (See Appendix L) and gave written consent. Parents or legal guardians gave permission for their children to participate by reading a letter describing the study and signing the attached permission slip (See Appendix M). Thirty-two of these sentences contained a lexically ambiguous or unambiguous control word. Furthermore, the

target word's context came before or after it appeared in the sentence. The remaining 30 sentences participants read acted as filler sentences. These filler sentences were shorter and never contained ambiguous words (See Appendix N for examples).

Each sentence was displayed, one word at a time, on the computer screen as previously described. In initial practice trials, participants were instructed orally to read the sentence and to press the spacebar button on the keyboard when they wished to display the next word in the sentence. Every participant engaged in two practice trials. In the first, they were asked to watch as the principal researcher moved through a six-sentence practice run and explained how to operate the program and answer the comprehension questions displayed.

Participants completed a brief reading comprehension task to ensure that they understood the material they read. This task verified the validity of the reading time data. Participants were asked to answer 15 questions interspersed between the 62 sentences they read containing lexically ambiguous words or unambiguous target words (see Appendix O). The comprehension questions corresponded to the sentence frames written for each of eight lexically ambiguous words, amounting to 16 possible comprehension questions. For half of the questions pertaining to a sentence frame written for a biased lexically ambiguous word, an affirmative answer was correct. For the other half, a negative answer was correct. Similarly, half of the comprehension questions written for sentence

frames containing a balanced lexically ambiguous word had a correct affirmative

answer, and half had a correct negative answer (See Appendix O).

Comprehension questions also appeared after participants read some of the

filler sentences. If no question was associated with the sentence, the sentence

reverted to its dashed form after the participant read it completely. The reading

comprehension questions appeared on the screen immediately after the participant

read the sentence and replaced the appearance of the final dashed form. Data from

participants who answered fewer than 10 of the total of 15 questions correctly

were excluded from final analyses.

Child participants were orally debriefed after completing the task, and

adult participants were given a printed debriefing statement to read (See

Appendix P). Additionally, ABE student participants were verbally debriefed.

After debriefing, ABE student and children participants were awarded their

participation incentive.

Data Analysis

The "movrnd" program recorded the number of milliseconds each

participant spent reading each word in the sentence. Participants' reading times

were noted for two different regions in the sentence: ambiguous target word or

unambiguous control word, and the post-target word region of every sentence.

The total time participants spent reading words in the sentences that

followed the target words were summed. The length of the post-target region

varied greatly (both in the number and length of the words) between sentence

frames. To equate this across trials, the total sum was divided by the number of characters (excluding spaces and punctuation) in each post-target word region. A mixed model ANOVA was run on these data, in which participant group was the between-groups variable and the other variables were repeated measures.

RESULTS

This study explored the amount of time less skilled adult readers, children, and skilled adult readers spent reading a sentence that contained either a lexically ambiguous target word or an unambiguous control word. Participants read sentences that varied in three ways: type of target word (lexically ambiguous target word or unambiguous control word), type of ambiguity (balanced or biased lexically ambiguous word), and location of disambiguating context (context preceded or followed the target word).

For each sentence, each participant's reading time was calculated on two regions: target word or non-ambiguous control word, and post-target word region of the sentence. The amount of time one spends reading the target word in a sentence reflects his or her initial processing of that word. Longer reading times indicate meaning access difficulties presented by the word, while shorter times indicate little meaning access difficulty. Importantly, readers do not immediately resolve processing difficulties presented by specific words in a sentence. Often readers' processing of a specific word "spill over" beyond the time spent reading that word alone, as a reader selects the appropriate meaning of the target word and integrates this meaning into the context of the sentence. These effects manifest as prolonged reading time on the region of the sentence following that word. Consequently, a more adequate measure of the processing difficulty a target word

presents includes reading time on the region of the sentence following the target word in addition to reading time exclusively on that word.

The post-target region began immediately after the target word and continued to the end of the sentence. The length of the post-target region of the sentences varied greatly. To account for this variability, it was necessary to calculate the post-target region reading time value in the following manner: summing the number of seconds each participant spent reading each word following the target word in each sentence, and dividing by the number of characters (excluding punctuation and spaces) that total reading time represented.

This study used a 3 (participant group: less skilled adult reader, skilled adult reader, child) x 2 (target word in sentence: lexically ambiguous or non-ambiguous word) x 2 (type of ambiguity: balanced or biased lexically ambiguous word) x 2 (contextualizing region: before or after target word) mixed groups design in which participant group was the between-groups variable. A mixed measures factorial ANOVA was performed to determine significant differences in mean reading times between participant groups on two regions of the sentence: target word in the sentence and region of the sentence following the target word. Further, paired *t*-tests were performed to determine the nature of significant two-way interactions. A Bonferroni correction was used on all post-hoc tests.

Data Selection

Two standards were established before data collection began to ensure that only valid data were included in final analysis. All the data associated with a

participant were discarded if that participant was not on-task while reading the sentences, as indicated by an excessively long time. Next, an outlier analysis was performed on the remaining data, and specific instances were eliminated. Both data elimination strategies are described below.

For reading time data to reflect participants' processing difficulties accurately, it was important that they stay on task while reading the sentences. Comprehension questions appeared after several of the sentences, and required participants to give a correct affirmative or negative response. If a participant had many incorrect answers, this indicated that he or she was not paying attention to what was read or there were substantial comprehension difficulties. Data from participants who answered fewer than ten of the total fifteen comprehension questions correctly were eliminated from final analysis since their reading time data was considered an unreliable measure of processing time. Altogether, comprehension rates were high for each population. On average, adult less skilled readers answered 81.4% of the comprehension questions correctly. Children answered 88.8% correctly, and adult skilled readers scored 90.4% correctly on average (see Appendix Q).

Outlier data were eliminated using the following method. The mean and standard deviation were calculated within each sample for both regions of interest within the sentence: the target word and post-target word region. A specific cut-off level was determined for each sample, and participants' reading times that were higher than this level were eliminated. The cut-off level was established at

two standard deviations above the mean. For example, it took children .660 seconds, on average, to read the target word in a sentence, with a standard deviation of .420 seconds. Every instance in which a child took over 1.49 seconds to read the target word in a sentence was eliminated from final analysis.

In the same manner, cut-off levels were established for children when they read the post-target region of the sentence and for both regions of interest for the two adult populations (see Appendix R). If more than half of a participant's target word or post-target region reading times were above the specified cut-off level, he or she was eliminated from final analysis. The amount of data eliminated from analysis of either region of interest from all participant populations' data never exceeded 3.88% (see Appendix S).

Using the methods described above, data from 12 total participants were eliminated from final analysis. Six less skilled adult reader participants' data were discarded because they answered fewer than 10 comprehension questions correctly. Two children's data were discarded for the same reason. Additionally, one of the less skilled reader's data did not fit the criteria regarding outlier elimination, and this participant was therefore discarded. Lastly, three children's data were discarded resulting from a programming error. All the adult skilled reader participants' data were included in final analyses.

Ultimately, data from 24 less skilled reader participants' and 25 participants each from the skilled reader and child populations were selected for analysis. Each participant's reading time on the two regions of interest were

averaged by condition. These data were entered into SPSS and analyzed using a

mixed model ANOVA, in which participant group was the between groups

variable and the other variables were repeated measures.

Target word region of sentence

Target word reading times were recorded to assess readers' initial

processing difficulty presented by lexically ambiguous words. As predicted, there

were significant differences among the different groups of readers, $F(2, 71)=17.3$,

$MSE=3.65$, $p<.001$. Adult skilled readers ($M=.423$) spent significantly less time

reading the target word than the less skilled adult readers ($M=.686$), $p<.001$.

Adult skilled readers ($M=.423$) also spent significantly less time reading the target

word in a sentence than children ($M=.615$), $p<.001$. There was no significant

difference in the amount of time adult less skilled readers ($M=.686$) and children

($M=.615$) spent reading the target word in a sentence, $p>.05$ (see Figure 1).

Contrary to the expected results, there was no significant difference in the

time participants spent reading a lexically ambiguous target word or an

unambiguous control word in a sentence. However, as anticipated, participants

spent significantly more time reading the target word (whether ambiguous or

unambiguous) in sentences in which the disambiguating context followed the

target word ($M=.588$) than sentences in which the disambiguating context came

before the target word ($M=.561$), $F(1, 71)=10.4$, $MSE=.0110$, $p=.002$. Although a

difference was expected, reading times for participants who read a sentence

Figure Caption

Figure 1. Mean proportional reading time in seconds of the target word in

sentence as a function of reader participant group.
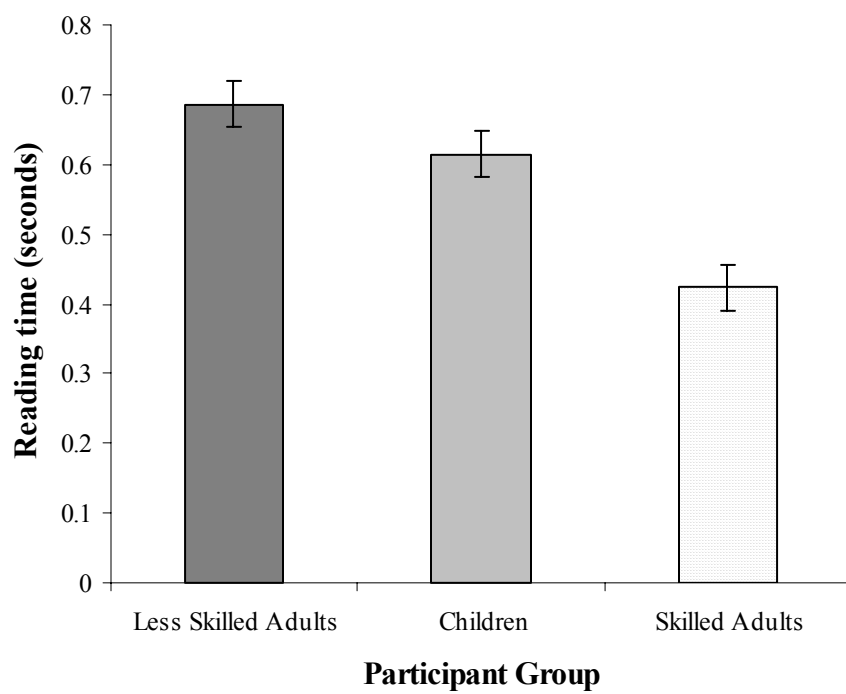
containing a biased lexically ambiguous target word or a balanced lexically ambiguous word were not significantly different.

None of the expected effects were observed between participant group and each of the repeated measures variables. There was no significant interaction between reader skill level and type of target word (lexically ambiguous target word or unambiguous control word) in the sentence. Nor was there a significant interaction between reader skill level and location of disambiguating context. Lastly, there was no significant interaction between reader skill level and type of lexically ambiguous word.

