Recent research suggests that low-skill readers rely more on context to recognize a word’s meaning (Andrews & Bond, 2009; Ashby, Rayner, & Clifton, 2005). Many studies on individual differences in reading have used reading comprehension as the primary measure of skill however, spelling skill may be a better predictor of reading ability than comprehension (Andrews & Bond, 2009). The current study takes spelling skill as the primary measure of reading ability and uses lexically ambiguous words to evaluate context use among high- and low-skill readers. Lexically ambiguous words have more than one distinct meaning; therefore, context is necessary for selecting the appropriate meaning. Participants read sentences containing ambiguous words. Context prior to the ambiguous word supported the infrequent, subordinate meaning. Results suggest that low-skill readers are able to resolve the ambiguity on the target word without incurring the time cost typically associated with ambiguous word processing. Conversely, high-skill readers show the typically time cost on the ambiguous word however, this does not appear to result in ambiguity resolution on the target word. Thus, the results support a larger influence of context for low-skill readers than for high-skill readers. Results are discussed in regard to the lexical quality hypothesis (Perfetti, 2007).
Word Recognition in High and Low Skill Spellers: Context effects on Lexical Ambiguity Resolution

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By

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Word Recognition in High and Low Skill Spellers: Context effects on Lexical Ambiguity Resolution

Reading is an extraordinary skill – in a fraction of a second marks on a page are processed perceptually and recognized as words. Word recognition occurs when readers access the long-term memory representation of the words meaning. This semantic processing imbues words with meaning which are then integrated within the larger text representation (Rayner, 1998). However, word recognition can be impacted by individual skill differences even among the population of skilled adult readers. That is, college-aged readers and adult readers who do not struggle with literacy and who do not report any reading disabilities exhibit individual differences in reading behavior. Readers who score high on measures of skill, such as reading comprehension or spelling ability, rely on lexical properties, such as how a word is spelled, syntax, and word frequency, to recognize words. In contrast, readers who do not perform well on skill measures have been shown to rely more on contextual features to recognize words (e.g. Andrews & Bond, 2009; Andrews & Scarratt, 1996; Ashby, Rayner, & Clifton, 2005; Hersch & Andrews, 2012; Perfetti, 1992). Many words can be recognized by their lexical properties; however, contextual support is crucial to accurately access the meaning of semantically ambiguous words. Semantically ambiguous words have more than one distinct meaning but often share the same spelling. Therefore, when reading these words, selecting the appropriate meaning typically depends on contextual support (e.g., Duffy, Morris, Rayner, 1988; Morris & Folk, 1998). Thus, by exploiting the ambiguity that occurs naturally in the language, the role of context on word recognition can be examined in a reading task.
Activating a word’s meaning is dependent on the influence of two types of processing: bottom-up processing oflexical properties and top-down processing of contextual information (see Andrews & Bond, 2009 for a review). Top-down influences on word recognition include factors such as predictability from context, and consistency of a word in the overall text representation. Bottom-up processing is impacted by lexical factors such as word frequency, word familiarity, and orthographic consistency or complexity. Orthographic consistency refers to how that word is spelled. Some words are spelled in a way that is consistent with spelling-sound relationships (e.g. cast). Other words, however, do not maintain that consistency (e.g. yacht) making them more difficult to process (e.g. Andrews, 1982; Baron & Strawson, 1976; Hino & Lupker, 2000). Skilled readers are adept at recognizing words relying strongly on bottom-up processing (Andrews and Bond, 2009; Hersch and Andrews, 2012). That is, a word’s meaning is quickly activated based on orthographic information – or how the word is spelled – with little influence from top-down processing. However, bottom-up word recognition is not impervious to contextual influence. Previous research has demonstrated that context can result in speeded access to a word (eg. Ehrlich & Rayner, 1981; Fischler & Bloom, 1979; Morris & Folk, 1998; Foss, 1982; Hess, Foss & Carroll, 1995; Morris, 1992; Schuberth, Spoehr & Lane, 1981). Stanovich and West (1979) presented skilled reading participants with sentence contexts but omitted the sentence-final target words. Contexts were either consistent or inconsistent with the target, and some target words were preceded only by the word the, a no-context control condition. The target word was also degraded in some of the trials, making it more difficult for participants to read it. When the target word was intact, there was no effect of context on naming time for the target word. However, degradation of the target word resulted in facilitation from context relative to the no-context control condition. The researchers argued that when the
target word was easy to read, participants quickly read the word based on bottom-up activation from the word’s letters. By degrading the target and making it more difficult, readers were sufficiently slowed, which allowed context to operate on the word recognition process.

Context effects have also been demonstrated in the eye movement record. (e.g. Morris, 1992; Morris & Folk, 1998; Rayner & Well, 1996; Warren & McConnell, 2007; Warren, McConnell, & Rayner, 2008). In eye movement studies, the time spent looking at a word is indicative of lexical processing or the time it takes to activate information about the word in long-term memory (see Rayner, 1998 for a review). Thus, difficulty processing a given word leads to longer reading times compared to words that are easy to process. Contextual support can facilitate word recognition and lead to shorter reading times. Previous research shows that readers spend less time looking at a target word when it appears in a highly-constraining, related context compared to when the same word appears in a less constraining context (Erhlich & Rayner, 1981; Rayner, Warren, Juhasz, & Liversedge, 2004; Rayner & Well, 1996). This is particularly true when the target word is also predictable from the context (Ehrlich & Rayner, 1981). For example, the word shark will be read more quickly in the highly constraining sentence, “The coast guard warned that someone had seen a shark off the north shore of the island,” than in the low-constraint sentence, “The zookeeper explained that the lifespan of a shark is longer than the other animals he talked about,” (Erhlich and Rayner, 1981). The target word shark receives a processing benefit from prior context. Researchers suggested that highly-constraining context lowers the activation threshold for word recognition, thereby decreasing the dependency on bottom-up processes. In this way contextual support can result in speeded access to a word’s meaning. However, recent research suggests that high- and low-skill readers may not use bottom-up processing and contextual support in the way or to the same degree. Instead, it
has been suggested that high-skill readers do not need to use context to recognize words but that low-skill readers rely more heavily on context to support word recognition (e.g. Andrews & Bond, 2009; Andrews & Scarratt, 1996; Ashby, et al., 2005; Hersch & Andrews, 2012; Perfetti, 1992).

Previous research investigating the relationship between context use and skill has largely been focused on developing readers (e.g. Jenkins, Fuchs, Van Den Broek, Espin, & Deno, 2003; Nation, & Snowling, 1998; Stanovich, West, & Feeman, 1981; West & Stanovich, 1978) or disordered populations (e.g. Balota, & Duchek, 1991; Federmeier, Kutas, & Schul, 2010; Hartman, 1991). For example, West and Stanovich (1978) presented readers of three different age groups – fourth graders, sixth graders and college students – with simple sentences in which a sentence-final, highly predictable noun was omitted. Participants were asked to read aloud the sentence context and, when the predictable noun was displayed after a short delay, to quickly read it aloud as well. Sentences were either congruous or incongruous with the target noun. A neutral context condition presented only the word “the” in place of sentence context. They found that congruous context facilitated naming, relative to the incongruous and neutral context condition, in younger readers but not in older readers. Similarly, young readers were slowed by the presentation of incongruous contexts, but adult readers were not. This suggests that younger readers rely on context for meaning activation. However, the researchers also measured spelling ability and found that spelling skill was more highly correlated with performance than was age, suggesting that low-skill spellers are more reliant on sentence context.

Spelling ability is one of many ways to assess skill in the adult reader population (ex. Reading comprehension, reading speed, vocabulary) but recent research suggests spelling may be a unique predictor of performance on reading tasks (Andrews & Bond, 2009; Andrews &
Hersch, 2010; Andrews & Lo, 2012; Burt & Jared, 2016; Hersch & Andrews, 2012). Perfetti (1992) argued that spelling ability better differentiates between high and low skill readers than reading comprehension ability because spelling requires precision whereas comprehension does not. Most words have only one correct spelling. To recall words correctly from memory, orthographic representations must include the exact letters of a given word and the order of those letters. Thus being a good speller requires precise orthographic representations. These orthographic representations are the gateway to word recognition in that they activate the semantic information associated with the orthography. Reading comprehension measures, however, do not necessarily require precision; good comprehenders can rely on multiple skills and strategies. For instance, readers may choose to read comprehension questions first and then seek out the answers in the text without having to read it in its entirety. Working memory also contributes to reading comprehension; those with higher working memory ability are more likely than people with low working memory ability to perform well on reading comprehension tests (e.g. Cain, Oakhill, & Bryant, 2004; Daneman, & Carpenter, 1980; Nation, Adams, Bowyer-Crane, & Snowling, 1999; Seigneuric, Ehrlich, Oakhill, & Yuill, 2000). Monitoring ability – how well one can keep track of their own comprehension – has also been shown to influence performance in reading comprehension (e.g. Cain, et al., 2004; Malone, & Mastropieri, 1991; Zinar, 2000). Thus, unlike spelling skill, measures of reading comprehension skill are likely to be influenced by the combined effects of multiple skills.

