The Role of Context, Familiarity and Word Frequency in the Processing of Idiom Final Words

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THESIS
Submitted as partial fulfillment of the requirements for the degree of Master of Arts in Psychology in the Graduate College of the University of Illinois at Chicago, 2015

Chicago, Illinois

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Acknowledgements

I would like to thank Matthew Kelley for his guidance during my time at Lake Forest College, as well as for encouraging me to attend graduate school. I would also like to thank Gary Raney for his encouragement, guidance, and assistance on this project.
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SUMMARY

The current study explored whether word frequency effects are altered when words are read as part of idiomatic phrases. Participants read a series of high or low familiarity idiom phrases ending with either high or low frequency target words in contexts that supported either the literal or figurative interpretation of the idiom phrases. Target words in high familiarity idioms were processed faster than target words in low familiarity idioms. Faster reading times for high frequency target words than for low frequency words (word frequency effect) were found in gaze duration and total time reading measurements. Importantly, the word frequency effect was eliminated in first fixation duration. The results suggest that inclusion of a word in an idiom phrase changes the way that word is initially processed.
I. INTRODUCTION

Mary kicked the bucket. Devoid of context, this statement can be interpreted in one of two ways: 1) Mary kicked an actual bucket or pail, or 2) Mary died. When we interpret *Mary kicked the bucket* to mean, “Mary kicked the pail,” we are interpreting the phrase literally. When we interpret *Mary kicked the bucket* to mean, “Mary died,” we are interpreting the phrase figuratively. That is because *kick the bucket* is an idiom and, as such, is a group of words established by usage as having a meaning not deducible from the meaning of the individual words. Given an appropriate context, this familiar idiom may easily be interpreted by a proficient speaker of English as meaning, “to die.” In contrast, the low familiarity idiom phrase, *give up the ghost* may not be understood as meaning, “to die,” even to native English speakers.

Given that idiom phrases, such as *kick the bucket*, can be interpreted either figuratively or literally, it is important to note that, throughout this paper, the terms “idiom phrase” and “idiom” will be used to indicate two separate things. “Idiom phrase” will refer to a group of words that could be interpreted figuratively or literally, depending on the context. “Idiom” will be used exclusively to refer to a phrase used in its figurative sense. In other words, *kick the bucket* is an example of an idiom phrase, unless it is placed in a context supporting its figurative meaning, in which case it is referred to as an idiom.

When reading an idiom phrase in text, readers must quickly access the correct meaning of the phrase or the text will not make sense. Several theories of idiom processing have been proposed to explain the time course of figurative meaning activation. While the focus of this research has been on how idiom phrases are processed as a whole, few studies have examined the processing of individual words in idiom phrases. Those studies that have examined the processing of individual words have done so primarily as a means of examining the processing
of the idiom as a whole, such as measuring individual word reading time to obtain total reading
time (Cronk et al., 1993). The question of whether or not the processing of individual words
changes as a result of being included in an idiom phrase has yet to be fully addressed.

The current study examines whether individual words are processed differently when
they are included in an idiom phrase that should be interpreted either figuratively or literally.
This was done by examining the relationship between context, familiarity, and word frequency
on the processing of the final words of idiom phrases. Participants read a series of high or low
familiarity idiom phrases ending with either high or low frequency target words in contexts that
supported either the literal or figurative interpretation of the idiom phrases while their eye
movements were recorded. This allowed measuring the reading time for the target words (final
words of the idioms) during natural reading.

The primary hypothesis is that word frequency effects will change as a function of idiom
familiarity. The word frequency effect refers to the common finding that high frequency words
are processed faster than low frequency words (Inhoff & Rayner, 1986; Monsell, 1991; Rayner,
1998). If an idiom phrase is familiar, I predict the frequency of the individual words in the phrase
will have less impact on processing time than when the idiom phrase is less familiar. This
supports the prediction that word frequency effects will be smaller for words included in high
familiarity idiom phrases than low familiarity idiom phrases, regardless of whether the context
supports a figurative or literal interpretation. This is expected because high familiar idiom
phrases (e.g., *kick the bucket*) are more likely to be processed as a single unit than less familiar
idiom phrases (e.g., *give up the ghost*). A secondary hypothesis is that the relationship between
idiom familiarity and word frequency will change as a function of context. More specifically, I
predict that word frequency effects will be smallest for high familiarity idioms presented in a figurative contexts.