None of the repeated measures variables interacted with any one of the others, which contradicts the hypothesized results. There was no significant interaction between the type of target word a sentence contained (lexically ambiguous target word or an unambiguous control word) and location of the disambiguating context. Also, there was no significant interaction between the type of target word a sentence contained and the type of lexically ambiguous word (biased or balanced). Finally, there was no significant interaction between the location of disambiguating context in a sentence and the type of lexically ambiguous word.

There was no significant interaction between type of lexically ambiguous word (biased or balanced), location of the disambiguating context in the sentence and type of target word (lexically ambiguous target word or an unambiguous control word). There was no significant interaction between reader skill level,

type of target word (lexically ambiguous target word or an unambiguous control word), and location of disambiguating context. Nor was there a significant interaction between reader skill level, type of target word (lexically ambiguous target word or an unambiguous control word), and type of lexically ambiguous word. Lastly, there was no significant interaction between reader skill level, type of lexically ambiguous word, and location of the disambiguating context in the sentence. These results are incongruent with the anticipated results.

Although several patterns were predicted, there was no significant interaction between reader skill level, type of target word (lexically ambiguous target word or an unambiguous control word), location of disambiguating context, and type of lexically ambiguous word (biased or balanced) (see Figure 2).

Post-target word region of a sentence

Reading times on the post-target word region were examined to investigate post-access processing difficulties. As predicted, there were significant differences among the different groups of readers, $F(2, 71)=12.1$, $MSE=.126$, $p<.001$. Adult skilled readers ($M=.107$) spent significantly less time reading the post-target region of a sentence than the less skilled adult readers ($M=.156$), $p<.001$. As further anticipated, adult skilled readers ($M=.107$) also spent significantly less time reading the post target region of the sentence than children ($M=.143$), $p=.002$. Lastly, there was no significant difference in the amount of time adult less skilled readers ($M=.156$) and children ($M=.143$) spent reading the post-target region of a sentence, $p>.05$ (see Figure 3).

Figure Caption

Figure 2. Mean proportional reading time in seconds of the target word in

sentence as a function of participant group, type of lexically ambiguous word,

location of disambiguating context, and type of target word.

Figure 3. Mean proportional reading time in seconds of the post-target region of

sentence as a function of participant group.
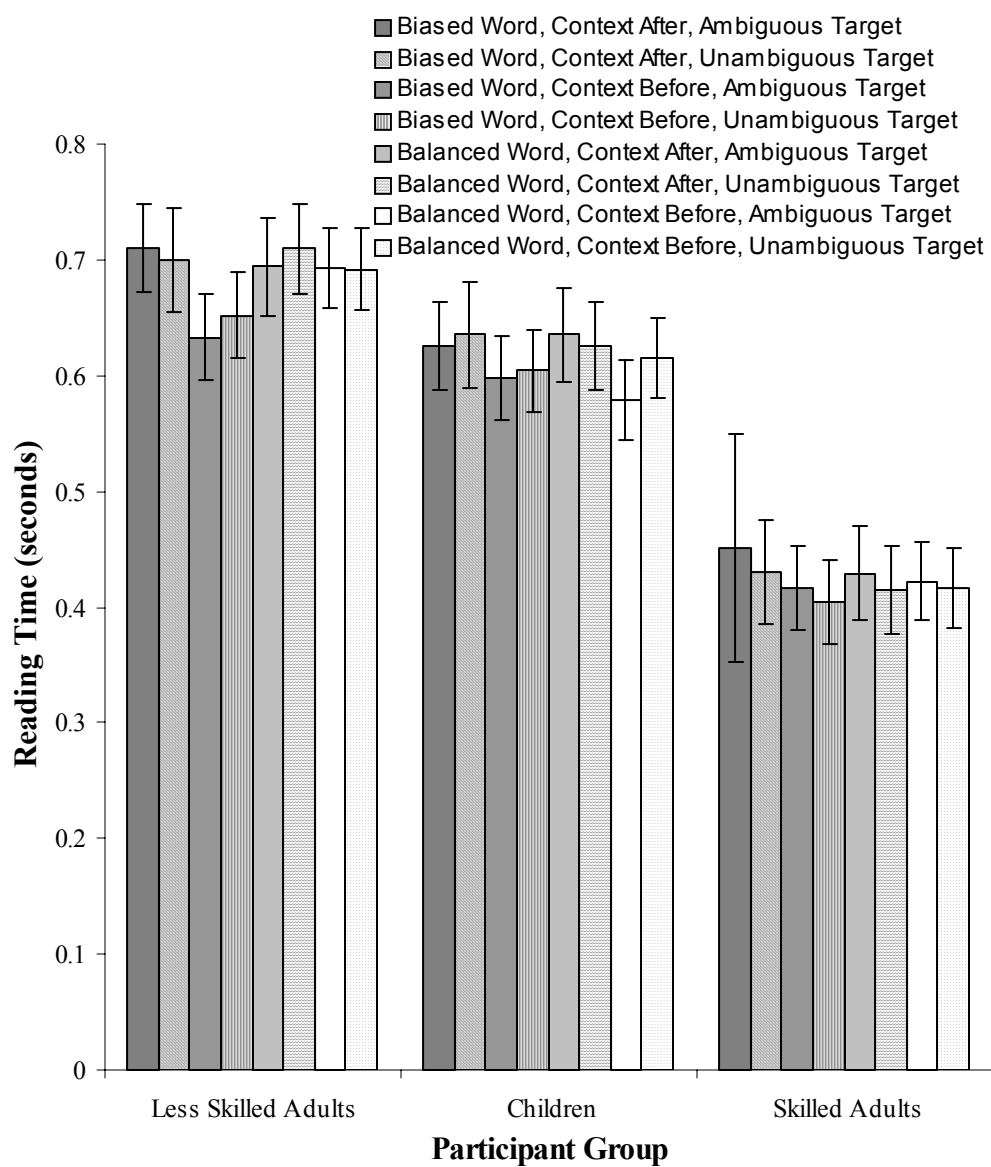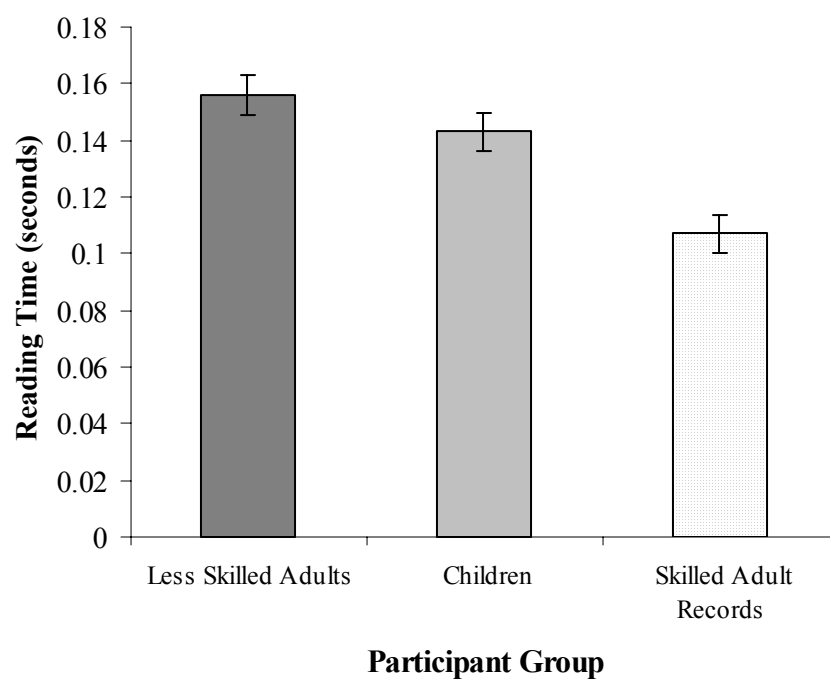
Participant Group

As anticipated, there was a marginally significant difference between the amount of time participants spent reading the post-target region of a sentence when the sentence contained a lexically ambiguous target word (M=.136) compared to an unambiguous control word (M=.134), $F(1, 71)$=3.17, MSE=.000411, p=.079. Contrary to the hypothesis, there was no significant difference between the amount of time participants spent reading sentences in which the disambiguating context followed the target word than when they read sentences in which the disambiguating context came before the target word. There was a significant difference between participants' reading times on the post-target region of the sentence when the type of lexically ambiguous word in the sentence varied. As expected, participants spent significantly more time reading the post-target region of the sentence when it contained a balanced lexically ambiguous target word (M=.141) than when it contained a biased lexically ambiguous word (M=.129), $F(1, 71)$=84.0, MSE= .000248, p<.001.

As anticipated, the location of the disambiguating context affected participant groups' reading times of the post-target region differentially. There was a significant interaction between participant population and location of disambiguating context in a sentence, $F(1, 71)$=8.32, MSE=.000411, p<.001. Adult skilled readers spent significantly more time reading the post-target region of sentences when the disambiguating context preceded (M=.111) the target word in a sentence than when the disambiguating context followed that target word (M=.103), $t(24)$ = -3.60, p=.001. For less skilled adult readers, there was no

significant difference in the amount of time participants spent reading the post-target region of sentences when the disambiguating context followed (*M*=.157) than when it preceded the target word (*M*=.155), *t*(23) = .550, *p* > .05. Finally, children spent significantly less time reading the post-target region of a sentence when the disambiguating context preceded (*M*=.138) rather than followed (*M*=.147) the target word in a sentence, *t*(24) = 2.96, *p*=.007 (see Figure 4).

None of the other predicted effects of participant population were observed. There was no significant interaction between participant group and type of target word (lexically ambiguous target word or unambiguous control word) in the sentence. Similarly, there was no significant interaction between participant population and type of lexically ambiguous word in a sentence.

Contrary to hypotheses, there was no significant interaction between the type of target word a sentence contained (lexically ambiguous target word or an unambiguous control word) and location of the disambiguating context in the sentence. Similarly, there was no significant interaction between the type of target word a sentence contained (lexically ambiguous target word or an unambiguous control word) and the type of lexically ambiguous word (biased or balanced).