Andrews and Bond (2009) investigated this relationship by classifying participants by both reading and spelling ability. Measures of comprehension ability and spelling ability were only moderately correlated in their samples (r=.35). In a memory-probe task, participants read a sentence containing an ambiguous word and were then presented with a probe word that was
either related to the meaning of the ambiguous word in the sentence or to the alternative meaning (She danced all night at the ball. – WALTZ/THROW). Participants then had to respond by saying whether or not the probe had been a part of the sentence. The results indicate that good spellers, regardless of reading comprehension ability, are less likely than poor spellers to falsely report that a probe related to the context was included in the sentence. This suggests that good spellers experienced less interference from context than the poor spellers. The researchers concluded that poor spellers are more likely to rely on context to activate word meanings. Poor spellers’ reliance on context led to a “false memory” of having seen the probe word in the sentence. Good spellers were less susceptible to these “false memories”, suggesting they relied on the spelling of the target word to determine that it was not present in the sentence.

Converging evidence from several studies suggests that less-skilled readers rely more on context during word recognition (Andrews & Bond, 2009; Ashby et al., 2005; Hersch & Andrews, 2012). However, it is unclear what it means to rely more on context. Before this question can even be addressed, one must first decide what is meant by context. There are two types of context defined in the literature: lexical context and message-level context. Lexical context effects arise due to the strong semantic associations that occur between words. Activating one of the associates can provide a processing boost to the other associate through the automatic process of spreading activation, sometimes referred to as intralexical priming (e.g. Collins & Loftus, 1975; Dell & Reich, 1981; Meyer & Schvaneveldt, 1976; Seidenberg, Tanenhaus, Leiman, & Bienkowski, 1982; Swinney, 1979). A second type of context is message-level context, which operates within the overall text representation (Folk & Morris, 1998; Morris, 1994; Traxler, Foss, Seely, Kaup, Morris, 2000). This type of context is not well understood, but it is thought to be the result of a consistent message in a sentence or longer text.
that is contextually related to a target word. Message-level context does not necessarily contain strong semantic associates and, therefore, any facilitation in word processing cannot be attributed to spreading activation. Instead, message-level context is thought to be the result of higher-order processes, such as making inferences and building a text representation, that maintain a general congruency between the message context and a target word. When message context is consistent with a target word, word recognition is facilitated. Previous research on individual differences in context use has not distinguished between these two types of context. Therefore, in order to address the question, what does it mean to rely more on context? it is necessary to begin by examining the role of skill in both types of contextual facilitation.

One way to examine the impact of context on word recognition is through the use of semantically ambiguous words that have two or more distinct meanings but only one correct spelling (e.g. bank: financial institution; side of a river). Thus, selecting the appropriate meaning is dependent on the context in which the word appears. In order to select a meaning, the word’s representation must be accessed in long term memory. Access to a word’s meaning is impacted by lexical factors, such as correct orthography-to-meaning mappings, and word frequency – how often the word is encountered in a language. The frequency of a word is directly related to how quickly that word will be accessed (e.g. Hyönä & Olson, 1995; Inhoff & Rayner, 1986; Jared, Levy, & Rayner, 1999; Kennison & Clifton, 1995; Rayner & Duffy, 1986; Rayner & Fischer, 1996; Rayner, Sereno, & Raney, 1996). Generally, high-frequency words are recognized more quickly than low frequency words. Relative meaning frequency is a crucial factor for how quickly the appropriate meaning of an ambiguous can be accessed. Lexically ambiguous words that have one meaning that is much more frequent than another are typically called “biased” words – one frequent, dominant meaning and another less-likely, subordinate meaning (e.g.
bank: financial intuition, frequent; edge of a river, less frequent) (e.g. Binder & Morris, 1995; Dopkins, Morris, & Rayner, 1992; Duffy, et al., 1988; Rayner & Duffy, 1986; Rayner & Frazier, 1989; Rayner, Pacht, & Duffy, 1994; Sereno, Pacht, & Rayner, 1992). In the absence of context, meaning frequency determines the order in which the meanings of a biased ambiguous word will be accessed; the dominant meaning will be selected with little or no competition from the subordinate meaning (Binder & Morris, 1995; Dopkins et al., 1992; Duffy, et al., 1988; Folk & Morris, 1995; Rayner & Duffy, 1986; Rayner & Frazier, 1989; Rayner, et al., 1994; Sereno, Pacht, & Rayner, 1992). However, according to the reordered access model of lexical ambiguity resolution (Duffy et al., 1988), context can interact with meaning frequency to temporarily reorder meaning dominance; instead of the frequent, dominant meaning being activated first and without competition, the reordering allows the less-frequent, subordinate meaning to become activated around the same time as the dominant meaning and leads to competition for meaning selection (Duffy, et al., 1992). For example, when context supports the infrequent, subordinate meaning as in “She forgot her fishing pole near the bank and ran towards the river,” reading times on the ambiguous word (bank) will increase due to meaning competition (Dopkins et al., 1992; Duffy et al., 1998; Rayner et al., 1994). Context boosts the activation of the appropriate meaning – in this case, the less-frequent, subordinate meaning. Preceding contextual support for the subordinate meaning, as in the example above, helps to boost the activation of this meaning allowing it to become activated close in time to the dominant meaning, resulting in a time consuming selection process based on meaning competition. Readers can select between the activated meanings and are more likely to choose the meaning that is supported by the context (Duffy et al., 1998; Rayner et al., 1994). Even though this results in increased reading times on the ambiguous word relative to a control word readers who select the appropriate meaning are
less-likely to encounter difficulty later in the text. When the contextually appropriate meaning is selected readers have little difficulty integrating this meaning into the rest of text. This results in shorter reading times in the post-target region compared to when context is neutral. This pattern – longer reading times on a biased ambiguous word but shorter post-target reading times – emerges only when prior context supports the less-likely subordinate interpretation of a biased ambiguous word and is called the subordinate bias effect (SBE). The presence of the SBE indicates that readers selected the appropriate meaning of the word after competition and experienced no difficulty integrating this meaning into the text representation (Rayner et al., 1994). The current study exploits lexical ambiguity and the SBE to examine how context influences word recognition in high- and low-skill readers.

**Current Study**

Recent attention to individual differences in adult readers has indicated that there are indeed differences in word recognition among skilled readers (Andrews & Bond, 2009; Andrews & Hersch, 2010; Ashby et al., 2005; Hersch & Andrews, 2012). Generally, high-skill readers are able to activate the meaning of a word through bottom-up processing – accessing a meaning directly from orthography, with little influence of context. Low-skill readers, on the other hand, tend to rely on contextual information to aid access to a word’s representation, presumably as a result of their weaker lexical representations of words (Andrews and Bond. 2009; Hersch and Andrews, 2012). However, some word meanings, like lexically ambiguous words, cannot be accessed based on orthography alone when they have a shared spelling (i.e. *bank*); context is necessary to select among possible meanings. Strictly bottom-up processing would likely lead readers to choose the dominant interpretation, as this meaning would be accessed rapidly due to high meaning frequency. Thus, skilled reading must involve both top-down and bottom-up
processing. However, *how* and *when* readers of different ability use these processes remains an open question.

There is converging evidence that low-skill readers rely on context during word recognition and that high-skill readers, by virtue of strong mappings between orthography and semantics, do not need to use context to activate a word’s meaning (Andrews & Bond, 2009; Ashby et al., 2005; Hersch & Andrews, 2012). However, to the author’s knowledge, no study has examined individual differences in context use during an on-line reading task. Drawing on the well-established effects of lexical ambiguity, it is possible to examine the interaction between skill and context use during a reading task to evaluate the claim that low-skill readers rely more on context. The current study examines the relationship between skill and context by embedding ambiguous words in sentences with preceding context supporting the subordinate meaning.

Materials used in the current study were adopted from Dopkins et al., (1992). Dopkins and colleagues examined whether or not the subordinate bias effect (SBE) was present in order to discriminate between competing models of lexical ambiguity resolution; their aim was to evaluate predictions from the integration model and the reordered access model of lexical ambiguity resolution. To do so, researchers embedded biased ambiguous words into sentences in which prior context was consistent with the infrequent, subordinate meaning. The text preceding the ambiguous word was: supportive of the subordinate meaning, provided evidence against the dominant meaning, or was neutral and did not provide any support for either meaning. Sentences supporting the subordinate meaning were termed positive. Sentences that “voted down” the dominant meaning were termed negative. Instead of comparing processing on an ambiguous word to a control word, Dopkins et al. (1992), looked for the SBE by comparing reading time on the ambiguous word in a related context to a neutral context. Researchers found that readers
spent more time looking at the ambiguous word when it was in the negative condition compared to the neutral condition – evidence of early competition between activated meanings. They also found that readers spent less time in the disambiguating region that followed the ambiguous word when context was available compared to the neutral condition. Researchers concluded that readers initially resolved the ambiguity appropriately by selecting the contextually consistent subordinate interpretation and therefore they did not experience any difficulty integrating this meaning with the disambiguating material. This pattern of early competition on the ambiguous word but with little difficulty integrating the meaning with the sentence context supports the predications of the reordered access model. Numerous studies have subsequently confirmed the predictions of the reordered access model and the presence of the SBE (e.g. Binder & Morris, 1995; Binder & Rayner, 1998; Rayner, et al., 1994; Sereno, et al., 1992; Sereno, O’Donnell, & Rayner, 2006). The current study draws upon this well-established effect using the same materials used in Dopkins, et al., (1992) to examine how context influences lexical ambiguity resolution in high- and low-skill spellers.