The remainder of this introduction is organized as follows. I will begin by describing factors known to influence idiom processing, focusing on context (whether the context supports a figurative or literal interpretation) and idiom familiarity. I will then discuss theories of idiom processing and the predictions these theories make about how individual words are processed. Next I will discuss how word frequency can be used as a tool to examine how individual words in an idiom phrase are processed. I will end by discussing the specific hypotheses of this study.

A. Context

As discussed above, the idiom phrase *kick the bucket* can be interpreted to mean that an individual has either a) kicked a pail, or b) has died. Contextual information biases a reader towards a literal or figurative interpretation of an idiom phrase (Titone & Connine, 1999). The following examples illustrate contexts supporting a figurative and literal interpretation of the idiom phrase *kick the bucket*.

1. Mary’s father hadn’t been feeling sick at all when he doubled over in pain. He clutched his chest. He had a heart attack and *kicked the bucket* before making it to the hospital.

2. Mary’s roof had been leaking since the recent storm. She put out a container to catch the rainwater. She forgot to watch where she was walking and *kicked the bucket* before falling over.

Several lines of research have examined the role of context in guiding the interpretation of idiom phrases. For example, Levorato (1993) gave children a series of idiom phrases that were
presented in a multi-sentence, supportive context or in isolation and asked the children to choose the meaning of the idiom phrase using a multiple-choice test. Levorato found a higher percentage of idiomatic answers for idioms presented in context versus those presented in isolation. These results show that context provides clues for young readers, who may have limited knowledge of idiom meaning, as to how to interpret idiom phrases. This may also have important implications as to the role context plays in helping adult readers disambiguate less familiar idioms.

Holsinger (2013) had adult participants listen to idiom phrases embedded in passages that were biased towards either a figurative or literal interpretation of the idiom phrase (e.g., *kick the bucket*). While listening to these passages, participants’ eye movements were tracked while looking at a screen containing one word related to the figurative interpretation of the idiom phrase (e.g., death), one word related to the literal interpretation of the idiom phrase (e.g., foot), as well as two distractors (e.g., triangle; animal). Gaze duration on each of the targets at different time points was compared. The results showed a strong preference for figuratively related targets in a figuratively biasing context and a strong preference for the literally related targets in a literally biasing context. To a lesser degree, these preferences were present even before the idiom phrase had been encountered. This implies that, given a figurative context, one will expect a conclusion to the story that is in line with the figurative interpretation of an idiom phrase. Overall, the results of this study point to the importance of contextual information in guiding the interpretation of idiom phrases.

The issue addressed in the current study is whether individual words in idiom phrases are processed in the same manner when presented in a context that requires a literal or figurative interpretation. Differences in the processing and comprehension of figurative and literal uses of idiom phrases may be expected because there is a distinct meaning associated with each of these
phrases. Interestingly, however, research has not found differences in the way figurative and literal usages of idiom phrases are processed (Estill & Kemper, 1982; Siyanova-Chanuturia et al., 2011).

In fact, when evaluating idioms that can be easily understood both figuratively and literally, researchers have found a facilitation effect for both the literal and figurative usages of idiom phrases as compared to matched literal phrases. For example, Siyanova-Chanuturia et al. (2011) monitored participants’ eye movements as they read a series of short stories that supported (a) the figurative interpretation of an idiom phrase (e.g., *at the end of the day*), (b) a literal interpretation of the idiom phrase, or (c) a matched literal phrase that has no figurative meaning (e.g., *at the end of the war*). Siyanova-Chanuturia et al. found faster reading times for idiom phrases (both the figurative and literal usages) compared to matched literal phrases. Importantly, no reading time differences were found between the figurative and literal usages of idiom phrases.