The predicted effect of the relationship between location of disambiguating context and type of lexically ambiguous word was observed. A significant interaction resulted between the location of disambiguating context and the type of lexically ambiguous word, *F*(1, 71)=35.8, *MSE*=.000198, *p*<.001. When participants read a sentence containing a balanced lexically ambiguous

Figure Caption

Figure 4. Mean proportional reading time in seconds of the post-target region of

sentence as a function of participant group and location of disambiguating
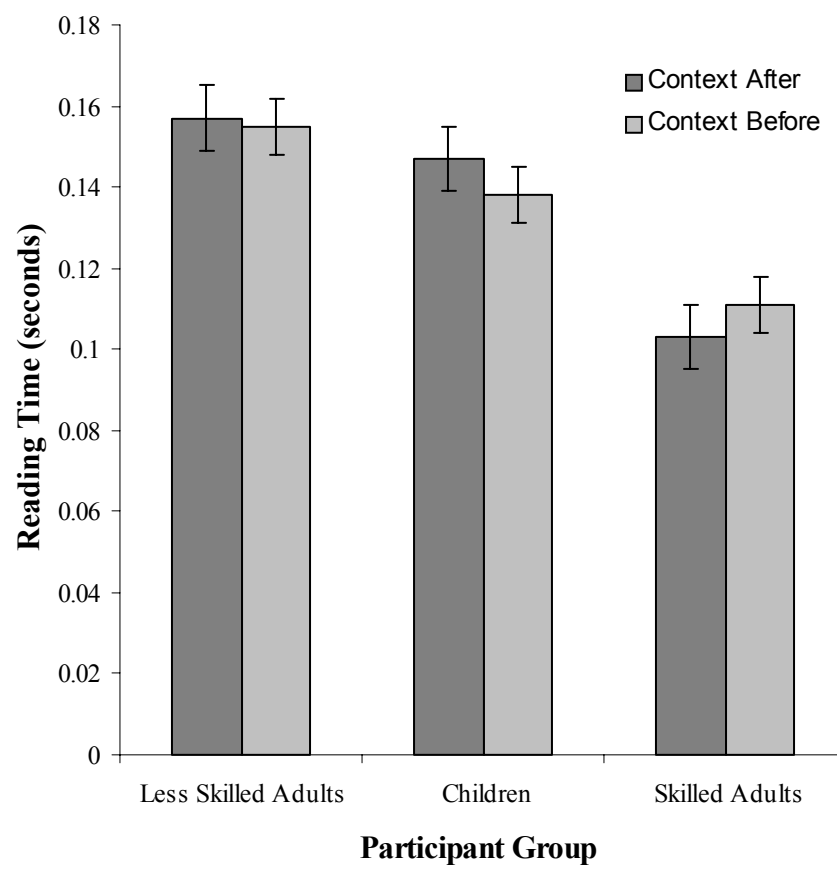
context.

word, they spent significantly more time reading the post-target region of the
sentence when the context preceded (*M*=.144) the target word than when the
context followed (*M*=.138) the target word, *t(73)*=-2.76, *p*<.001. Conversely,
when participants read a sentence containing a biased lexically ambiguous word,
they spent significantly more time reading the post-target region of the sentence
when the context followed (*M*=.133) the target word than when the context
preceded (*M*=.125) the target word, *t(73)*=3.59, *p*<.001 (see Figure 5).

There was no significant interaction between target word (lexically
ambiguous target word or an unambiguous control word), type of lexically
ambiguous word (biased or balanced), and location of the disambiguating context.
There was no significant interaction between reader skill level, type of target
word (lexically ambiguous target word or an unambiguous control word), and
location of disambiguating context in a sentence. Nor was there a significant
interaction between reader skill level, type of target word (lexically ambiguous
target word or an unambiguous control word), and type of lexically ambiguous
word. Lastly, there was no significant interaction between reader skill level, type
of lexically ambiguous word, and location of the disambiguating context in the
sentence. None of these results conform to the predictions generated.

Several other predictions were developed regarding the nature of the four
variables' pattern of interaction, but few were supported. However, there was no
significant interaction between reader skill level, type of target word (lexically
ambiguous target word or an unambiguous control word), location of

Figure Caption

Figure 5. Mean proportional reading time in seconds of the post-target region of

sentence as a function of type of lexically ambiguous word and location of

disambiguating context.

Type of Lexically Ambiguous Word in Sentence

disambiguating context, and type of lexically ambiguous word (biased or

balanced) (see Figure 6).

Figure Caption

Figure 6. Mean proportional reading time in seconds of the post-target region of
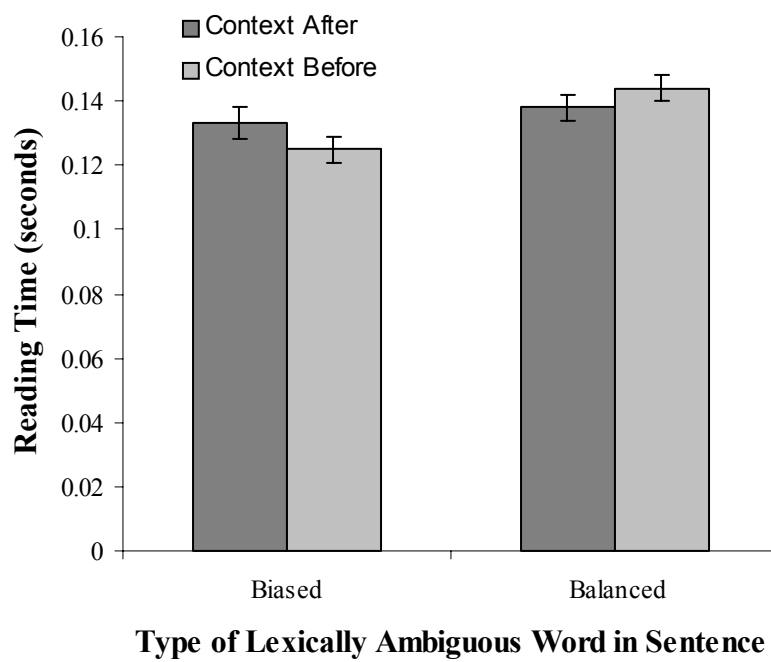
sentence as a function of participant group, type of lexically ambiguous word,

location of disambiguating context, and type of target word.

Biased Word, Context After, Ambiguous Target
Biased Word, Context After, Unambiguous Target
Biased Word, Context Before, Ambiguous Target
Biased Word, Context Before, Unambiguous Target
Balanced Word, Context After, Ambiguous Target
Balanced Word, Context After, Unambiguous Target
Balanced Word, Context Before, Ambiguous Target
Balanced Word, Context Before, Unambiguous Target
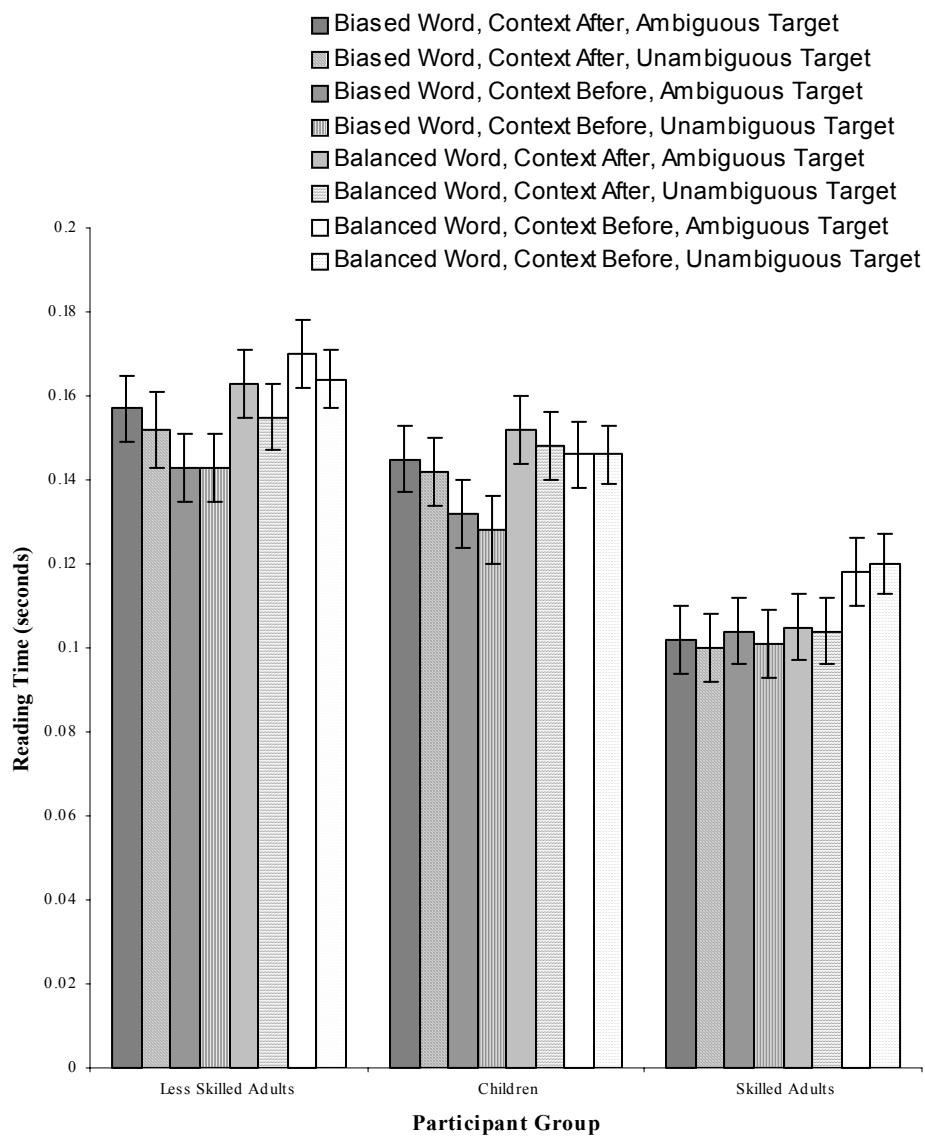
DISCUSSION

The lexical quality hypothesis makes predictions about how one's reading behavior is affected by the strength of various constituents affecting lexical representation. The present study investigated the lexical quality hypothesis' potential to explain differences in reading skill between three groups of readers (adult less skilled readers, children and adult skilled readers). Three independent variables with two levels each were manipulated: type of target word embedded in a sentence, type of lexically ambiguous target word, and location of disambiguating context. To assess the effects of lexically ambiguous words on meaning processing, two regions were considered: the target word and the post-target region. Collectively, these two were termed the "regions of interest." Results were not completely consistent with the predicted outcomes. Below, I briefly report and interpret the significant effects revealed by the present study. Interpretation of these results and a comparison to the predicted outcomes are offered in a subsequent section (entitled *Present Results Compared to Predicted Outcome*).

As predicted, skilled adult readers read both regions of interest in a sentence more quickly than either of the less skilled groups (adults and children). This is in accordance with the hypothesis that skilled readers have high quality lexical representations that allow them to select a word's appropriate connotation

quickly and efficiently when there is more than one meaning possible. No significant differences in target word or post-target region reading time were observed between the less skilled adult readers and children, which was inconsistent with the hypothesized effect on post-target region reading times.

Context was found to have an overall effect on participants' target word reading time. Participants experienced decreased difficulty in initial processing when they read a target word that was preceded by disambiguating context, compared to when neutral context preceded the target word in a sentence. This indicates that readers were able to use context to resolve reading difficulty presented by the lexically ambiguous word quickly. Additionally, context influenced reading time on the post-target region differentially within each reader group. Adult skilled readers experienced more post-access processing difficulty reading neutral context after the target word than when disambiguating context followed the target word. This effect was not observed for either less skilled reader population. When children read the disambiguating context after the target word in a sentence, they experienced more processing difficulties than when they read neutral context after the target word. No effect of the disambiguating context's location on less skilled adult readers' post-access processing time was observed.