All three context conditions employed in Dopkins, et al., (1992) were included in the current study, however, positive and negative contexts have been redefined. Positive context is defined as being strongly biased to the subordinate meaning and contains words strongly related to that interpretation. This condition is akin to lexical context; reading one word facilitates recognition of another strongly associated word through spreading activation (e.g. Collins & Loftus, 1975; Dell & Reich, 1981; Meyer & Schvaneveldt, 1976; Seidenberg et al., 1982; Swinney, 1979). In the negative context condition, the preceding context is biased to the subordinate only in that it suggests that the dominant meaning is inappropriate but does not contain context supportive of the subordinate. Negative preceding context does not contain any
words strongly related to either meaning of the target ambiguous word (See Methods section for a full discussion). This type of context functions as a message-level context (Morris & Folk, 1998; Morris, 1994; Traxler et al., 2000).

Since little is known about how these two types of context differ in terms of their mechanisms for contextual facilitation, it is difficult to make predictions specific to context type. If high-skill readers do not rely on context during meaning activation, or if context does little to influence meaning activation, then high-skill readers are more likely to select the wrong meaning of the ambiguous word initially, leading to confusion later in the sentence. This would be supported by longer reading times, or equivalent reading times, after encountering disambiguating material that follows the ambiguous word, compared to a neutral condition where preceding context is not available. Readers would be expected to initially select the more frequent dominant interpretation in the absence of prior biasing context. Conversely, low-skill readers relying on context should show the typical SBE with longer reading times on the ambiguous word, resulting in shorter reading times in the disambiguating region when compared to a neutral condition. When there is strong support for the subordinate meaning as in the positive condition, low-skill readers are likely to use context to activate both the dominant and subordinate meanings close enough in time to allow them to compete for selection. These readers can then use the contextual support to choose the appropriate interpretation. High-skill readers, who are less likely to rely on context, may be more likely to initially select the wrong interpretation; orthography may quickly activate the dominant meaning with little competition from the subordinate interpretation. Thus, it may be that efficient bottom-up processing of the ambiguous word will leave little time for reordering meaning and therefore lead high-skill
readers to choose the dominant interpretation despite the contextual evidence that the subordinate is appropriate.

It is unclear how readers will respond to weak contextual support as in the negative context condition. If relying on context also means low-skill readers are more sensitive to contextual information, then they may be able to make more efficient use of context. This sensitivity may result in the SBE. However, if the negative context is too weak to reorder meaning dominance, then it is predicted that the low-skill readers will erroneously select the dominant interpretation and experience confusion once encountering the disambiguating material. High-skill readers relying solely on orthography-to-meaning mappings are likely to exhibit the same pattern as in the positive condition – no effect of context on initial meaning activation that leads to selecting the dominant interpretation based on meaning frequency. The interaction between context type and spelling ability will contribute to understanding how context influences meaning activation in readers with different skill levels.

Methods

Participants

One hundred and eight Kent State University students participated in this study for course credit. All participants had normal or corrected vision and reported having no reading disabilities. All participants reported speaking English as a first language. 12 participants were removed from analysis for answering less than 80% of comprehension questions correctly. An additional 6 participants were removed due to track loss resulting in less than 50% of trial data available for analysis. Thus, a total of 90 participants contributed data for analyses.
Reading skill was measured using the comprehension subtest percentile score on the Nelson-Denny Reading Test. The average score was at the 58th percentile (SD=22.36) and ranged from the 2nd to the 95th percentile.

Participants also completed a spelling recall assessment. The assessment was comprised of 20 items. The average score was 48.6% correct (SD=23) and ranged from 10% to 95% correct. Participants received course credit for participation.

Participants also completed a vocabulary measure. This was included to ensure that participants knew both meanings of the ambiguous words used in experimental sentences. The test was an effort to ensure that any effect on the ambiguous word or in the following disambiguating region could be attributed to context and was not the result of participant’s not being aware of two possible interpretations of the target word. Participants failed to report the subordinate meaning of the ambiguous words on 22% of trials.

Stimuli and Design

Materials for the reading portion of the study were adopted from Dopkins et al. (1992). 23 biased ambiguous words were embedded into sentences between two clauses. The first clause contained either positive, negative, or neutral context. In the positive and negative context conditions, the preceding context always biased the subordinate meaning of the ambiguous word. Neutral context provided no support for either the dominant or the subordinate meaning. In all conditions, the clause following the ambiguous word always was consistent with the subordinate meaning.

Latent Semantic Analysis (LSA) was used to determine the degree of relatedness between the preceding context and the subordinate meaning of the target word (Landauer & Dumais, 1997). LSA uses over 57 million words pulled from 444 works of literature to determine
statistically the relatedness of words, phrases and/or entire documents to each other by dividing the words into 300 factors in a multidimensional semantic space. The degree of relatedness is measured on a scale of -1.0 to +1.0. A +1.0 score indicates complete semantic relatedness (identical words). A score of +.30 or higher indicates a strong semantic connection. To determine the degree of semantic relatedness in the current study, the entire preceding context region was compared to a synonym for the subordinate meaning for each of the 23 target words and all three context conditions. For example, the context region, *viciously snarling and growling*, was compared to the word *dog*, a synonym for the subordinate interpretation of the target word, *boxer*. The mean LSA score for the positive condition was .30. There was no indication that the preceding context was semantically related to the target word in either the negative (-.0009) or neutral (.006) conditions.

A separate set of 30 participants completed a cloze task where they were presented with sentences containing context up to the ambiguous words. Participants were asked to supply the following word in the sentence. No participant predicted the ambiguous word. This ensures that none of the target words were predictable from context.

In total, there were 69 experimental sentences, three for each of the 23 ambiguous words (see Appendix A). Three counterbalancing groups were created so that participants read one sentence from each of the three context conditions: positive, negative, and neutral for each ambiguous word. An example from each condition is presented below:

**Positive:** *Viciously snarling and growling, the boxer soon barked at the baggage attendant.*

**Negative:** *Arriving from Chicago in a crate, the boxer soon barked at the baggage attendant.*
Neutral: *As we had all expected and feared, the boxer soon barked at the baggage attendant.*

To ensure participants were reading for comprehension, true or false questions were presented after each experimental sentence as well as after each of 24 filler sentences. Twelve participants were removed for scoring below 80% on the comprehension questions. The average comprehension question score for the 90 participants for whom data was analyzed was 92%.

The vocabulary measure consisted of the 23 ambiguous words embedded in experimental sentences and an additional 25 filler words. Eleven of the filler words were ambiguous words but they were not encountered while reading the experimental sentences. See Appendix B for experimental vocabulary items.

**Apparatus**

Data were collected using an SR Research Eyelink 1000 Plus eye tracker. The eye tracker has a sampling rate of 1000Hz. Sentences were presented on a 21.5-inch iMac Retinal Display screen. Participants were seated approximately 60cm away from the screen. Eye movements were recorded from the right eye only, but reading was binocular. One degree of visual angle was equal to 2.4 letters.

**Procedure**

Informed consent was obtained from all participants. The experimental procedure consisted of three parts: skills assessment, reading session, and a vocabulary test. Participants began by completing the skills assessments. The comprehension subtest of the Nelson-Denny Reading Test was administered first. The comprehension test consists of seven short passages followed by 38 comprehension questions. Participants were given 20 minutes to complete this test and notified of the time remaining at 10 minutes, 15 minutes and 19 minutes.
Participants then completed a spelling assessment consisting of both recall and recognition components. The recall portion was administered first. Participants listened to an audio recording of 20 words adopted from Burt and Tate (2002) and were instructed to spell the word correctly on the provided answer sheet. They then completed the recognition portion of the assessment. Participants were given unlimited time to circle all the incorrectly spelled words from a list of 50 words. Twenty-five words were misspelled.

Following the skill assessments, participants eye movements were monitored as they read the experimental and filler sentences, with randomized presentation. Participants were instructed to read 23 experimental and 23 filler sentences silently for comprehension. Participants pressed a button when they had finished each sentence after which they were presented with a yes-or-no comprehension question. Participants were to press a button to indicate their answer. Average accuracy for comprehension questions was 86%. Once a response was made, the experimenter presented the next sentence. The reading session took approximately 15 minutes.

Before beginning the reading sessions, the experimenter calibrated the eye tracker. Participants were instructed to look as a white circle in the center of the screen. Participants were told to follow the white circle with their eyes as it moved to nine different positions on the screen. This was done to determine gaze positions. When the degree of visual angle error was less than .50 degrees, calibration was considered acceptable. Before each trial, the experimenter ensured the degree of visual angle error remained less than .50 degrees. If the error increased beyond this limit, the experimenter recalibrated the eye tracker and continued with the reading session.

After completing the reading session, participants completed a vocabulary measure comprised of the ambiguous words encountered during eye tracking. They were told that they
would be given a word and asked to select from a list all the possible definitions of that word. There was no time limit for completing this measure however; the average time to complete the vocabulary session was 10 minutes.

**Results**

The data were analyzed with the statistical program R, version 2.11.1 (R Project, 2011) using Linear Mixed-Effects Models (LMM), a type of hierarchical linear model that allows for random effects of both subject and item. A fully random model was employed whenever possible. However, fully specified models often failed to converge. In this case, the item random slope was omitted first. If this model also failed to converge or when there were high correlations between slopes, a non-random model was used (Andrews & Veldre, 2014). A \( t \) or \( z \) value greater than 1.96 indicates statistical significance. Analyses with dichotomous variables, such as regressions, were analyzed using logistic LMMs.

Spelling skill was entered into the model as a fixed effect and analyzed as a continuous variable across all context conditions. Context type was also entered into the model as fixed effect. However, positive and negative context types were analyzed separately. Thus, positive context was compared to the neutral condition along with spelling skill; negative context was compared to the neutral condition along with spelling skill. The interactions between skill and each context type were also analyzed separately.