Additionally, Estill and Kemper (1982) examined response times to idiom final words presented in four different contexts: figurative, literal, neutral, and matched literal phrases (in which the idiom final word was presented in a non-idiomatic context). Participants were presented with a cue word before listening to a sentence containing the idiom phrase or its matched literal control. Participants were instructed to respond when they heard a word (the target word) that either matched the cue word, rhymed with the cue word, or shared a semantic meaning with the cue word. Among all idiom phrase conditions (figurative, literal, neutral), faster response times to idiom final words were found across all target word manipulations relative to the matched literal phrase condition.
 Taken together, the research comparing literal and figurative usage of idiomatic phrases suggests that literal uses of idiom phrases enjoy the same facilitation effects seen with figurative uses of idiom phrases relative to purely literal phrases. This is true when an idiom phrase is presented in a one-sentence biasing context (Estill & Kemper, 1982) and a multi-sentence biasing context (Siyanova-Chanturia et al., 2011). So while context serves an important role in guiding the reader to the correct interpretation of the idiom phrase, there are no differences in processing time between the figurative and literal uses of idiom phrases. This suggests that the processing advantage associated with an idiom phrase is not due to the meaning assigned to it (as provided by the context), but may in fact be due to the familiarity of the phrase itself.

B. Familiarity

Familiarity of the idiom phrase is another factor that is known to impact the way an idiom is processed. Familiarity is defined by one’s experience with a given idiom phrase (e.g., how often you have encountered the idiom) and not necessarily one’s knowledge of the meaning of the idiom phrase (Libben & Titone, 2008). It is important to note that this distinction does not mean that there is no relationship between idiom familiarity and idiom knowledge. In fact, Schraw, Trathen, Reynolds and Lapan (1988) have found strong, positive correlations between measures of idiom familiarity and measures of idiom knowledge. Additionally, Flores D’arcais (1993) found that high familiarity idioms have a larger proportion of correct paraphrase choices as compared to low familiarity idioms. Given that the bulk of the literature maintains the distinction between idiom familiarity and knowledge of the idiom’s meaning, I will also maintain this distinction. Therefore, a high familiarity idiom phrase (e.g., *kick the bucket*) is one that an individual recalls hearing or using often in daily life. A low familiarity idiom phrase (e.g., *give up the ghost*) is one that an individual does not recall hearing or using often in daily life.
Several researchers have shown processing advantages for high familiarity idioms over low familiarity idioms. For example, using a meaningfulness classification task (e.g., Is this sentence a meaningful one?), Libben and Titone (2008) found that high familiarity idioms were classified as meaningful sentences significantly faster than low familiarity idioms. Other research has found reading time differences between high and low familiarity idioms (Schweigert, 1985). Schweigert (1985) presented high and low familiarity idioms in one-sentence contexts that supported the figurative interpretation, supported the literal interpretation, or were neutral. Schweigert found that high familiarity idioms were read faster than low familiarity idioms when the idioms were placed in supportive contexts (literal or figurative). No differences in processing time were found between low and high familiarity idioms when they were used in unbiased contexts. Taken together, these studies demonstrate that high familiarity idioms are processed faster than low familiarity idioms, even when the idiom phrase is interpreted literally.

Why are high familiarity idiom phrases processed faster than low familiarity idiom phrases? The time course of figurative meaning activation has been used to explain this finding, but different theories of idiom processing offer different accounts of figurative meaning activation. These theories of idiom processing and their proposed accounts of figurative meaning activation will be explored in the next section.

C. Time Course of Figurative Meaning Activation

One of the earliest idiom-processing theories, the standard pragmatic model, posits that the figurative meaning of an idiomatic expression is activated only after the literal meaning has been successfully computed and rejected (Bobrow & Bell, 1973). The standard pragmatic model has largely fallen out of favor due to the prevalence of data suggesting that the figurative
meaning of a well-known idiom phrase is activated at least at the same time as the literal meaning and, in some cases, earlier (Swinney & Cutler, 1979; Cacciari and Tabossi, 1988). The following discussion will focus on the lexical representation hypothesis and the configuration hypothesis, both of which posit that, among well-known idiom phrases, activation of the figurative meaning occurs before the conclusion of the idiom phrase. The purpose of the present research is not to test these models, but to use these models to derive predictions about how the final words of idiom phrases are processed.