These results indicate that skilled readers were unable to use the context provided before the target word in a sentence efficiency to resolve the difficulty presented by the lexically ambiguous target word. Children, however, experienced

fewer spillover processing difficulties of the target word when disambiguating context preceded that word in a sentence. Importantly, the location of context did not facilitate less skilled adult readers' processing difficulty of the lexically ambiguous word. Since there was no significant interaction between type of lexically ambiguous word in the sentence, this outcome does not provide support for the idea that adult readers' stronger semantic constituent allows them to use context to more easily resolve processing difficulties presented by lexically ambiguous words.

Two of the three sample populations were sensitive to the presence of disambiguating context in a sentence to resolve difficulties presented by lexically ambiguous words—skilled adults and children. It should be noted that the time course for adult skilled readers and children varied. This indicates that the children and skilled reader adult populations were sensitive to the location of disambiguating context in different ways. Less skilled adult readers did not display any difference in post-access processing time of the target word whether the disambiguating context appeared before or after the target word in a sentence. This may indicate that they were not sensitive to the location of context. Alternatively, it is possible that no effect emerged once the biased and balanced word conditions were combined, for which I hypothesized opposite effects.

Participants' reading time on the post-target region differed depending on the type of lexically ambiguous word and the location of its disambiguating context. When reading a balanced word, participants' post-access processing was

facilitated when neutral context preceded the target word in a sentence, compared to when disambiguating context preceded the balanced word. The opposite effect was observed when participants read a biased lexically ambiguous word in a sentence.

It is important to note that frequency differences existed between the balanced and biased lexically ambiguous words used in the present study (see Appendix I). On average, the balanced words used in the study occurred less frequency in written text than the biased words (Francis & Kucera, 1982). Participants' inflated reading time on sentences in which a balanced word appeared may be explained by this frequency difference: Several studies with skilled adult readers have revealed that participants read high frequency words in a sentence more quickly than low frequency words (e.g. Onifer & Swinney, 1981).

Present Results Compared to Predicted Outcome

The first hypothesis posited that skilled readers' high quality lexical representations allow them to select quickly the meaning of a balanced lexically ambiguous word in a sentence when it is preceded by disambiguating context. This hypothesis also acknowledged that less skilled readers' low quality representations will result in processing difficulties both in initial meaning access and post-access meaning selection. Since reader groups' reading time on the target word and post-target region did not differ significantly on this condition, these results do not reflect the conviction that reader groups of differential skill

vary in the amount of processing difficulty with which they are faced. Nor do these results support the notion that skill level is the result of a reader's differential quality of lexical representations.

The second hypothesis made predictions about reader groups' differential performance on the target word and post-target region of sentences in which the neutral context precedes a balanced lexically ambiguous word. No reading time differences on the target word or post-target region were observed between reader groups for this condition. The idea that skilled readers would experience difficulties with initial meaning access and post-access meaning selection was not supported. Likewise, I predicted that adult less skilled readers would be able to utilize their better-developed semantic constituents to use sentence context to release themselves from processing difficulty more efficiently than children. However, less skilled adults had no significant processing advantage over children for that condition.

A more sensitive assessment of post-target region reading times may have revealed significant differences among populations. It may have been useful to define the post-target region of the sentence as the first three words following the target region, instead of as all the words that followed. If I had performed a finer analysis of the post-target region, I may have seen less skilled adults recovering from reading difficulties more quickly than children.

The third prediction concerned the processing difficulty that presented readers when they read a biased word preceded by disambiguating context.

Differences in post-target word reading time did not support the idea that less skilled readers' processing difficulties are delayed because of their low quality lexical representations. This hypothesis further stated that skilled readers' processing difficulty should most prominently manifest in initial meaning access (as marked by the time spent reading the target word). An assumption of the lexical quality hypothesis provided the rationale for this prediction: Because skilled readers have high quality lexical representations, these individuals quickly access both meanings of the biased lexically ambiguous word from which they must select that which is most appropriate. However, none of the resulting reading time data evidenced this processing difficulty.

The final hypothesis made predictions about processing difficulties of reader groups when they read a biased lexically ambiguous word that appeared after neutral context in a sentence. I argued that less skilled readers' more advanced cognitive abilities provide them with a better-developed semantic constituent than children who read at the same level possess. Further, this well developed constituent ought to help less skilled readers use context to diminish processing difficulties more quickly than children. This hypothesis was not supported by post-target region reading time differences in this condition between less skilled adult readers and children.

Adaptation of the Lexical Quality Hypothesis

The results of the present study did not support the hypotheses developed using the lexical quality hypothesis as a guiding framework. Adult skilled readers

spent the least amount of time reading both the target word in a sentence and the post-target region of all three participant groups, which is congruent with our general expectation that skilled readers' high quality lexical representations allow them to read quickly and with a high comprehension rate. However, participants' overall performance in this experiment failed to illustrate differences in constituent strength and the overall quality of lexical representations among reader groups.

Of particular interest are the similarities between the performance of less skilled adult readers and children. Using assumptions of the lexical quality hypothesis, I predicted that this similarity arose for a different reason in each participant population. However, it still may be possible to employ the lexical quality hypothesis to explain children and adults' comparable performance in the reading time on either region of interest. We should consider children's and less skilled readers' differential strengths of phonological and orthographic constituents. Recent formal phonics training gives children a well-developed phonological constituent; adults' daily experience with printed text bolsters their orthographic constituent. Both reader groups possess a deficiency in at least one of three constituents.

A further investigation into the relative importance of these constituents is warranted. How can we investigate these two constituents' effects on processing? Previous studies have evaluated skilled and less skilled college-level readers' ability on tests of orthographic and phonological skills (e.g. Bell & Perfetti,

1994). However, a study designed specifically to investigate processing

difficulties that homophones present children and low literate adults may

highlight the differential importance of the phonological and orthographic

constituents among less skilled reader populations. When children read a

homophone in a sentence, they will likely activate both representations associated

with that word. This is because they employ the word's phonology to access word

meaning. Adult less skilled readers, alternatively, should activate word meaning

through orthography only.

For example, children should take more time than less skilled adult readers

to read the target word "flower" in a sentence, because they likely use the

phonological form of the word, "flou / ər," to access its meaning (Rayner,

Pollatsek, & Binder, 1998). As a result, both meanings for that phonology are

activated. The child is forced to select which among the following definitions fits

better into the sentence: the ingredient for baking, or the fragrant blossom.

Conversely, adults should not have an inflated reading time on this word, since

they activate word meaning through orthography (Greenberg et al., 1997; 2002).

The fragrant blossom connotation for "flou / ər" is the only meaning associated

with the "flower" spelling. As a result, I would predict that adults would have no

trouble selecting this meaning when they read "flower" in a sentence, and

experience little, if any, initial meaning access processing difficulty.

This study would provide a more sensitive assessment of the relative

strengths of the phonological and orthographic constituents effect on reading

processing for readers. The explanation offered above considered that less skilled readers' possess weaker constituent strength, which may account for children's and adult less skilled readers' largely similar performance in the present study.

Statistical Power Considerations

There are three important ways in which statistical power may have been compromised. In the following section, *Defining the Readers,* I will address the potential ways in which specific characteristics of each population may have affected the outcome of the present study. In this section, I address the source of other power deficits, and offer suggestions for their elimination.

Although no significant interactions were found when all four independent variables are considered, some of the patterns of reading behavior that emerged were consistent with the hypothesized outcome. Increasing sample size, strengthening the manipulations, and increasing the sample's homogeny will increase statistical power, and thereby may reveal the manner in which the three variables elicit significant differences in reading time on the two regions of interest for the reader groups.

Sample Size. In the present study, participants' reading times were recorded as they read sentences on a computer screen, one word at a time. This methodology, termed the "moving window paradigm," is characterized by its regulation of participants' reading: individuals' fixations on text are constrained to one predetermined "window" at a time of a longer string of words. Moving window experiments, however, require a much larger sample to reveal significant

differences between reader groups' performance, since there is more variability associated with these data when compared to eye movement data.

In a 1988 study of the same design, Duffy and her research team (1988) tracked skilled readers' gaze duration and fixation patterns as they read biased or balanced lexically ambiguous words in a sentence in which the disambiguating context either preceded or followed the target word. This research uncovered a pattern of reading behavior for skilled readers, in which participants spent more time gazing at ambiguous words than their controls. Additionally, participants did not spend significantly more time reading balanced words compared to their control when disambiguating context appeared after this target word. Participants did, however, spend more time reading the biased word compared to its control. A subsequent ANOVA was performed using reading time data from adult skilled readers exclusively. Preliminary analyses of these data indicate that this population of skilled readers followed the patterns established in previous research (Duffy et al., 1988), but these differences were not statistically significant.

There is another piece of evidence supporting the notion that inadequate sample size was a major contributor to the absence of many significant differences between participants' reading times. Moving window studies typically employ large sample groups of around 60 participants. In this study, however, there were fewer than thirty participants in each population group.

Strength of manipulation. The words used were determined as "biased" or "balanced" based on the results of a norming task completed locally. In the norming task, participants were asked to name the first thing to come to mind when presented with a lexically ambiguous word. These responses were tabulated, and used to establish the identity of lexically ambiguous words as balanced or biased.

In the Method section, I addressed an issue that could provide insight into the lack of significant differences in participants' reading time when reading a lexically ambiguous or unambiguous target word in a sentence and a mere marginal significance in post-target region reading time: biased lexically ambiguous words employed as "unambiguous" control words. An additional analysis was performed in which data associated with questionable items were removed (see Appendix T). No differences in the pattern of reading behavior were observed. It follows that the replacement control words, even when they were ambiguous words, did not affect reading time data significantly.

Preserving the balanced or biased identity for lexically ambiguous words across three reader populations was not straightforward. In some cases, the words selected were not ideally biased or balanced for all populations. For example, ninety-one percent of children reported that the first meaning of the word race to come to mind was a contest of speed. Therefore, "race" was a strongly biased word for children. However, "race" was not so strongly biased for the adult populations: Seventy-four percent of adult less skilled readers and a meager fifty-

percent of adult skilled readers initially reported this meaning (see Appendix F). More norming data should be collected to verify the identity of the selected biased and balanced words for each participant group. Further, these words should not cross identity boundaries between participant groups.

My above advice outlining the necessity of more norming data collection assumes that lexically ambiguous words are an appropriate measure by which to test the lexical quality hypothesis' ability to explain differences in reading skill across the three sample reading groups. Importantly, the type of target word in a sentence (ambiguous or unambiguous control) was not found to interact significantly with any of the other variables examined. This indicates that lexically ambiguous and unambiguous words had the same effect on readers' processing. We cannot assume that lexically ambiguous words interfered with the quality of readers' lexical representations. Subsequently, it is worth exploring the capability of lexically ambiguous words to investigate the elements of the lexical quality hypothesis. Here, it is important to note the peculiar finding that, like many previous studies in this laboratory with the same reader populations, the variability associated with each condition is constant across all groups.