This data analysis approach was employed so that any effect of context in either context condition could be compared to the neutral condition. This is important because determining the presence of the SBE rests in the difference between reading times in a context condition and reading times in a neutral condition. The neutral condition provides a baseline for reading times when context is unavailable. In this condition, readers are likely to select the frequent, dominant
meaning of the ambiguous word because there is no context to suggest otherwise. Therefore, readers are likely to experience confusion in the disambiguating region and thus spend additional time in this region. Comparing the reading times in the neutral condition to those in the positive and negative context conditions allows for an examination of how of context influences meaning selection. Separate analyses not only allowed for such a comparison but also excluded the uninformative comparison between reading times in the positive condition and reading times in the negative condition. This comparison is not theoretically motivated and thus no specific predications were made regarding skill differences in the positive and negative conditions.

Simple effects were analyzed to examine the effect of each type of context for both high and low-skill readers. For the purposes of these analyses, high-skill readers are those who scored above a 66% (n=21) on the spelling measure. Low-skill readers are those who scored below a 33% (n=25) on the spelling measure. Within in both skill groups, negative and positive context were separately analyzed with respect to the neutral condition.

Fixation durations less than 100ms as well as those greater than 1,000ms were excluded from analysis as they are not reflective of typical lexical processing and are instead caused by eye blink or track loss (Rayner, 1998). This resulted in a loss of 2% of all trials.

The target word region consisted of the ambiguous word. A second critical region, the disambiguating material, was defined as the word following the target to the end of the sentence. The context region consisted of all the material preceding the ambiguous word.

Several dependent measures of early and late processing were included. All dependent measures were centered prior to analysis. Early measures reflect lexical processing; late measures are indicative of higher level processing such as comprehension and text integration. The SBE arises from lexical processing and thus early reading measures were used to detect the
effect of context on meaning selection while late measures were employed to examine
difficulties in comprehension and text integration. Two measures of early processing were
included: gaze duration and first pass time. Gaze duration refers to the sum of all fixations on the
target word before the eyes leave the target. Similarly, first pass time is the sum of all fixations in
a region before the eyes first leave that region. Thus, first pass time was used to analyze early
processing in the disambiguating region while gaze duration was used to analyze early
processing on the ambiguous word. Go-past time refers to the sum of all fixations made before
the eyes first move to the disambiguating region. Thus, it differs from gaze duration in that it
includes regressions to earlier parts of the sentence and refixations of the target word. In this
way, it is reflective of both early and late processing and can be indicative of difficulties in both
lexical processing and text comprehension. Late processing was also examined through the
measure of total time. This measure includes all fixations in a region or on a target word,
including refixations and regressions or re-reading within the region. Total time was analyzed for
both the target word and the disambiguating region. Regressions were also included as a measure
of late processing. Regressions refer to percentage of time readers left a region to reread an
earlier part of the sentence.

Tables were constructed based on the group means for both high- and low-skill spellers.
High-skill spellers are defined as those who scored 66% and above on the spelling recall
measure. Low-skill spellers are those who scored 33% or below on the spelling measure.

**Target Word Regions**

*Initial Processing:* There was a significant main effect of spelling skill on gaze duration
on the target word, $\beta = -1.22$, $SE= .323$, $t= -3.77$. This indicates that higher-skill spellers spent
less time reading the ambiguous word when they first encountered it relative to lower-skill
spellers (See Table 1 for LME results). The main effect of positive context on gaze durations for
the target word ($M=282\text{ms}, SD=144$) failed to reach significance when compared to the neutral
condition ($M=275\text{ms}, SD=133$), $\beta = 6.75, SE=7.96, t=.849$. There was a trend towards a
significant interaction between positive context and spelling skill, $\beta = .553, SE=.353, t= 1.60$. An analysis of simple effects indicates that high-skill spellers spent significantly more time
fixated on the ambiguous word in the positive context condition ($M=257\text{ms}, SD=129$) than the
neutral condition ($M=226\text{ms}, SD=87$), $\beta = -32.19, SE = 13.45, t = 2.39$ (See Table 2 for skill
means). Low-skill spellers did not show this pattern. Gaze duration on the ambiguous word did
not differ significantly in the positive condition ($M=286\text{ms}, SD=158$) compared to the neutral
condition ($M=291\text{ms}, SD=145$), $\beta = -6.03, SE = 15.51, t = -.389$.

The main effect of negative context ($M=291\text{ms}, SD=144$) on the ambiguous word was
not significant when compared to the neutral condition ($M=275\text{ms}, SD=133$), $\beta = 8.38, SE=7.93,$
$t=1.06$. The interaction between spelling skill and negative context also failed to reach
significance, $\beta=.620, SE=.351, t=1.78$. However, the simple effects analyses revealed
differences based on skill. For high-skill spellers, gaze duration on the target word significantly
increased in the negative context condition ($M=269\text{ms}, SD=128$) compared to the neutral
condition ($M=226\text{ms}, SD=87$), $\beta = 44.02, SE = 13.25, t = 3.32$. Low-skill spellers did not show
any effect of negative context on the ambiguous word; gaze duration in the negative context
condition ($M=285\text{ms}, SD=143$) did not differ significantly from gaze duration in the neutral
condition ($M=291\text{ms}, SD=145$), $\beta = -4.03, SE = 18.06, t = -.223$. Longer reading times when
countext precedes the target word are attributed to competition between multiple activated
meanings. Thus, high-skill spellers show an effect of context on the target word in line with the
typical SBE pattern, but low-skill spellers do not.
**Total Time.** There was a significant main effect of spelling skill on total time measures on the ambiguous word, $\beta = -2.35$, $SE = .78$, $t = -3.02$. This suggests that as spelling skill increases, total reading time on the ambiguous word decreases (see Table 1 for LME results). The main effect of context in the positive condition ($M=446ms$, $SD=318$) did not reach statistical significance when compared to the neutral condition ($M=474ms$, $SD=316$), $\beta = -30.17$, $SE = 17.55$, $t = -1.72$. The interaction between spelling and positive context was not significant, $\beta = .58$, $SE = .78$, $t = .738$. The simple effects analyses revealed that total reading time on the ambiguous word did not significantly differ for high-skill spellers in positive context ($M=388ms$, $SD=253$) compared to the neutral condition ($M=387ms$, $SD=245$), $\beta = -.198$, $SE = 29.82$, $t = -.007$ (see Table 4 skill group means). Thus, high-skill spellers only showed inflated reading times on the ambiguous word in the positive versus neutral context conditions for initial processing, not for a measure that includes re-reading. For low-skill spellers, there was also no significant difference in total time on the target word when it was in the positive context ($M=469ms$, $SD=341$) compared to the neutral ($M=516ms$, $SD=347$), $\beta = -50.39$ $SE = 37.67$, $t = -1.34$ (see Table 4).

There was no main effect of negative context ($M=501ms$, $SD=332$) on total reading time for the ambiguous word when compared to total reading time in the neutral condition ($M=474ms$, $SD=347$), $\beta = 23.28$, $SE = 17.48$, $t = 1.33$. High-skill spellers spent significantly more time on the target word in the negative context ($M=448ms$, $SD=265$) compared to the neutral ($M=387ms$, $SD=245$), $\beta = 61.97$, $SE = 30.42$, $t = 2.04$. Low-skill spellers did not show a significant difference in total reading time on the ambiguous word between the negative ($M=513ms$, $SD=319$) and neutral context conditions ($M=516ms$, $SD=347$), $\beta = 10.93$, $SE = 38.78$, $t = .282$.

**Go-Past Region: Prior Context and the Target Word**
There was a significant effect of spelling skill on go-past reading time, $\beta = -15.21$, $SE = 3.47$, $t = -4.38$, such that as spelling skill increases reading time in the go-past region decreases (see Table 1 for LME results). The analysis also revealed a significant main of effect of go-past time in the positive context condition ($M=2292ms$, $SD=1513$) compared to the neutral condition ($M=2158ms$, $SD=1115$), $\beta = 133.15$, $SE = 53.5$, $t = 2.49$. This suggests that when positive context was available, readers took longer to move out of the go-past region than when there was neutral context preceding the ambiguous word. The interaction between positive context and skill was also significant, $\beta = -5.09$, $SE = 2.29$, $t = -2.22$. Follow-up analyses revealed no significant effect of positive context ($M=1754ms$, $SD=834$) on go-past time for high-skill spellers compared to the neutral condition ($M=1774$, $SD=986$), $\beta = -45.98$, $SE = 77.74$, $t = -.592$ (see Table 3 for skill means). Low-skill spellers, however, took significantly more time to move past the ambiguous word when in the positive context condition ($M=2867ms$, $SD=1931$) compared to the neutral condition ($M=2544ms$, $SD=957$), $\beta = 314.6$, $SE = 127.8$, $t = 2.46$. This may suggest that low skill spellers were particularly sensitive to the positive context.

In contrast to the results for the positive context condition, there was no significant main effect of negative context ($M=2190ms$, $SD=1179$) on go-past reading times compared to the neutral condition ($M=2158ms$, $SD=1115$), $\beta = 24.79$, $SE = 53.53$, $t = .463$. The interaction between negative context and spelling skill was also not significant, $\beta = -.92$, $SE = 2.29$, $t = -.401$. High-skill spellers did not have significantly different go-past time in the negative context condition ($M=1800ms$, $SD=916$) compared to the neutral condition ($M=1774ms$, $SD=986$), $\beta = 10.06$, $SE = 84.51$, $t = .12$. Similarly, there was no significant effect of negative context ($M=2621ms$, $SD=1186$) on go-past reading time compared to the neutral condition ($M=2544ms$, $SD=957$), $\beta = 64.18$, $SE = 90.76$, $t = .71$, for low-skill spellers. Therefore, only low-skill spellers
spent more time reading the context region and subsequent target word only in the positive condition. This suggests low-skill spellers may be immediately impacted by the presence of context (see discussion).