The lexical representation hypothesis posits that idioms and their figurative meanings are stored in the lexicon and accessed as a single meaning unit in much the same manner as individual words (Swinney & Cutler, 1979). According to this model, the meaning of literal phrases is processed computationally whereas the meaning of idioms is retrieved directly from the lexicon. For example, the figurative meaning of the idiom phrase *kick the bucket* (meaning “to die”) is stored and retrieved from the lexicon as a single lexical entry. In contrast, the literal phrase *kick the pail* requires that each individual word comprising the phrase (“kick,” “the,” and “pail”) be accessed from the lexicon in order to compute the meaning of the phrase. Given these differences in storage and retrieval from the lexicon, the lexical representation hypothesis predicts faster reading and response times to idiom phrases as compared to matched literal phrases. This is because the retrieval of one lexical item (the lexicalized idiom) from the lexicon is faster than the retrieval and computation of several lexical items.

The configuration hypothesis, on the other hand, posits that the processing advantage found for idiom phrases is due to predictability of well-known expressions and not due to the automatic retrieval of expressions from the lexicon (Cacciari and Tabossi, 1988). Furthermore, according to the configuration hypothesis, idioms are processed computationally (word-by-word),
like any literal statement, up until an idiom key point. The idiom key point is the point at which the idiom has been recognized as an idiom and the figurative meaning is activated. The location of the idiom key point within the idiom phrase varies as a function of idiom predictability. Idiom predictability refers to the degree to which one can predict the particular configuration of words in an idiom phrase. In highly predictable idioms (e.g., *bite the bullet*), the idiom key point occurs earlier in the idiom (after *bite* or *the*) and, thus, the figurative meaning of the idiom phrase is activated earlier. On the other hand, the idiom key point of a low predictability idiom (e.g., *shoot the breeze*) often does not occur until idiom offset (e.g., the last word of the idiom).

Again, it is important to stress that the goal of the current study is not to test the lexical representation hypothesis and configuration hypothesis. These theories are described here to demonstrate that there is a theoretical basis for the predictions of the current research. Both theories predict that high familiarity idiom phrases will be processed faster than low familiarity idiom phrases. The lexical representation hypothesis predicts faster processing of high familiarity idiom phrases because high familiarity idiom phrases are lexicalized whereas low familiarity idiom phrases have not been lexicalized. The configuration hypothesis predicts faster processing of high familiarity idiom phrases because the configuration of words in these phrases is recognized as an idiom phrase faster than in low familiarity idiom phrases, whose idiom key point occurs later in the idiom phrase. Neither of the theories makes any specific predictions regarding the role of context (figurative, literal) in idiom processing.

Importantly, both the lexical representation hypothesis and configuration hypothesis predict facilitation of individual words occurring late in the idiom phrase (e.g., the idiom final word) relative to the final word of matched literal phrases. According to the lexical representation hypothesis, the automatic retrieval of the figurative meaning from the lexicon
allows for faster processing of the individual words comprising the idiom phrase. According to the configuration hypothesis, an expectation about the conclusion of an idiom phrase causes facilitation of individual words in the idiom phrase after the idiom key point. Thus, according to either theory, the final word of well-known idiom phrases should be processed faster than the final word of a matched control phrase or a lesser-known idiom phrase.

D. Facilitation of the Idiom Final Word

Estill and Kemper (1982) examined response times to idiom final words presented in four different contexts: (a) contexts supporting the literal interpretation of idiom phrases, (b) contexts supporting the figurative interpretation of idiom phrases, (c) contexts that were neutral and did not support either interpretation of idiom phrases, or (d) control contexts in which the target words were embedded within non-idiomatic phrases. Participants were placed in one of three conditions: the identity cue condition, the rhyme cue condition, or the category cue condition. In the identity cue condition, participants were given a cue word (e.g., hatchet) and instructed to respond when they heard that particular word being spoken (e.g., respond to “hatchet” in bury the hatchet). In the rhyme cue condition, participants were given a cue word (e.g., ratchet) and instructed to respond when they heard a word that rhymes with the cue word. In the category cue condition, participants were given a semantic category (e.g., tools) and instructed to respond when they heard a word matching that semantic category. Estill and Kemper’s main finding was that response times to target words were facilitated for all idiomatic contexts (literal, ambiguous and figurative) as compared to the matched control context. Relative to a matched control condition where the target word was the final word of a non-idiomatic phrase, access to the target word itself, its phonological properties, as well as the literal meaning of the target word was facilitated when that word was included as the final word of an idiom phrase.
Siyanova-Chanuturia et al. (2011) examined the reading times of words occurring before and after the idiom key point. Participants’ eye movements were recorded as they read a series of short stories that supported either the figurative or literal interpretation of an idiom or a novel phrase. While their study was not designed specifically to address this question, the authors found tertiary evidence that appeared to find reading times for words following the recognition point are faster than the reading times for words that preceded the recognition point. This study demonstrates facilitation of reading time for words occurring late in the idiom phrase.