Defining the Readers

Strength of the control populations. In the present study, two populations provided controls for the less skilled adult readers population. Children provided an approximate grade level match, and adult skilled readers provided an approximate age match. If the two control populations (age and grade-level) had

been a closer match to the adult less skilled readers, we may have expected to see significant differences in reading patterns between the two less skilled populations.

Interestingly, although there were significant reading level differences between the adult less skilled and children readers, these two populations did not display significant differences in reading time. This may have resulted from an inaccurate measure of ABE students' reading level as measured by their grade-level equivalent (GLE) score. Indeed, researchers have criticized the GLE score's adequacy as a measure by which to assess ABE students' progress (Venezky, Bristow, & Sabatini, 1994). When a group of ABE students was tested at three points in time, students' scores were found to vary significantly on the same battery of math and reading tests. Students experienced significant gains *and* declines in their scores over the testing periods. These findings illustrate the critical need for researchers to develop an evaluation system for adult literacy programs that engages more than the single multiple-choice test employed presently. Venezky and his research team proposed that this multi-measure evaluation tool should necessarily reflect the multiple goals of ABE programs rather than employing the conventional elementary- and secondary-school grade level to generate progress reports for adult learners (Venezky et al., 1994).

Bilingualism. As previously discussed, heterogeneous groups of students comprise ABE classes. These students vary in their age, reason for enrolling, and reading ability, and they may have diagnosed or undiagnosed learning disabilities.

Another potentially important difference between ABE students is that some are native English speakers, and some have learned English as a second language.

Unlike the adult skilled readers and children in the study, almost one half of the adult less skilled readers were native Spanish speakers who learned English simultaneously or after having learned Spanish (see Appendix U).

Previous studies with English-Spanish bilinguals revealed differences in reading behavior when these results are compared to those from the monolingual literature (see Altarriba, 2003 and Harris, 1992 for reviews). These results indicated that contextual constraint within a sentence and an individual's ability to retrieve a word's lexical representation in their native language both affect bilinguals' processing of cross-language ambiguity (Altarriba, Carlo, & Kroll, 1992 as cited in Altarriba, 2003; Chen & Leung, 1989).

In the present study, however, bilingual speakers' sentence processing was not significantly different from native English-only speakers'. A subsequent ANOVA was performed on adult less skilled readers' data in which native language was the between-groups variable. This analysis revealed no significant differences in the patterns of results between native English speakers and those who learned English after their native language. Further, this pattern mimicked that displayed by all adult less skilled readers combined. There was no performance difference between native and non-native English speakers that may have affected the group's overall performance.

The studies described above were conducted with "proficient" Spanish-English bilinguals (Altarriba, Kroll, Sholl, & Rayner, 1996) or individuals who self-rated their reading and writing ability in both English and Spanish close to "very fluent" (Altarriba, Kambe, Pollatsek, & Rayner, 2001). Adult less skilled reader participants in the present study were not asked to rate their spoken and written literacy for English and their native language. The non-native English speakers in the present study had achieved spoken literacy, but clearly were not print literate in English. Also, it may be that many of these individuals were not print literate in their native language.

Discrepancies in bilingual participants' literacy abilities in their native language may account for the similarities in native English-only speakers' and bilinguals' sentence processing. Perhaps this indicates that possessing spoken and print literacy contribute to a critical difference between bilinguals' reading processing. Bilinguals may process sentences and difficulties presented by lexical ambiguity differently than their peers who speak only English. When we consider that almost half of this ABE student sample learned English after their native language, the great need for research with low literate adult bilinguals becomes apparent.

Directions for Future Research

As mentioned in the *Statistical Power Considerations* section above, this investigation into the ability of the lexical quality hypothesis would profit by collecting data from a larger participant sample. The sample populations may also

be matched more closely for age and reading level. In addition, more norming task data should be collected to assess the strength of the manipulation for the biased and balanced words used. If the hypothesized patterns emerge with increased statistical power and a stronger manipulation, this would provide experimental support for the validity of the lexical quality hypothesis to explain groups of readers' differential reading skill.

Instructional Implications for the Lexical Quality Hypothesis. Notably, the lexical quality hypothesis emphasizes the significance of three lexical constituents in reading. If one constituent is weak for a reader, then his or her entire reading process is disrupted. The lexical quality hypothesis posits that less skilled adult readers possess a strong orthographic constituent, which affords them good spelling skills and the ability to recognize words' printed forms. In addition, these readers have a well-developed semantic constituent, which permits them to understand complicated material.

Based upon this knowledge, a well-designed reading instruction program should focus on developing ABE learners' phonological skill in ways that respects their age and cognitive abilities. According to the lexical quality hypothesis, spelling instruction should not contribute largely to developing less skilled adult readers' acquisition of reading skill, since they already have been equipped with these skills through their daily immersion in print-rich environments. This program should highlight readers' well-developed semantic

constituent by presenting opportunities for learners to practice phonological skills in interesting and relevant subject matter.

Since adults are skilled at using context to resolve reading difficulties, the materials they encounter in reading instruction may be more complicated than materials typically used with children. Embedding some opportunities to practice the skills they lack in pertinent subject matter should facilitate ABE students' learning in two ways: It will foster their self-efficacy by presenting them with reading challenges that their strong semantic constituents equip them to overcome, and it will promote their continued interest in learning by engaging students in enjoyable tasks. In this sense, well-designed programs should assist ABE students' learning by allowing their strengths to assist the development of their weaknesses.

The lexical quality hypothesis, if supported by future research, offers promise for improving reading instruction in ABE programs. However, the recommendations offered above must be tested in an intervention study to evaluate their effectiveness. I suggest that one such study include an experimental condition in which ABE students read a narrative that includes words they are likely to encounter in their daily lives, and a few they are unlikely to encounter. The instructor's role would be to teach students how to use phonics to decode the unfamiliar words.

In this scenario, students may develop and reinforce phonics skills in the context of what they already know. This instruction is different from the abstract

phonics training children receive, which adults may find somewhat patronizing. Students in the control condition in this intervention would receive phonics training in which they learn how letter combinations correspond to letter strings, and how to decode short, simple words like "cat, " etc. (see Adams, 1990 for a review). The effectiveness of such an intervention would be evaluated by students' reading level scores before and after several months of instruction, and through students' reports of the how enjoyable and effective they found the learning experience.

Effects of Prior Formal School Experience. Another interesting question centers around the amount of formal schooling these participants have received: Do ABE students who completed eleventh grade before dropping out differ from individuals who stopped school in seventh grade in their performance on any condition? For what levels of schooling will we see significant effects? This comparison highlights the contribution of a strong phonological constituent in adult reading acquisition.

Considering Bilingual Students' Needs. Given the large proportion of bilingual ABE learners in the present sample and in classes nationwide, more research is warranted to outline the precise ways in which bilinguals differ from monolinguals in acquisition of reading skill. Previous studies with Spanish-English bilinguals have focused primarily on cross-language ambiguity resolution (see Altarriba & Gianico, 2003 for a review). Reading time and eye tracking studies support the notion that bilinguals can process one language separately

from another (Altarriba, Carlo, & Kroll, 1992 as cited in Altarriba & Gianico, 2003). That is, they enter a "single-language mode," and experience minimal reading difficulties. Future studies should determine if significant differences exist between the ability of bilinguals and monolinguals to process single-language lexical ambiguities. If future studies reveal no differences in the ways in which bilinguals and monolinguals process English-only lexically ambiguous words, this would provide support for the assertion that the instructional changes I offered previously are of equal value to native English speakers and bilingual ABE students.

Studies with bilinguals provide important insight into the reading patterns of bilinguals who are speech and print literate, but do not accurately describe the reading abilities of most bilingual ABE students. I noted previously one key difference between the bilingual participant sample and that in previous research: one's achievement of spoken and/or print literacy. Researchers should investigate the ways in which reading behavior differs between bilinguals who have achieved print and spoken literacy and those who have achieved only spoken literacy in their native language or English.

Conclusion

We should acknowledge that defining differential reading ability is a complicated and difficult task. Even among those considered less skilled readers, individuals' reading skill may be deficient in different ways. The present study did not successfully demonstrate that differential constituent strength contributes

to the overall quality of an individual's word representations as a useful way to explain differences in reading skill. Unfortunately, no conclusive evidence was uncovered that would explain differences in the ways functionally illiterate adults differ from children and skilled adult readers.

With increased statistical power, the lexical quality hypothesis may emerge as a viable explanation of reading skill difference. Unlike the adult skilled readers and children in the study, half of adult less skilled reader sample consisted of native Spanish speakers who learned English simultaneously or after Spanish. Future research focusing specifically on bilingual speakers' processing of sentences containing English-only lexically ambiguous words may reveal differences between bilinguals and monolingual English speakers. Examining the experimental conditions in which these two groups' reading times differ and converge may illuminate important new research questions by which to examine the lexical quality hypothesis' validity.

We cannot eradicate the crisis of adult illiteracy in America if reading research does not continue. There is a critical need for a fundamental body of literature with a focus on functionally illiterate adult readers. Once trends in adults' patterns of reading acquisition are established, these valuable data could inform the direction of curricula and instructional methods that best suit adult learners. In addition to providing instruction that will best facilitate their learning, programs that are tailored to adult learners' strengths and weaknesses will engage them by appealing to their interests and abilities. Better instructional methods may

positively contribute to ABE programs' retention and completion rates, and further instill learners with confidence and enthusiasm to learn. When more students are encouraged to complete literacy training programs, the number of individuals affected by the negative social consequences associated with low literacy skills is reduced.

FOOTNOTES

[1] Adult skilled readers were administered the definition norming task differently than were the adult less skilled readers and children. After reporting the meanings they knew for a specific word, adult less skilled readers and children were offered the chance to confirm or deny their familiarity with the meanings of the word, even if they did not report it initially. Adult skilled readers were not prompted in this fashion, and therefore these data may not accurately reflect the knowledge base of the adult skilled readers. However, this population is likely to have the greatest lexicon of the three populations. Therefore, we assumed that adult skilled readers were prompted in the same way, the data from this population would more closely replicate that of the other two populations.

[2] For most sentence frames, the replacement control word is an unambiguous word. In two sentences, this control word is a biased ambiguous word ("bill" replaces "issue" and "film" replaces "date"). If the control word is a biased ambiguous word, the dominant meaning is always instantiated in the version of the sentence frame containing the control word, and its subordinate meaning would not fit into the sentence. For example, the control word "film" replaces the lexically ambiguous word "date" in the sentence "She had looked forward to the *date* (*film*) for weeks, but it ended up being terrible since her boyfriend was in a bad mood." It does not follow that one is able to look forward to a thin covering or coating in the same way that one may excitedly anticipate viewing a recent blockbuster. There is experimental evidence suggesting that readers selectively access the dominant meaning of lexically ambiguous words. Correspondingly, a hypothesis of the present study predicted that participants would read biased words and their control words at different rates when neutral context precedes the target word, so this should have little if any effect on the results.