**Disambiguating Region**

The LME analysis yielded a significant main effect of spelling skill on first pass reading time in the disambiguating region, $\beta = -9.91$, $SE = 1.85$, $t = -5.36$. This suggests that as spelling skill increases, first pass time decreases (See Table 5 for LME results). The main effect of positive context ($M=1376\text{ms}$, $SD=815$) on first pass time was not significant in comparison to the neutral context condition ($M=1412\text{ms}$, $SD=820$), $\beta = -48.63$, $SE = 38.99$, $t = -1.25$. The interaction between positive context and spelling skill failed to reach significance, $\beta = 3.01$, $SE = 1.67$, $t=1.80$. High-skill spellers did not show significant difference in processing time in the disambiguating, post-target region when prior context was positive ($M=1181\text{ms}$, $SD=710$) compared to when prior context was neutral ($M=1139\text{ms}$, $SD=767$), $\beta = 33.89$, $SE = 75.76$, $t = .447$ (See Table 6 for skill group means). However, high-skill spellers spent less time numerically on the first pass of the disambiguating material, this difference was not significantly different from first pass time in that region in the neutral context condition. For low-skill spellers there was a marginally significant effect of positive context ($M=1492\text{ms}$, $SD=835$) on first pass time when compared to the neutral context condition ($M=1630\text{ms}$, $SD=835$), $\beta = -144.58$, $SE = 75.72$, $t = -1.91$.

There was a significant main effect of negative context ($M=1337\text{ms}$, $SD=803$) on first pass time compared to the neutral condition ($M=1412\text{ms}$, $SD=820$), $\beta = -82.77$, $SE = 39.01$, $t = -2.12$. First pass reading time in the disambiguating post-target region in the negative context condition was significantly faster than reading time in the neutral condition. Importantly, there
was also a significant interaction of negative context and spelling skill, $\beta = 3.58$, $SE= 1.67$, $t= 2.14$. First pass time in negative condition ($M=1213ms$, $SD=758$) did not differ significantly from the neutral condition ($M=1139ms$, $SD= 767$), $\beta = 63.05$, $SE = 84.47$, $t = 0.75$, for high-skill spellers. Low-skill spellers, on the other hand, were significantly faster in the negative condition ($M=1465ms$, $SD=794$) when compared to the neutral condition ($M=1630ms$, $SD=835$), $\beta = 160.15$, $SE = 76.01$, $t = -2.11$. Low-skill spellers displayed the pattern typical of the SBE – shorter first pass reading time when context is available than when context is neutral – though this difference was only marginally significant in the positive condition. The null effect displayed by high-skill spellers may suggest difficulty integrating the selected meaning with the disambiguating material.

There was a significant main effect of spelling skill on total time in the disambiguating region, $\beta = -11.88$, $SE = 3.32$, $t = -3.58$. This indicates that as spelling skill increases, total time in the disambiguating region decreases (See Table 5 for LME results). There was a significant main effect of positive context ($M=1925ms$, $SD=1177$) when compared to the neutral context condition ($M=2024ms$, $SD=1197$), $\beta = -118.55$, $SE = 48.97$, $t= -2.42$. The interaction between positive context and spelling skill was not significant, $\beta =-7.04$, $SE= 2.10$, $t= -.335$. However, high-skill spellers were found to spend significantly less total time in the disambiguating region when the context was positive ($M=1550ms$, $SD=820$) compared to when it was neutral ($M=1718ms$, $SD=1068$), $\beta = -194.07$, $SE= 89.27$, $t= -2.17$ (See Table 7 for skill group means). For low-skill spellers, there was no significant difference in total time for the positive context condition ($M=2184ms$, $SD=1299$) compared to the neutral context condition ($M=2246ms$, $SD=1093$), $\beta = -79.59$, $SE=100.86$, $t= -.789$. 

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There was no significant main effect of negative context (\(M=2013\text{ms, } SD=1133\)) on total reading time in comparison to the neutral context condition (\(M=2024\text{ms, } SD=1197\)), \(\beta = -21.17, SE= 48.99, t = -.432\). The interaction between negative context and spelling skill was also nonsignificant, \(\beta = .779, SE = 2.10, t = .371\). There was no significant difference between the negative condition (\(M=1782\text{ms, } SD=1014\)) and the neutral condition (\(M=1718\text{ms, } SD= 1068\)) for total reading time in the disambiguating region, \(\beta = 43.15, SE = 113.02, t = .382\), for high-skill spellers. Similarly, for low-skill spellers, total time in the disambiguating region for the negative context condition (\(M=2210\text{ms, } SD=1099\)) was not significantly different from reading time in the neutral condition (\(M=2246\text{ms, } SD=1093\)), \(\beta = -38.86, SE = 94.51, t = -.41\). Total time results suggest both high-skill and low-skill spellers may have reread the disambiguating material when the ambiguous word was presented in the negative context. This may indicate difficulty integrating the subordinate meaning with the text.

Results indicate no significant difference of context on regressions out of the disambiguating region (Negative, 14%; Positive, 14%; Neutral, 14%) and no effect of spelling skill on rate of regressions out of the region (High:14%; Low: 14%). This suggests that low reading times in the disambiguating region were not the result of leaving the region early to reevaluate an erroneous meaning selection.

Summary

Neither high-skill or low-skill spellers exhibited the typical subordinate bias effect of longer reading times on the target word when preceding context is available followed by shorter reading times in the disambiguating region when compared to the neutral condition. High-skill spellers had significantly longer reading times on the ambiguous word, which is typical of the SBE and indicative of competition between activated meanings. However, reading times in the
disambiguating region were not significantly faster than the neutral as would be expected if readers resolved the ambiguity on the word correctly. That is, if readers selected the subordinate interpretation that was consistent with the prior context (positive or negative), they should have been faster in the disambiguating region than when prior context was neutral. In the absence of prior biasing context in the neutral condition, the dominant interpretation should have been available for selection first, and selected. That interpretation would be inconsistent with the disambiguating region that followed the ambiguous word. The data pattern for high-skill spellers suggests that they experienced difficulty integrating the selected meaning of the ambiguous word with the disambiguating context as is evidenced by reading times comparable to the neutral condition. Taken together, it is possible that high-skill readers initially activated both possible meanings of the ambiguous word, as indicated by the inflated gaze duration times in the positive and neutral conditions relative to the neutral condition. However, because of their reliance on bottom-up processing, they sometimes selected the inappropriate (dominant) meaning resulting in confusion in the disambiguating region. The null effects of go-past reading time suggest high-skill spellers may not be immediately sensitive to sentence context.

Low-skill spellers showed an opposite pattern. There was no effect of context on initial reading times for the ambiguous word. Despite the lack of evidence for competition between meanings, low-skill spellers, surprisingly, did not show signs of confusion upon entering the disambiguating region. This suggests they selected the appropriate meaning of the ambiguous word even though they did not spend additional time on the target word. Shorter reading times in the disambiguating region (compared to the neutral condition) for both context conditions suggest low-skill spellers successfully integrated the appropriate meaning of the ambiguous word into the text. Additionally, low-skill spellers had longer go-past reading times in the positive
context condition. This suggests that low-skill spellers may be more sensitive to sentence context than high-skill spellers. One possible explanation for this pattern stems from low-skill spellers having longer reading times overall. Because low-skill spellers read more slowly than their high-skill counterparts, there is more time for context to influence the activation of meaning for ambiguous words, leading to correctly selecting the appropriate meaning without incurring a time cost on the ambiguous word.

**General Discussion**

The current study demonstrates the differential influence of context during word recognition among skilled readers. Furthermore, the findings support the use of spelling skill as a predictor of reading ability and replicate previous individual differences research. The results support the claim of previous researchers suggesting low-skill spellers rely more on context for word recognition than high-skill spellers (Andrews & Bond, 2009; Andrews & Scarratt, 1996; Ashby et al., 2005; Hersch & Andrews, 2012; Perfetti, 1992).

The context effects demonstrated in the current study are best framed within the reordered access model of ambiguity resolution (Binder & Morris, 1995; Binder & Rayner, 1998; Dopkins et al., 1992; Duffy et al., 1988; Rayner & Duffy, 1986; Rayner & Frazier, 1989; Rayner et al., 1994; Sereno et al., 1992). Even though skilled readers in the current sample did not demonstrate the typical SBE, the data remain consistent with the model. For low-skill readers, the effect of context was evident in the disambiguating region; for high-skill readers context effects were observed on the target word. For both high- and low-skill readers, context impacted the availability of ambiguous word meanings, however, *when* and *how* context impacted reading behavior differed by spelling ability.