Libben and Titone (2008) explored whether reading time differences would extend to the individual words comprising the idiom phrase and whether reading times would vary based on familiarity of the idiom phrases. Using a word-by-word reading task, they found that the final words of high familiarity idiom phrases were read significantly faster than the final words of low familiarity idiom phrases. This finding demonstrates that the facilitation of idiom final words varies as a function of idiom familiarity.

Libben and Titone (2008) are essentially demonstrating a speed-up in processing time for final words of high familiarity idiom phrases. In many ways, a speed-up in processing time for final words of high familiarity idiom phrases makes sense given that research has shown that high familiarity idiom phrases are read faster than low familiarity idiom phrases (Schweigert, 1985). The goal of the current study is to demonstrate changes in processing of idiom final words. Changes in the processing of idiom final words can be examined by comparing word frequency effects in low and high familiarity idioms phrases.

E. Word Frequency

One of the central tenants of the current research is that the familiarity of the idiom
affects the way that the individual words within the idiom are processed. One way to examine the processing of individual words within an idiom is to use the word frequency effect. The word frequency effect refers to the finding that words that are used more frequently in our language (e.g., fire) are accessed more quickly from the lexicon than low frequency words (e.g., sack). Word frequency has been shown to effect the processing of words in isolated word response time tasks (Monsell, 1991) and in sentences (Rayner, 1998). In reading tasks, low frequency words have longer first fixation durations (e.g., the duration of the first fixation on a word), gaze durations (e.g., sum of all the fixations on a word before looking at another word), and total reading time (e.g., sum of all the fixation on a word in a trial) than high frequency words of matched word length (Inhoff & Rayner, 1986; Raney & Rayner, 1995) and similar orthographic familiarity (White, 2008). Using word frequency cut-offs consistent with those used in the current study, Raney and Rayner (1995) found that reading time differences between high and low frequency words are smallest in first fixation duration (21 ms), larger in gaze duration (48 ms) and largest in total time (63 ms). In addition to influencing reading time measurements, word frequency also influences the probability of word skipping such that high frequency words are more likely to be skipped during reading (White, 2008). These studies demonstrate that the word frequency effect is very robust and affects multiple measurements of word processing.

Despite the robustness of the word frequency effect, there have been several studies demonstrating that the word frequency effect can be reduced or eliminated (Rayner & Raney, 1996; Scarborough, Cortese & Scarborough, 1997). In Rayner and Raney (1996), participants’ eye movements were monitored as they read passages containing high and low frequency target words or while they completed a visual search task in which they were told to search for a particular word. In the visual search task, the high and low frequency target words were
presented two or three lines before the search word so that participants had to go past the target words to find the search word. In the passage reading task, the standard word frequency effect was found—low frequency words had longer reading times than high frequency words. In the visual search task, however, no word frequency effect was found. Rayner and Raney concluded that there were no significant differences in the reading time of low and high frequency target words when lexical access of the word was not required for the task, as in the search task.

Scarborough, Cortese and Scarborough (1997) examined word frequency effects in a lexical decision task and an old-new task. In the old-new task, participants were asked to identify whether or not they had previously seen a given letter string. The results showed no effect of word frequency in the old-new task whereas the word frequency effect was found in the lexical decision task. The old-new task can be completed by matching stimuli, which does not require complete lexical access.