Appendix A

Balanced and Biased Word List Selected for Use in Study

Biased words	*Balanced words*
Case	Charm
Club	Chest
Foot	Company
Interest	Date
Issue	Gear
Race	Match
Ruler	Pitcher
Temple	Record

Appendix B

Figure Caption

Figure 1. JPEG image of consent form as it appeared embedded in online

web form

_____

This image and the image in Appendix D are part of the same web form that may be
viewed online at http://www.mtholyoke.edu/~ecwelch/wordassoc.html

CONSENT FORM

Title of Study: Word Association and Sentences
Investigators: Emily Welch and Lama Mansour

The following informed consent is required by the Department of Psychology and Education for any person involved in a Department-sponsored research study. This study has been approved by the Department's Ethics Committee on Human Subjects. I will be asked to perform some word association tasks and create sentences.

A. My participation is voluntary.

B. I may withdraw my consent and discontinue participation in this study at any time. My refusal to participate will not result in any penalty.

C. You will give me an explanation of the procedures to be followed in the project, and you will answer any inquiries that I may have.

D. All of the information from this study will be strictly confidential. No names will be associated with the data in any way. I understand that the data will be stored in locked offices in the Psychology-Education Building and will be accessible only to members of the researching lab group.

E. The results of this study will be made part of a final research report and may be used in papers submitted for publication or presented at professional conferences, but under no circumstances will my name or other identifying characteristics be included.

I hereby give my consent to participate in this research.

Name [   ]   Date [   ]

Email Address [   ]

Appendix C

Adult's Word Association and Definition Task Word List

Angel	Game	Pupil
Artist	*Garlic*	Race
Ball	Gear	*Radar*
Bank	*Goal*	Record
Barn	Habit	*River*
Bat	*Health*	Ruler
Beam	Interest	*Salad*
Block	Issue	Scale
Bolt	Lace	Season
Bride	*Lake*	*Shelf*
Brush	Letter	*Sofa*
Bulb	Litter	Speaker
Calf	*Lung*	Star
Case	Match	*Statue*
Chalk	*Menu*	Stitch
Charm	Mole	Story
Chest	*Movie*	Straw
Clog	Nail	*Street*
Club	Note	Stroke
Comet	*Ocean*	Suit
Company	Organ	*Sunset*
Corn	*Path*	Temple
Date	Pen	*Thorn*
Draft	Pitcher	Toast
Fabric	Plant	Trunk
File	*Poem*	*Tunnel*
Film	Pole	Vault
Finish	Pool	Volume
Foot	Post	*Wallet*
Frog	Present	Yard

Unambiguous words are italicized above.

Appendix D

Figure Caption

Figure 1. JPEG image of text boxes in which participants typed their

responses as embedded in online web form

This image and the image in Appendix B are part of the same web form that may be
viewed online at http://www.mtholyoke.edu/~ecwelch/wordassoc.html

For each noun listed below, please write the first word that comes to mind in the first blank space. Then, please use the given word in a sentence and write the sentence in the second blank space.

Angel

Artist

Ball

Bank

Appendix E

Children's Word Association and Definition Task Word List

Angel	Litter
Artist	*Lung*
Barn	Match
Bat	Mole
Beam	*Movie*
Bride	Nail
Calf	*Ocean*
Case	Organ
Chalk	Pitcher
Charm	Pool
Chest	Present
Clog	Pupil
Club	Race
Comet	Record
Company	*River*
Date	Ruler
Draft	*Salad*
Fabric	Season
Foot	*Sofa*
Frog	Speaker
Garlic	Star
Gear	*Sunset*
Interest	Temple
Issue	*Tunnel*
Lace	Volume
Lake	*Wallet*
Letter	Yard

Unambiguous words are italicized above.

Appendix F

Results of Word Association Norming Task for All Three Participant Populations

	Meaning	ABE	Children	MHC
Biased Target Words				
Case	storage	61%	70%	34%
	bookcase	8%	10%	2%
	court	31%	20%	64%
Club	dance	85%	66%	83%
	stick	10%	33%	13%
Foot	body	*100%*	91%	92%
	length	*0%*	9%	8%
Interest	hobby	78%	95%	90%
	bank	22%	5%	10%
Issue	problem	95%	90%	75%
	magazine	5%	10%	25%
Race	run	74%	91%	*50%*
	color	26%	9%	*50%*
Ruler	measure	95%	81%	88%
	king	5%	19%	12%
Temple	church	77%	91%	94%
	head	24%	9%	6%
Balanced Target Words				
Charm	charming	44%	31%	33%
	bracelet	56%	69%	66%
Chest	body	64%	*50%*	55%
	storage	36%	*50%*	45%
Company	friends	48%	70%	30%
	business	52%	30%	70%
Date	girl	56%	45%	44%
	time	44%	45%	46%
	fruit	0%	10%	10%
Gear	shift	53%	62%	44%
	clothes	47%	38%	56%
Match	fire	40%	52%	58%
	tennis	8%	24%	22%
	combine	53%	29%	22%
Pitcher	baseball	46%	38%	51%
	water	54%	66%	49%
Record	music	56%	70%	63%
	police	44%	30%	37%

The meanings of each lexically ambiguous word are listed to the right of each lexically ambiguous word. The percentage of participants from each population for whom that meaning was the first to come to mind is listed to the right.

Appendix G

Norming Task One Participant Response Means

	Meanings	**ABE**	**Children**	**MHC**	**Mean**
Biased					
Case	Storage	61%	70%	34%	*55%*
Club	dance/chess	85%	66%	83%	*78%*
Foot	Body	100%	91%	92%	*94%*
Interest	Hobby	78%	95%	90%	*88%*
Issue	Problem	95%	90%	75%	*87%*
Race	Run	74%	91%	50%	*72%*
Ruler	Measure	95%	81%	88%	*88%*
Temple	Church	77%	91%	94%	*87%*
					81%
Balanced					
Charm	Bracelet	56%	69%	66%	*64%*
Chest	Body	64%	50%	55%	*56%*
Company	Business	52%	30%	70%	*51%*
Date	Girl	56%	45%	44%	*48%*
Gear	Shift	53%	62%	44%	*53%*
Match	Fire	40%	52%	58%	*50%*
Pitcher	Water	54%	66%	49%	*56%*
Record	Music	56%	70%	63%	*63%*
					55%

The dominant meanings for the biased words are listed above. Similarly, the dominant meanings of the balanced words are presented. The percentages listed in italics on the right represent the mean percentage of participants who initially reported that meaning across all three populations. The italicized percentages in bold above represent the average amount of participants who initially reported the dominant meaning of a biased or balanced lexically ambiguous word, across all three populations.

Appendix H

Results of Definition Norming Task for All Three Participant Populations

	Meaning	ABE	Children	MHC
Biased				
Case	storage	83%	100%	32%
	bookcase	13%	30%	2%
	court	80%	100%	65%
Club	dance	100%	100%	84%
	stick	73%	91%	15%
Foot	body	100%	100%	94%
	length	70%	100%	6%
Interest	hobby	93%	100%	90%
	bank	67%	76%	10%
Issue	problem	96%	100%	77%
	magazine	46%	80%	23%
Race	run	100%	100%	No data
	color	87%	86%	No data
Ruler	measure	93%	100%	87%
	king	76%	100%	13%
Temple	church	96%	100%	85%
	head	75%	62%	55%
				73%
Balanced				
Charm	charming	67%	79%	42%
	bracelet	82%	100%	58%
Chest	body	93%	100%	55%
	storage	75%	95%	45%
Company	friends	83%	100%	21%
	business	93%	100%	79%
Date	girl	89%	100%	52%
	time	96%	100%	41%
	fruit	32%	25%	7%
Gear	shift	88%	95%	43%
	clothes	71%	91%	57%
Match	fire	93%	95%	50%
	tennis	37%	86%	24%
	combine	87%	100%	26%
Pitcher	baseball	89%	100%	45%
	water	81%	100%	55%
Record	music	87%	100%	68%
	police	97%	100%	32%
				72%

The potential meanings are listed to the right of each lexically ambiguous word. To the right, the percentage of participants from each population that reported knowing that meaning of each lexically ambiguous word are listed. Average comprehension rates across all three populations for all meanings of the words are in bold.

Appendix I

Frequency Ratings for Ambiguous Words and Unambiguous Control Words

Target Word	Frequency	Control Word	Frequency	Difference
Low Frequency Target Words:				
Charm	25	**Ring**	39	*14*
		Prayer	41	*16*
Gear	28	**Coat**	52	*24*
Match	24	**Outfit**	16	*8*
		Mixture	34	*10*
Pitcher	29	**Catcher**	19	*10*
Ruler	13	**Mayor**	47	*34*
		Tutor	5	*8*
Medium Frequency Target Words:				
Chest	57	**Box**	82	*25*
Temple	41	**Eyebrow**	13	*28*
		Forehead	18	*23*
High Frequency Target Words:				
Case	503	**Job**	302	*201*
		Door	348	*155*
Club	178	**Gun**	142	*36*
Company	453	**Friends**	294	*159*
Date	120	**Meal**	56	*64*
		Film	127	*7*
Foot	361	**Piece**	219	*142*
Interest	408	**Business**	412	*4*
Issue	200	**Bill**	133	*67*
Race	120	**Sex**	95	*25*
		Age	275	*155*
Record 214		**Music**	216	*2*

Frequency ratings taken from *Frequency Analysis of English Usage* (Francis and Kucera, 1997).

Appendix J

Biased Lexically Ambiguous Word List

Case (pertaining to law; an action or a suit or just grounds for an action)

Club (a heavy stick, suitable for use as a weapon)

Foot (a measurement equal to twelve inches)

Interest (money earned for storing money in the bank, equal to a percentage of the

total amount)

Issue (a single copy of a periodical)

Race (a human population classified together based on shared physical

characteristics)

Ruler (one that rules or governs; monarch)

Temple (the flat region of either side of the forehead)

The subordinate meaning for these biased lexically ambiguous words follow in parentheses.
The meanings reported above were adapted from definitions provided in the American Heritage
Dictionary, Third Edition.

Appendix K

Sentences Containing Lexically Ambiguous Words and Unambiguous Control
Words

(1)
People were interested in Mr. Butler's new *case* because his client was a famous actor.
Because his client was a famous actor, Mr. Butler's new *case* interested people.
People were interested in Mr. Butler's new *job* because his client was a famous actor.
Because his client was a famous actor, Mr. Butler's new *job* interested people.

(2)
Mr. Swanson decided to close the *case* in the courthouse once the jury finally decided
that the man was guilty of murder.
Once the jury finally decided that the man was guilty of murder, Mr. Swanson decided to
close the *case* in the courthouse.
Mr. Swanson decided to close the *door* in the courthouse once the jury finally decided
that the man was guilty of murder.
Once the jury finally decided that the man was guilty of murder, Mr. Swanson decided to
close the *door* in the courthouse.