Low-skill spellers in the current study appear to make more efficient use of context and, therefore, were able to choose the contextually appropriate meaning of the lexically ambiguous
words without spending more time fixated on the ambiguous word. Findings such as this have led to the conclusion that low-skill readers rely more on context to recognize words (e.g. Andrews & Bond, 2009; Ashby et al., 2005). However, what it means to rely more on context remains unclear. This is in part because researchers have not yet fully identified the mechanisms that give rise to context effects. Two types of contexts have been discussed in literature: lexical context and message-level context. Lexical context refers to strong associations between individual words such that the context is semantically related to the target word activation (e.g. Collins & Loftus, 1975; Dell & Reich, 1981; Meyer & Schvaneveldt, 1976; Seidenber et al., 1982; Swinney, 1979). A second type of context is message-level context that operates on the text representation (Folk & Morris, 1998; Morris, 1994; Traxler et al., 2000). Lexical context effects have been attributed to spreading activation where the activation of one word facilitates the subsequent activation of a semantic associate. Message-level context is thought to be the result of consistency between the prior sentence representation and the target word (Morris, 1994; Traxler et al., 2000). Message-level context does not need to contain semantically associated words and is not necessarily predictable. The context conditions in the current study can be likened to these different types of contexts: positive context contains lexically-associated words but negative context suggests the subordinate meaning is appropriate without using lexically-associated words. Latent Semantic Analysis (Landauer & Dumais, 1997) confirmed that the positive context condition had a high degree of semantic relatedness to the subordinate meaning of the ambiguous word. There was no evidence to suggest that the negative or neutral contexts were semantically associated with the target word. Therefore, the positive context used here is akin to lexical context and the negative context is most like that of a message-level
context. This distinction can begin to explain why neither high- nor low-skill spellers show the typical pattern associated with the SBE.

A crucial property of the context used in the current study is that in no sentence does it irrefutably exclude the dominant interpretation. Instead, in both conditions context either directly or indirectly suggests the subordinate meaning is most appropriate but does not rule out the possibility of a dominant interpretation. Thus, it may be reasonable to assume high-skill readers will not make use of this context and instead activate word meaning based on orthography alone. However, the data suggest high-skill readers are sensitive to prior context because they show increased reading times on the ambiguous word in both context conditions relative to the neutral condition. However, they do not show signs of successful ambiguity resolution in the disambiguating region. Measures of late word processing suggest that high-skill readers had particular difficulty in the negative context condition: greater rereading of the ambiguous word when context was negative and less rereading of the disambiguating region when context was positive. Taken together, this indicates lexical context may have a greater influence than message context on the word recognition processes of high-skill readers.

Previous research suggests that high-skill spellers may activate lexical neighbors, words of the same length that differ by only one letter (e.g., pitch/patch), more quickly than low-skill spellers. Andrews and Hersch (2010) found inhibitory effects of masked priming for high-skill spellers but facilitatory effects for low-skill readers. For high-skill spellers, the masked prime quickly activates neighbors, but they are also quick to inhibit these neighbors. Thus when the target – a neighbor of the prime word – is revealed, high-skill spellers are slower to respond because it had been previously inhibited. This suggests that spreading activation may be faster in high-skill readers and is consistent with previous research suggesting a quicker build up and
release from confusion when processing words in context (Balass, Nelson, & Perfetti, 2010). Thus, in the current study, lexical context may have activated the subordinate interpretation of the ambiguous word more so than message context for high-skill spellers.

If lexical context facilitates recognition in high-skill spellers, then it would be reasonable to expect that they would resolve the ambiguity on the word as predicted by the reordered access model. However, reading times in the disambiguating region were not significantly faster in either context condition compared to the neutral condition. Nevertheless, high-skill readers do resolve the ambiguity as evidenced by accurate responses to comprehension questions. Together this suggests that the ambiguity was not resolved on the word but at some point later in the sentence – namely, the disambiguating region.

High-skill readers in the current study may have activated both meanings of the ambiguous word – as suggested by longer gaze duration times on the ambiguous words in context conditions compared to neutral context – but did not complete meaning selection until after entering the disambiguating region. Previous research by Mason and Just (2007) suggests that high-skill readers – defined as high working memory ability – suspended meaning selection for ambiguous words until after reading the disambiguating material. This interpretation is consistent with the results of the current study, particularly with regard to lexical context. Lexical context may have facilitated activation of the subordinate meaning so that it was available to compete for selection close in time with the dominant meaning, as reflected in inflated gaze duration times on the ambiguous word in positive versus neutral context. However, because prior context does not completely rule out a dominant interpretation, high-skill readers may have maintained both meanings in memory and only selected among them after reading the disambiguating material. The additional time needed for selection would increase first pass time.
in the disambiguating region, and thus, may be what accounts for reading times comparable to neutral contexts in that region.

Late processing measures provide additional support for this interpretation. Positive context resulted in decreased total time in the disambiguating region while negative context produced no significant difference in total time compared to neutral. Conversely, there was an increase in total time on the ambiguous word in the negative context condition compared to neutral but not when context was positive. This pattern is consistent with the view that high-skill spellers suspended meaning selection when lexical context was available prior to the ambiguous word. Spreading activation from lexical associates may have boosted the activation of the subordinate interpretation so that it was available close in time with the more frequent dominant interpretation. Meaning selection may have been delayed until after reading the disambiguating material, leading to longer first pass times in the disambiguating region. However, the contextually appropriate meaning would have been selected and additional rereading in earlier areas of the sentence would not be necessary.

Message-level context may not have been constraining enough to produce the same effect. Instead, prior message context may have resulted in the fast activation of both meanings. This less-constraining context may necessitate rereading in earlier parts of the sentence to gather more information about the contextually appropriate meaning. This view is consistent with total time measures in the negative condition which suggest greater rereading of the ambiguous word and confusion in the disambiguating region which persists beyond initial processing.

The results of the current study can further be explained within the framework of the lexical quality hypothesis (LQH) (Perfetti & Hart, 2001). Lexical quality refers to the strength of the representation for individual words. A fully specified representation consists of orthography
(spelling), phonology (pronunciation), and meaning. High and low skill readers are differentiated by the number of such representations and their quality – the extent to which a representation contains all three components. Within this view, a high-skill reader is assumed to have many strong and accurate representations that allow for fast and direct activation of meaning from orthography. Low-skill readers, however, lack strong connections between components or may have underspecified representations that do not have fast, direct connections to meaning. When reading, this means high-skill readers are able to activate the meaning of a word based on spelling alone, or from the bottom-up, without the use of other information. Low-skill readers, due to impoverished spelling ability, may use context to support meaning activation.

According to the LQH, slower initial processing on the ambiguous word in the context conditions compared to neutral by high-skill readers might not be a result of contextual reordering of meaning. Rather, meanings may have been available close in time based on fast bottom-up activation of both meanings. This would imply that the subordinate meaning is not actually less frequent than the dominant meaning. Precious research has suggested that high-skill readers show a reduced frequency effect – there is a reduction in the time cost associated with reading low frequency words compared to high frequency words (Ashby, et al., 2005). Thus, both ambiguous word meanings in the current study may have been high frequency or high lexical quality for high-skill spellers. As a result, efficient bottom-up processing of orthography could activate both meanings of the ambiguous word close in time for high-skill spellers, without needing to posit that prior context boosted the activation of the subordinate interpretation. Contextual processing, however, is still necessary to select between available meanings. Low-skill spellers, who are assumed to have poor bottom-up processing because of weak connections
between orthography and semantics, would be less likely to activate both meanings without support from context. Instead, sluggish bottom-up processing may provide a window of opportunity for context to exert an influence on activation. Thus, for low-skill spellers, context may provide a stronger reordering of activation, allowing the contextually appropriate subordinate interpretation to be selected with little competition from the more frequent dominant interpretation. Therefore there is little evidence of competition for selection.

Surprisingly, low-skill spellers do not show signs of competition between meanings on the ambiguous word; yet, they do show evidence of successful resolution. In this particular reading situation, low-skill spellers may have the ‘benefit’ of being slow readers. All of the ambiguous words in the current study were, overall, low frequency. This means that while one meaning may be relatively more frequent than the other, the word form frequency is still low. Thus, bottom-up processing would be expected to be particularly slow for low-skill readers. Indeed, low-skill readers in the current study were found to read more slowly overall than high-skill readers. The additional time need for bottom-up processing may have allowed the context to be processed before meaning activation was achieved, thereby allowing context to influence activation and meaning selection of the ambiguous word. In this way, context may be able to provide a strong boost to activate the subordinate meaning rendering it available for selection with little competition from the dominant meaning.

However, context effects are robust even in the absence of ambiguity (see introduction). Several follow up studies will look at whether or not context facilitates word recognition when ambiguous words are not included. Future studies will also investigate differences between word-level and message-level context effects and how readers of different skill levels use these two types of contexts to aid in recognizing words. Finally, an additional follow up study will
specifically investigate whether or not readers were able to resolve the ambiguity accurately. The current results do not indicate that the readers experienced any confusion in the disambiguating region suggesting that they did in fact choose the appropriate meaning. However, future research could include disambiguating information that is incongruous with the context region of the sentence. Readers who resolved the ambiguity on the word would therefore experience confusion once they enter the disambiguating region. Signs of confusion in an incongruous sentence would support the finding that low-skill readers are able to resolve the ambiguity correctly without a time penalty.

The current study supports previous research in showing that context may play a larger role in word recognition for low-skill readers than high-skill readers (e.g. Andrews & Bond, 2009, Ashby, et al., 2005). However, much of the research in individual differences in reading has used reading comprehension as an indicator of skill. Recently, spelling has been shown to be a reliable and precise measure of reading ability (Andrews & Bond, 2009; Andrews & Hersch, 2010; Andrews & Lo, 2012; Burt & Jared, 2016; Hersch & Andrews, 2012). The current study replicates the validity of spelling ability as a predictive indicator of reading skill. However, numerous skill measures are available (e.g. print exposure, reading comprehension, working memory span, reading speed etc.). Some researchers have chosen to classify participants based on both reading and spelling ability or along other multiple dimensions. How skill is measured and what skill is investigated may influence the strength of – or even eliminate – the relationship between skill and context use. Future research should be mindful of this possibility and researchers should chose skill measures motivated by their research questions.

Conclusion
The current study supports previous research which has found that low-skill readers use context to aid in word recognition more so than high-skill readers. This reliance on context likely occurs as a result of poor bottom-up processing. High-skill readers have efficient bottom-up processing and have been shown to have reduced frequency effects, which may allow them to activate both meanings from orthography alone. Context becomes necessary only to select among possible interpretations. Future research should investigate how differences in bottom-up processing among skilled readers may contribute to differences in higher order cognitive processing.
References


Footnotes

1 Nelson-Denny Reading Test scores were not included in the current study

2 Spelling Recognition was not included in the current study. Spelling recognition and spelling recall scores were significantly correlated, $r=.61$, $p=.00$. Spelling recall has been shown to discriminate between high and low skill spellers (Andrews & Bond, 2009).

3 Data was first analyzed without trials on which participants failed to report both meanings of the ambiguous word. However, including these trials in analyses did not impact significant results. Thus, all data was included in analyses to increase power.

4 Comparing the context with the target word artificially lowers semantic relatedness because LSA does not account for both possible meanings of the ambiguous word.

5 Go-past time encompasses reading time in the context region.
Table 1

Results of the generalized mixed effects models for processing of the ambiguous word

<table>
<thead>
<tr>
<th>Measure</th>
<th>Fixed Effect</th>
<th>b</th>
<th>SE</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaze Duration</td>
<td>Intercept</td>
<td>196.13</td>
<td>15.15</td>
<td>12.95</td>
</tr>
<tr>
<td></td>
<td>Positive Condition</td>
<td>-34.45</td>
<td>12.19</td>
<td>-2.67</td>
</tr>
<tr>
<td></td>
<td>Negative Condition</td>
<td>-30.01</td>
<td>15.36</td>
<td>-1.95</td>
</tr>
<tr>
<td></td>
<td>Spelling Recall</td>
<td>-5.70</td>
<td>1.26</td>
<td>-4.52</td>
</tr>
<tr>
<td></td>
<td>Positive Condition X</td>
<td>3.22</td>
<td>1.19</td>
<td>2.71</td>
</tr>
<tr>
<td></td>
<td>Spelling Recall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Negative Condition X</td>
<td>3.11</td>
<td>1.41</td>
<td>2.21</td>
</tr>
<tr>
<td></td>
<td>Spelling Recall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Go-Past</td>
<td>Intercept</td>
<td>2795.82</td>
<td>180.88</td>
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<tr>
<td></td>
<td>Positive Condition</td>
<td>344.99</td>
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<td>.715</td>
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<td>Spelling Recall</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Negative Condition X</td>
<td>-6.28</td>
<td>11.36</td>
<td>-.553</td>
</tr>
<tr>
<td></td>
<td>Spelling Recall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Time</td>
<td>Intercept</td>
<td>348.85</td>
<td>25.27</td>
<td>13.81</td>
</tr>
<tr>
<td></td>
<td>Positive Condition</td>
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<td></td>
<td>Negative Condition</td>
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<tr>
<td></td>
<td>Spelling Recall</td>
<td>-5.18</td>
<td>2.32</td>
<td>-2.23</td>
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</table>

46
<table>
<thead>
<tr>
<th>Condition X</th>
<th>2.25</th>
<th>2.39</th>
<th>.941</th>
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<tbody>
<tr>
<td>Spelling Recall</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Negative Condition X</td>
<td>2.30</td>
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<td>.886</td>
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<tr>
<td>Spelling Recall</td>
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</table>
Table 2
*Gaze Duration on the ambiguous word by skill in milliseconds*

<table>
<thead>
<tr>
<th>Condition</th>
<th>Negative</th>
<th>Neutral</th>
<th>Positive</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>285</td>
<td>291</td>
<td>286</td>
<td>287</td>
</tr>
<tr>
<td>Average</td>
<td>294</td>
<td>291</td>
<td>292</td>
<td>292</td>
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<tr>
<td>High</td>
<td>269</td>
<td>226</td>
<td>257</td>
<td>251</td>
</tr>
<tr>
<td>Total</td>
<td>285</td>
<td>276</td>
<td>282</td>
<td>281</td>
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</tbody>
</table>
Table 3
*Go-Past Time by skill in milliseconds*

<table>
<thead>
<tr>
<th>Condition</th>
<th>Negative</th>
<th>Neutral</th>
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<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>2621</td>
<td>2544</td>
<td>2867</td>
<td>2678</td>
</tr>
<tr>
<td>Average</td>
<td>2117</td>
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<tr>
<td>High</td>
<td>1800</td>
<td>1774</td>
<td>1754</td>
<td>1776</td>
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<tr>
<td>Total</td>
<td>2190</td>
<td>2158</td>
<td>2292</td>
<td>2213</td>
</tr>
</tbody>
</table>

Note: *Go-Past is calculated from the moment the reader begins the sentence to when the eyes leave the ambiguous word to the right.*
Table 4
Total Time on ambiguous word by skill in milliseconds

<table>
<thead>
<tr>
<th>Condition</th>
<th>Negative</th>
<th>Neutral</th>
<th>Positive</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>513</td>
<td>516</td>
<td>469</td>
<td>499</td>
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<tr>
<td>Average</td>
<td>520</td>
<td>488</td>
<td>460</td>
<td>489</td>
</tr>
<tr>
<td>High</td>
<td>448</td>
<td>387</td>
<td>388</td>
<td>408</td>
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<tr>
<td>Total</td>
<td>501</td>
<td>474</td>
<td>446</td>
<td>474</td>
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Table 5
Results of the generalized mixed effects models for processing of the disambiguating region

<table>
<thead>
<tr>
<th>Measure</th>
<th>Fixed Effect</th>
<th>$b$</th>
<th>$SE$</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Pass Time</td>
<td>Intercept</td>
<td>1910.95</td>
<td>114.93</td>
<td>16.63</td>
</tr>
<tr>
<td></td>
<td>Positive Condition</td>
<td>-183.49</td>
<td>89.19</td>
<td>-2.06</td>
</tr>
<tr>
<td></td>
<td>Negative Condition</td>
<td>-265.77</td>
<td>90.31</td>
<td>-2.94</td>
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<tr>
<td></td>
<td>Spelling Recall</td>
<td>-51.90</td>
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<td>-5.78</td>
</tr>
<tr>
<td></td>
<td>Positive Condition X</td>
<td>14.45</td>
<td>8.33</td>
<td>1.74</td>
</tr>
<tr>
<td></td>
<td>Negative Condition X</td>
<td>18.64</td>
<td>8.28</td>
<td>2.25</td>
</tr>
<tr>
<td>Total Time</td>
<td>Intercept</td>
<td>2587.87</td>
<td>183.96</td>
<td>14.07</td>
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<td></td>
<td>Positive Condition</td>
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<td>Negative Condition</td>
<td>-60.93</td>
<td>118.32</td>
<td>-.515</td>
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<td></td>
<td>Spelling Recall</td>
<td>-61.11</td>
<td>14.44</td>
<td>-4.23</td>
</tr>
<tr>
<td></td>
<td>Positive Condition X</td>
<td>-4.35</td>
<td>11.60</td>
<td>-.37</td>
</tr>
<tr>
<td></td>
<td>Negative Condition X</td>
<td>3.74</td>
<td>10.97</td>
<td>.341</td>
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</table>
Table 6
First-pass time in the disambiguating region by skill in milliseconds

<table>
<thead>
<tr>
<th>Condition</th>
<th>Negative</th>
<th>Neutral</th>
<th>Positive</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>1465</td>
<td>1630</td>
<td>1492</td>
<td>1529</td>
</tr>
<tr>
<td>Average</td>
<td>1321</td>
<td>1419</td>
<td>1402</td>
<td>1381</td>
</tr>
<tr>
<td>High</td>
<td>1213</td>
<td>1139</td>
<td>1181</td>
<td>1177</td>
</tr>
<tr>
<td>Total</td>
<td>1337</td>
<td>1412</td>
<td>1376</td>
<td>1375</td>
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</tbody>
</table>
Table 7
Total time in the disambiguating region by skill in milliseconds

<table>
<thead>
<tr>
<th>Condition</th>
<th>Negative</th>
<th>Neutral</th>
<th>Positive</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>2210</td>
<td>2246</td>
<td>2184</td>
<td>2213</td>
</tr>
<tr>
<td>Average</td>
<td>2009</td>
<td>2047</td>
<td>1952</td>
<td>2002</td>
</tr>
<tr>
<td>High</td>
<td>1782</td>
<td>1718</td>
<td>1550</td>
<td>1685</td>
</tr>
<tr>
<td>Total</td>
<td>2013</td>
<td>2024</td>
<td>1925</td>
<td>1987</td>
</tr>
</tbody>
</table>
Appendix A

Sentence a = positive; b = negative; c = neutral

1a. Although it was neglected by the lawyer, the suit, finally, was settled out of court.
1b. Although it was drawn out for months, the suit, finally, was settled out of court.
1c. As near as Mary Ellen could remember, the suit, finally, was settled out of court.

2a. After being pronounced by the judge, the sentence, surprisingly, was served willingly.
2b. After being lightened considerably, the sentence, surprisingly, was served willingly.
2c. To the relief of Mrs. Williams, the sentence, surprisingly, was served willingly.