(3)
There were many different types of *clubs* in the closet of the police station, so Officer
O'Brady was disappointed to learn he could carry only one at a time.
Officer O'Brady was disappointed to learn he could carry only one at a time since there
were many different types of *clubs* in the closet of the police station.
There were many different types of *guns* in the closet of the police station, so Officer
O'Brady was disappointed to learn he could carry only one at a time.
Officer O'Brady was disappointed to learn he could carry only one at a time since there
were many different types of *guns* in the closet of the police station.

(4)
The magazine article mentioned the *club* the criminal used in the bank robbery on
Saturday.
In the bank robbery on Saturday, the criminal used a *club* that was mentioned in the
magazine article.
The magazine article mentioned the *gun* the criminal used in the bank robbery on
Saturday.
In the bank robbery on Saturday, the criminal used a *gun* that was mentioned in the
magazine article.

(5)
He decided that one *foot* was not enough after he cut the ribbon.
After he cut the ribbon, he decided that one *foot* was not enough.
He decided that one *piece* was not enough after he cut the ribbon.
After he cut the ribbon, he decided that one *piece* was not enough.

(6)
Sarah needed only one *foot* of string to tie the package together.
To tie the package together, Sarah needed only one *foot* of string.
Sarah needed only one *piece* of string to tie the package together.
To tie the package together, Sarah needed only one *piece* of string.

(7)
Harry was excited by his *interest* that he gained because his savings account had doubled in size.
Because his savings account had doubled in size, Harry was excited by his *interest* that he gained.
Harry was excited by his *business* that he gained because his savings account had doubled in size.
Because his savings account had doubled in size, Harry was excited by his *business* that he gained.

(8)
She wanted all of her *interest* to increase every month, so she moved her money from one bank to another with better services.
She moved her money from one bank to another with better services, since she wanted all of her *interest* to increase every month.
She wanted all of her *business* to increase every month, so she moved her money from one bank to another with better services.
She moved her money from one bank to another with better services, since she wanted all of her *business* to increase every month.

(9)
Paul still had several *issues* that he would receive, even though he cancelled his magazine subscription months ago.
Even though he cancelled his magazine subscription months ago, Paul still had several *issues* that he would receive.
Paul still had several *bills* that he would receive, even though he cancelled his magazine subscription months ago.
Even though he cancelled his magazine subscription months ago, Paul still had several *bills* that he would receive.

(10)
Jane thought that her dad had too many *issues* on the coffee table, but they were all from one magazine subscription.
They were all from one magazine subscription, but Jane thought that her dad had too many *issues* on the coffee table.
Jane thought that her dad had too many *bills* on the coffee table, but they were all from one magazine subscription.
They were all from one magazine subscription, but Jane thought that her dad had too many *bills* on the coffee table.

(11)
Sally did not know the *race* of the criminals, although they appeared to be white.
Although they appeared to be white, Sally did not know the *race* of the criminals.
Sally did not know the *sex* of the criminals, although they appeared to be white.
Although they appeared to be white, Sally did not know the *sex* of the criminals.

(12)
Allan expected that many *races* would be represented, but only young, white people attended the diversity conference.
Only young, white people attended the diversity conference, but Allan expected that many *races* would be represented.
Allan expected that many *ages* would be represented, but only young, white people attended the diversity conference.
Only young, white people attended the diversity conference, but Allan expected that many *ages* would be represented.

(13)
Harry was not used to the *ruler* his town elected, since she had only been in office for three weeks.
Since she had only been in office for three weeks, Harry was not used to the *ruler* his town elected.
Harry was not used to the *mayor* his town elected, since she had only been in office for three weeks.
Since she had only been in office for three weeks, Harry was not used to the *mayor* his town elected.

(14)
The classroom had only one *ruler* to instruct them, but every student thought they were the one in charge.
Every student thought they were the one in charge, but the classroom had only one *ruler* to instruct them.
The classroom had only one *tutor* to instruct them, but every student thought they were the one in charge.
Every student thought they were the one in charge, but the classroom had only one *tutor* to instruct them.

(15)
She could see her *temple* in the mirror, even though her hair covered the rest of her forehead.
Even though her hair covered the rest of her forehead, she could see her *temple* in the mirror.
She could see her *eyebrow* in the mirror, even though her hair covered the rest of her forehead.
Even though her hair covered the rest of her forehead, she could see her *eyebrow* in the mirror.

(16)
Every Saturday morning her *temple* hurt, but was the only time she ever got headaches.
The only time she ever got headaches was when her *temple* hurt every Saturday morning.
Every Saturday morning her *forehead* hurt, but was the only time she ever got headaches.
The only time she ever got headaches was when her *forehead* hurt every Saturday morning.

(17)
Of all her *charms* she kept from her childhood, she liked the silver and ruby one the best.
She liked the silver and ruby one the best of all her *charms* she kept from her childhood.
Of all her *rings* she kept from her childhood, she liked the silver and ruby one the best.
She liked the silver and ruby one the best of all her *rings* she kept from her childhood.

(18)
He felt good about using his *charm* that night to bring good luck to his favorite baseball team.
To bring good luck to his favorite baseball team, he felt good about using his *charm* that night.
He felt good about using his *prayer* that night to bring good luck to his favorite baseball team.
To bring good luck to his favorite baseball team, he felt good about using his *prayer* that evening.

(19)
Jack pounded on his *chest* over and over again, but he could not get the lid to come off.
He could not get the lid to come off, though Jack pounded on his *chest* over and over again.
Jack pounded on his *box* over and over again, but he could not get the lid to come off.
He could not get the lid to come off, though Jack pounded on his *box* over and over again.

(20)
Sally wrapped the towel around her *chest* tightly so her cats would not scratch the wooden surface.
So her cats would not scratch the wooden surface, Sally wrapped the towel around her *chest* tightly.
Sally wrapped the towel around her *box* tightly so her cats would not scratch the wooden surface.
So her cats would not scratch the wooden surface, Sally wrapped the towel around her *box* tightly.

(21)
On Sunday, our *company* came over for lunch, instead of coming for dinner like usual.
Instead of coming for dinner like usual, our *company* came over for lunch on Sunday.
On Sunday, our *friends* came over for lunch, instead of coming for dinner like usual.
Instead of coming for dinner like usual, our *friends* came over for lunch on Sunday.

(22)
We were lucky that our *company* had good manners, since they stayed almost three weeks at our house.
Since they stayed almost three weeks at our house, we were lucky that our *company* had good manners.
We were lucky that our *friends* had good manners, since they stayed almost three weeks at our house.
Since they stayed almost three weeks at our house, we were lucky that our *friends* had good manners.

(23)
Last week it would have been a good *date*, except that Steve was still too nervous to eat around Becky.
Steve was still too nervous to eat around Becky, otherwise it would have been a good *date* last week.
Last week it would have been a good *meal*, except that Steve was still too nervous to eat around Becky.
Steve was still too nervous to eat around Becky, otherwise it would have been a good *meal* last week.

(24)
She had looked forward to the *date* for weeks, but it ended up being terrible since her boyfriend was in a bad mood.
It ended up being terrible since her boyfriend was in a bad mood, even though she had looked forward to the *date* for weeks.
She had looked forward to the *film* for weeks, but it ended up being terrible since her boyfriend was in a bad mood.
It ended up being terrible since her boyfriend was in a bad mood, even though she had looked forward to the *film* for weeks.

(25)
It was easy to reach the *gear* because she packed it at the top of her backpack.
She packed it at the top of her backpack, so the *gear* was easy to reach.
It was easy to reach the *coat* because she packed it at the top of her backpack.
She packed it at the top of her backpack, so the *coat* was easy to reach.

(26)
Ralph could see the *gear* on display in the outdoor store's front window.
In the outdoor store's front window, Ralph could see the *gear* on display.
Ralph could see the *coat* on display in the outdoor store's front window.
In the outdoor store's front window, Ralph could see the *coat* on display.

(27)
She looked carefully at the *match* she made to see if the colors went well together.
To see if the colors went well together, she looked carefully at the *match* she made.
She looked carefully at the *outfit* she made to see if the colors went well together.
To see if the colors went well together, she looked carefully at the *outfit* she made.

(28)
Dave tried every *match* there was, but none of the paint colors seemed right for each other.
None of the paint colors seemed right for each other, though Dave tried every *match* there was.
Dave tried every *mixture* there was, but none of the paint colors seemed right for each other.
None of the paint colors seemed right for each other, though Dave tried every *mixture* there was.

(29)
Her favorite *pitcher* dropped the ball during the last baseball game of the season.
During the last baseball game of the season, her favorite *pitcher* dropped the ball.
Her favorite *catcher* dropped the ball during the last baseball game of the season.
During the last baseball game of the season, her favorite *catcher* dropped the ball.

(30)
Aaron did not notice the *pitcher* was new until the announcer said his name at the end of the baseball game.
Until the announcer said his name at the end of the baseball game, Aaron did not notice the *pitcher* was new.
Aaron did not notice the *catcher* was new until the announcer said his name at the end of the baseball game.
Until the announcer said his name at the end of the baseball game, Aaron did not notice the *catcher* was new.

(31)
Sam kept the *record* from his aunt, even though he could not play it on his stereo.
Even though he could not play it on his stereo, Sam kept the *record* from his aunt.
Sam kept the *music* from his aunt, even though he could not play it on his stereo.
Even though he could not play it on his stereo, Sam kept the *music* from his aunt.

(32)
Of all the different *records* in the library, Sam liked the jazz the best.
Sam liked the jazz the best of all the different *records* in the library.
Of all the different *music* in the library, Sam liked the jazz the best.
Sam liked the jazz the best of all the different *music* in the library.

The four versions of each sentence frame displayed above correspond to the four conditions: ambiguous word/context after, ambiguous word/context before, unambiguous word/context after, unambiguous word/context before. Sentence frames 1 through 16 were written for biased lexically ambiguous words. Sentence frames 17 through 32 were written for balanced lexically ambiguous words.

Appendix L

MOUNT HOLYOKE COLLEGE
INFORMED CONSENT FORM

Title of Study: Reading Sentences
Investigator(s):   Emily Welch

Brief description of project and procedures to be followed:
This project has been approved by the Institutional Review Board of Mount Holyoke College. The following informed consent is required by Mount Holyoke College for all participants in human subjects research. You will be asked to read sentences on a computer screen. Occasionally, you will be asked to answer questions about these sentences.

A. Your participation is voluntary.

B. You may withdraw your consent and discontinue participation in this study at any time. You will not be penalized in any way if you decide not to participate.

C. The procedures to be followed in the project will be explained to you, and any questions you may have about the aims or methods of the project will be answered.