3a. Having been examined by the king, the page was soon marched off to bed.
3b. Having been hurt by the bee-sting, the page was soon marched off to bed.
3c. Just as Henrietta had feared, the page was soon marched off to bed.

4a. Although the corpse showed signs of drinking, the glasses, surprisingly, contained not a drop of liquor.
4b. Although they were scattered through the house, the glasses, surprisingly, contained not a drop of liquor.
4c. When I finally found them in the bedroom, the glasses, surprisingly, contained not a drop of liquor.

5a. Having been heavily praised by the drinkers, the port was soon guzzled to the last drop.
5b. Having been carried for miles by mule-train, the port was soon guzzled to the last drop.
5c. Just as Mark and Wilma had predicted, the port was soon guzzled to the last drop.
6a. Although there was still a crowd on the dance floor, the ball was suddenly ended at midnight.

6b. Almost as if it had never even taken place, the ball was suddenly ended at midnight.

6c. Just as Mitchell and Marvin had expected, the ball was suddenly ended at midnight.

7a. Shortly after it was locked up, the pen was completely rebuilt with new materials.

7b. Since it was so easy to get into, the pen was completely rebuilt with new materials.

7c. Over the objections of Mr. Mills, the pen was completely rebuilt with new materials.

8a. Inaudible as a result of the static, the speaker was completely rewired by the technician.

8b. Having been opened and disassembled, the speaker was completely rewired by the technician.

8c. Before either of us could do anything, the speaker was completely rewired by the technician.

9a. After it was used to calculate the numbers, the table was completely revised to fit the new predictions.

9b. After it was copied on the Xerox machine, the table was completely revised to fit the new predictions.

9c. Over the objections of John and Frank, the table was completely revised to fit the new predictions.
10a. Having stopped to allow a rest for the horses, the coach was noticeably squeaky when it hit the road again.

10b. Having been taken apart and cleaned, the coach was noticeably squeaky when it hit the road again.

10c. Patrick and Michael griped loudly that the coach was noticeably squeaky when it hit the road again.

11a. In the living room, over near the fireplace, the poker still leaned against the wall.

11b. Having been repaired again by the blacksmith, the poker still leaned against the wall.

11c. In Andrew’s fond memories of the house, the poker still leaned against the wall.

12a. Having been forgotten by the storyteller, the yarn was never heard by the children.

12b. Having been permanently recorded on tape, the yarn was never heard by the children.

12c. For some strange reason that nobody knew, the yarn was never heard by the children.

13a. Viciously snarling and growling, the boxer soon barked at the baggage attendant.

13b. Arriving from Chicago in a crate, the boxer soon barked at the baggage attendant.

13c. As we had all expected and feared, the boxer soon barked at the baggage attendant.

14a. Having been overlooked by the musician, the note was never heard by the audience.

14b. Having dispersed into the summer air, the note was never heard by the audience.

14c. As the old fortune-teller had predicted, the note was never heard by the audience.
15a. Appearing briefly in the film, the star inexplicably danced a jig on the lawn.

15b. Hearing the results of the tests, the star inexplicably danced a jig on the lawn.

15c. As the duchess emerged from the house, the star inexplicably danced a jig on the lawn.

16a. Because of its projected role in the manufacture of the new product, the plant was completely modernized by the owners.

16b. Having been allowed to sit vacant for more than six months, the plant was completely modernized by the owners.

16c. During the three months in which Frank was over in Europe, the plant was completely modernized by the owners.

17a. Having captured the attention of the jeweler, the band was finally worn at the fashion show.

17b. After sitting for years in its box, the band was finally worn at the fashion show.

17c. While Mr. Worth was out of town on the trip, the band was finally worn at the fashion show.

18a. Days after being chosen by the president, the cabinet finally spoke with the press.

18b. After discussing the issue for two hours, the cabinet finally spoke with the press.

18c. Just as we were beginning to give up hope, the cabinet finally spoke with the press.

19a. Since it was made almost entirely of gleaming metal, the bar ultimately was melted down and reshaped.
19b. Having been carelessly bent by the workman, the bar ultimately was melted down and reshaped.

19c. According to what we heard through the grapevine, the bar ultimately was melted down and reshaped.

20a. Having caused the barefooted boy much pain, the corn was finally amputated by the doctor.

20b. Having been carefully anesthetized, the corn was finally amputated by the doctor.

20c. Early in the following month, the corn was finally amputated by the doctor.

21a. As the colony’s only trace and record, the log was eagerly read by historians.

21b. Having been carefully transcribed to a computer disk, the log was eagerly read by historians.

21c. Although nobody else seemed to be very interested, the log was eagerly read by historians.

22a. Delivered to the outpost by a cheerful messenger, the wire was carefully read by the journalists.

22b. Contradicting the bizarre claims of the top generals, the wire was carefully read by the journalists.

22c. Fortunately for the brash officer who was running things, the wire was carefully read by the journalists.
23a. In the midst of the morning silence, the racket nearly drowned out our thoughts.

23b. Continuing for several hours, the racket nearly drowned out our thoughts.

23c. As John and Margaret had feared, the racket nearly drowned out our thoughts.

24a. Steadily washed by the sparkling water, the bank was completely eroded by the end of the decade.

24b. Too spongy to support plant life, the bank was completely eroded by the end of the decade.

24c. Because nobody thought to do anything about it, the bank was completely eroded by the end of the decade.
Appendix B

1. Suit
   a. A space for entertaining
   b. A type of clothing, typically worn by men
   c. A legal prosecution
   d. An industrial vehicle
   e. A kind of plant
   f. None of these

2. Sentence
   a. A grammatical unit
   b. A legal decision
   c. A type of head covering
   d. A punishment
   e. A tool used in carpentry
   f. None of these

3. Page
   a. A sheet of paper for writing
   b. A male servant
   c. A summary
   d. A machine use to bend metal
   e. The edge of a river
   f. None of these

4. Glasses
a. Dishware used for drinking  
b. Corrective lenses  
c. A device worn to correct poor vision  
d. A place where goods are manufactured  
e. A plumbing fixture  
f. None of these  

5. Port  
a. A harbor  
b. A place where ships load and unload cargo  
c. A type of sweet wine  
d. A small opening  
e. A long, thin piece of metal capable of conducting electricity  
f. None of these  

6. Ball  
a. A spherical object  
b. A formal party  
c. A type of sweet wine  
d. A formal party  
e. A chemical used for cleaning  
f. None of these  

7. Pen  
a. A writing instrument containing ink  
b. A fenced in area such as for farm animals  

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c. A land form surrounded by water on three sides

d. An industrial vehicle

e. A male servant

f. None of these

8. Speaker
   a. An electronic device that emits sound
   b. A person who delivers an address, usually to a crowd
   c. A component of an audio system
   d. A professional fighter
   e. A tool used in masonry
   f. None of these

9. Table
   a. A piece of furniture with a flat top
   b. A legal decision
   c. A means of visually presenting information such as research data
   d. Used to convey information much like a chart of a graph
   e. None of these

10. Coach
    a. An electronic device that emits sound
    b. A fenced in area such as for farm animals
    c. A horse-drawn carriage
    d. A person who trains an athlete or a team
    e. A piece of jewelry
11. Poker
   a. An electronic device that emits sound
   b. A card game
   c. A long rod, typically made of steel
   d. A machine used to bend metal
   e. A tool for stirring a fire
   f. None of these

12. Yarn
   a. A thread used for weaving and knitting
   b. A formal party
   c. A tale or long story
   d. A decaying tree trunk
   e. The edge of a river
   f. None of these

13. Boxer
   a. A breed of dog
   b. A professional fighter
   c. A celestial body
   d. A short, written communication
   e. A tool used in carpentry
   f. None of these

14. Note
a. A short, informal letter
b. A grammatical unit
c. A single sound in music
d. A historical record
e. An organism that produces food through photosynthesis
f. None of these

15. Star
a. A celebrity
b. A card game
c. A celestial body
d. A gaseous body in outer space
e. A piece of jewelry
f. None of these

16. Plant
a. A spherical object
b. Vegetation
c. A factory
d. A place where goods are manufactured
e. An organism that produces food through photosynthesis
f. None of these

17. Band
a. A musical ensemble
b. A thin circle of metal worn around a finger
c. A group of people such as a tribe or a troop
d. A decaying tree trunk
e. A piece of jewelry
f. None of these

18. Cabinet

a. A piece of furniture with shelves used for storage
b. An advisory body
c. A group of people chosen by the president for council
d. A loud, persistent noise
e. A chemical used for cleaning
f. None of these

19. Bar

a. An establishment serving alcohol
b. A long counter
c. A solid piece of material such as gold or steel
d. A gaseous body in outer space
e. A tool for stirring a firee
f. None of these

20. Corn

a. A musical ensemble
b. A fenced in area such as for farm animals
c. A type of sweet wine
d. A hardened layer of skin, usually on the hands or feet
21. Log
   a. An electronic device that emits sound
   b. A garment typically worn by men
   c. A fallen limb of a tree
   d. A decaying tree trunk
   e. A historical record
   f. None of these

22. Wire
   a. A musical ensemble
   b. A fenced in area such as for farm animals
   c. A component of an audio system
   d. A short communication such as a telegraph
   e. A long, thin piece of metal
   f. None of these

23. Racket
   a. A grammatical unit
   b. A piece of sporting equipment used in tennis
   c. A dishonest scheme
   d. A loud, persistent noise
   e. A tool for stirring a fire
   f. None of these
24. Bank

a. A punishment

b. A legal decision

c. A place where people keep money and valuables

d. The edge of a river

e. A financial institution

f. None of these