D. All of the information from this study will be treated as strictly confidential. No names will be associated with the data in any way. If you provide your address in order to receive a report of this research upon its completion, that information will not be used to identify you in the data. The data will be stored in a locked office in Reese Psychology and Education Building at Mount Holyoke College, and the data will be accessible only to the investigators.

E. The results of this study will be made part of a final research report and may be used in papers submitted for publication or presented at professional conferences, but under no circumstances will your name or other identifying characteristics be included.

If you understand the above, and consent to participate in the project, please sign here:
_____ (Participant sign here)
_____ (Participant print name here)
_____ (Date)

If you have any questions about this research, contact one of the following individuals:
Emily Welch at (907) 227-5699 or ecwelch@mtholyoke.edu, Professor of Psychology Kathy Binder at (413) 538-2105 of kbinder@mtholyoke.edu, or the Chair of Mount Holyoke College's Institutional Review Board, Sirkka Kauffman, at (413) 538-2867 or skauffma@mtholyoke.edu.

Would you like a report on the group results of this research project upon its completion?

YES   NO

Address to which the report should be sent: _____

Appendix M

Letter to Parents Describing the Study and Permission Slip

January, 2005

Dear Parent or Guardian,

We are conducting a research project with fourth through eighth graders. Some of these students attend your child's school, and we are asking permission for your child to participate. This study is being conducted by Emily Welch, a psychology student at Mount Holyoke College, and is supervised by a Psychology faculty member, Kathy Binder. This study has been reviewed and approved by the Mount Holyoke College Internal Review Board.

While the focus of the larger study involves assessing literacy skills of functionally illiterate adults who are attending literacy training, we also need to assess the same skills in children who are acquiring these skills. Thus, the group of school-aged children will serve as a comparison group for the adults. Many literacy programs for adults are modeled after programs that are used to teach children how to read, and we would like to assess whether or not this approach is appropriate. Thus, the major purpose of this study is to assess the similarities and differences between children and adults who are learning to read.

Each child will participate individually in the task. Your child may choose not to participate, or if he or she does participate, he or she may withdraw from the activity at any time. This task will be presented as a game, which children generally like. We expect that this will be a positive experience for your child. We are primarily interested in two aspects of learning to read:
1) How the words with more than one potential meaning present challenges in reading, and
2) How context within a given sentence helps a reader overcome that difficultly

Each child's performance is confidential. The researcher will need to know only the first name of your child and his or her age.

I hope you feel that the exploration of how children (and adults) acquire reading skills is a worthwhile project, and you will be willing to let your child participate. If you should have any additional questions about this study, do not hesitate to contact me (907-227-5699 or ecwelch@mtholyoke.edu), the faculty supervisor Kathy Binder (413-538-2105 or kbinder@mtholyoke.edu) or the Chair of Mount Holyoke College's Institutional Review Board, Sirkka Kauffman, at 413-538-2867 or skauffma@mtholyoke.edu. I would greatly appreciate it if you would return the attached permission slip by _____. A copy of the final paper will be sent to your school for you to view.

Thank you,

Emily Welch
907-227-5699

Dear Parent or Guardian,

Please sign below next to your response concerning your child's participation the literacy study described in the attached letter, and return this form to your child's teacher.

_____ **YES**   I have read the attached letter, and I agree to let my child,

_____, participate in the study of literacy skills.

Signed _____ Date: _____

_____ **NO**   I have read the attached letter, and I have decided not to let my child,

_____, participate in the study of literacy skills.

Signed _____ Date: _____

Thank you very much for considering this request.

Sincerely,

Emily Welch

Please return this form to your child's teacher by: _____, 2005

Appendix N

Example Filler Sentences

I could not find an outlet for the lamp.

Bob ran into his cousin at the mall.

Anne did not giggle after she received detention.

Her welcome packet is not complete.

I enjoy sitting in the alcove to read.

Dad paid for an awning with his extra money.

My mother berated me for failing my quiz.

I can see the stain on his lapel from here.

Appendix O

Reading Comprehension Questions

Biased Word Questions – Affirmative Answer is Correct

Case
Was Mr. Butler's client an actor?
Did the jury decide the man was guilty?

Foot
Did he make the decision after he cut the ribbon?
Did Sarah tie the package together?

Biased Word Questions – Negative Answer is Correct

Club
Did Officer O'Brady carry two clubs (guns) at a time?
Did the criminal rob a gas station?

Issue
Did Paul cancel his magazine subscription last week?
Did her Dad subscribe to three magazines?

Balanced Word Questions – Affirmative Answer is Correct

Company
Did company (friends) come over for lunch?
Did the guests have good manners?

Record
Did Sam keep the record (gift) from his aunt?

Balanced Word Questions – Negative Answer is Correct

Date
Was Steve comfortable around Becky?
Was her boyfriend in a good mood?

Pitcher
Was the ball dropped during the first game of the season?
Did Aaron hear the announcer speak at the beginning of the game?

Appendix P

Debriefing Statement for Adult Participants

Thank You!

Thank you very much for your time and participation in our study. The task you just completed focused on lexically ambiguous words. Lexically ambiguous words are those that have only one spelling and pronunciation, with two or more meanings. For example, the word "pitcher" has only one spelling and pronunciation, but may refer to the container for liquids or the position on a baseball team.

In the task you just performed, you were presented with a sentence that contained either a lexically ambiguous or non-ambiguous word. You read sentences on a computer screen one word at a time. Occasionally you were asked to answer a comprehension question about a sentence you recently read. As you read, the amount of time you spent reading each word was recorded. This important information will inform the direction of future research about how readers resolve comprehension difficulties upon encountering lexically ambiguous words.

If you have any questions regarding this study, please do not hesitate to contact either of the investigators using the information listed below.

| Emily Welch | ecwelch@mtholyoke.edu | 907-227-5699 |
| Kathy Binder | kbinder@mtholyoke.edu | 413-538-2105 |

Appendix Q

Reading Comprehension Scores by Participant Group

Less Skilled Adults			Children			Skilled Adults		
S70	11	73.3	K22	14	93.3	MH68	14	93.3
S71	12	80	K23	15	100	MH69	14	93.3
S72	12	80	K24	13	86.7	MH70	15	100
S73	13	86.7	K25	12	80	MH71	15	100
S74	11	73.3	K26	14	93.3	MH72	14	93.3
S75	12	80	K27	13	86.7	MH73	14	93.3
S76	12	80	K28	14	93.3	MH74	13	86.7
S77	12	80	K29	14	93.3	MH75	13	86.7
S78	12	80	K30	12	80	MH76	10	66.7
S80	13	86.7	K31	15	100	MH77	14	93.3
S81	11	73.3	K32	15	100	MH78	13	86.7
S82	13	86.7	K33	14	93.3	MH80	12	80
S84	15	100	K34	11	73.3	MH81	14	93.3
S85	12	80	K35	12	80	MH82	14	93.3
S87	11	73.3	K36	13	86.7	MH83	15	100
S88	15	100	K37	15	100	MH84	13	86.7
S89	13	86.7	K38	12	80	MH85	14	93.3
S90	12	80	K39	15	100	MH86	15	100
S91	12	80	K40	14	93.3	MH87	14	93.3
S93	13	86.7	K41	13	86.7	MH88	15	100
S95	10	86.7	K42	12	80	MH89	11	73.3
S96	12	80	K44	14	93.3	MH90	13	86.7
S98	13	86.7	K45	10	66.7	MH91	14	93.3
S100	11	73.3	K50	14	93.3	MH92	15	100
			K51	13	86.7	MH93	11	73.3
Average	*12.2*	*81.4*		*13.3*	*88.8*		*14*	*90.4*

Comprehension rates are listed above for those participants whose data was included in final analysis. Participant number is noted in the first column. The center column specifies the number of questions that participant answered correctly out of fifteen. The column on the right presents the percentage of correctly answered questions. The average number of correctly answered questions and percent correct are italicized and listed in bold below its corresponding column.

Appendix R

Outlier Elimination Cut-Off Values by Participant Population

		Less Skilled Adults	Children	Skilled Adults
Target Word	**Mean**	0.79	0.66	0.45
	SD	0.56	0.42	0.21
	Cut-Off	*1.88*	*1.49*	*0.87*
Post-target Region	**Mean**	0.17	0.15	0.11
	SD	0.084	0.08	0.45
	Cut-Off	*0.34*	*0.32*	*0.2*

The cut-off value in italics above was calculated by adding two standard deviation values to the mean reading time on the target word or post-target region. These means and standard deviations were calculated within each population group.

Appendix S

Percentage of Total Data Eliminated as Outliers

		Less Skilled Adults	Children	Skilled Adults
Target Word	**Biased**	12/768 = *1.56%*	14/800 = *1.75%*	14/800 = *1.75%*
	Balanced	7/768 = .911%	9/800 = *1.13%*	11/800 = *1.38%*
	Total	*2.471%*	*2.88%*	*3.13%*
Post-target Region	**Biased**	7/758 = .923%	15/800 = *1.88%*	13/800 = *1.63%*
	Balanced	7/768 = .911%	8/800 = *1.00%*	18/800 = *2.25%*
	Total	*1.834%*	*2.88%*	*3.88%*

The percentages in italics above denote how much data from each participant group was excluded from final analysis as a result of the outlier elimination.

Appendix T

Weak Sentences Eliminated from Analysis

(1) Sally did not know the *sex* of the criminals, although they appeared to be white. (1)

(2) Although they appeared to be white, Sally did not know the *sex* of the criminals. (2)

(3) It ended up being terrible since her boyfriend was in a bad mood, even though she had looked forward to the *film* for weeks. (1)

(4) She had looked forward to the *film* for weeks, but it ended up being terrible, since her boyfriend was in a bad mood. (4)

(5) Jane thought that her dad had too many *bills* on the coffee table, but they were all from one magazine subscription. (2)

(6) They were all from one magazine subscription, but Jane thought that her dad had too many bills on the coffee table. (3)

(7) Paul still had several *bills* that he would receive, even though he cancelled his magazine subscription months ago. (3)

(8) Even though he cancelled his magazine subscription months ago, Paul still had several *bills* that he would receive. (4)

Reading time data from when participants read the above sentences were eliminated. The counterbalancing condition number in which these weaker sentences were presented follows in parentheses. Reading time data from two sentences were eliminated for each participant.

In sentences 1 and 2 above, the unambiguous control word "sex" does not fit as well into the sentence frame as the ambiguous target word "race."
In sentence 3 and 4 above, the control word "film" replaced the ambiguous target word "date." Likewise, the control word "bill" replaced the ambiguous target word "issue" in sentences 5 through 8 above. Since "film" and "bill" are also a lexically ambiguous words, reading time data associated with sentences in which these appeared as control words were removed before performing the subsequent analysis.

Appendix U

Native Language Rates by Reader Population

	Less Skilled Adults	Children	Skilled Adults
Yes	14	24	20
	56%	*96%*	*80%*
	10	3	1
No			
	40%	*12%*	*4%*
	1	2	0
Bilingual			
	4%	*8%*	*0%*

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