The results of Rayner and Raney (1996) and Scarborough, Cortese and Scarborough (1997) demonstrate that the word frequency effect can be reduced or eliminated in tasks that do not require participants to fully access the meaning of words from the lexicon. Such findings are crucially important to the current study, in which a reduced word frequency effect is expected for the final words of high familiarity idioms. However, it is important to distinguish the results of Rayner and Raney (1996) and Scarborough et al. (1997) from the current study in that these authors found reduced word frequency effects when the tasks did not require full access of the word from the lexicon. In the current study, the reduced word frequency effect is predicted to reflect facilitated access to the final word of the idiom phrase in a task (normal reading) that does require full access of words from the lexicon.
I also predict that facilitation for words in idioms will be larger (e.g., larger reductions in reading time) for low frequency final words than high frequency final words. This is because high frequency final words can suffer from a floor effect, which means that high frequency words reach their minimal processing time sooner than do low frequency words because high frequency words initially are processed faster. Such floor effects for high frequency words have been demonstrated in the literature. For example, Rayner, Raney and Pollasetek (1995) measured reading times for words that occurred multiple times in a text. Low frequency words showed substantial reduction in reading times across three-to-four occurrences (repetitions) whereas high frequency words showed substantial reduction in reading times only from the first-to-second occurrence. This shows that high frequency words reached their minimum processing time sooner than did low frequency words.

F. Context, Familiarity and Word Frequency in Idioms

Very little research has directly examined the effect of word frequency in idiom processing. Through a series of norming studies on a set of 219 idioms that followed a “She verbed x noun” structure (e.g., She kicked the bucket, She took a beating), Libben and Titone (2008) examined the relationship between word frequency, idiom familiarity and idiom processing. The authors found that idiom familiarity was positively correlated with the frequency of an idiom phrase’s final noun (e.g., bucket, beating). High familiarity idioms tended to include high frequency nouns. The authors also found that idiom predictability was negatively correlated with the frequency of an idiom phrase’s verb (e.g., kicked, took). In other words, highly predictable idioms often begin with low frequency verbs. Additionally, idioms beginning with low frequency verbs were classified as meaningful faster than idioms beginning with high frequency verbs. Furthermore, in a word-by-word reading task, Libben and Titone found that
idioms beginning with low frequency verbs (e.g., kick) show facilitated reading time of idiom final words (e.g., bucket). If idioms that begin with low frequency words have fewer possible completions (making the completion more predictable) than idioms that begin with high frequency words, then the processing advantages found for idioms beginning with low frequency verbs make sense given that highly predictable idioms show a processing advantage over low predictability idioms (Tabossi, Fanari & Wolf, 2005). The results of Libben and Titone suggest that the word frequency of the individual words comprising the idiom phrase is related to factors like idiom familiarity, and can also influence the speed at which individual words in the idiom phrase as well as the idiom phrase itself are processed.

Given that word frequency can influence the processing of individual words within an idiom phrase, it would be interesting to see if word frequency interacts with other factors important to idiom processing, such as idiom familiarity and context (figurative or literal). To my knowledge, only one study has examined this issue. Cronk et al. (1993) examined the relationship between word frequency and idiom familiarity using a self-paced moving window paradigm. Consistent with prior research, high familiarity idioms were read significantly faster than low familiarity idioms. Importantly, Cronk et al. found an interaction between idiom familiarity and word frequency such that reading times for high familiarity idiom phrases containing high frequency words ($M = 538$ ms) were significantly faster (96 ms) than high familiarity idiom phrases containing low frequency words ($M = 634$ ms). Among low familiarity idiom phrases, reading times for idiom phrases containing high frequency words ($M = 616$ ms) were also significantly faster (32 ms) than idiom phrases containing low frequency words ($M = 648$ ms), but this difference was significantly smaller than in the high familiarity idiom phrase condition. In other words, Cronk et al. found reduced word frequency effects among low
familiarity idiom phrases. This is in direct contrast to the predictions made in the current study. I predict reduced word frequency effects will occur among high familiarity idiom phrases.

What can explain this discrepancy between what I predict and the results found by Cronk et al.? For one, Cronk et al. (1993) defined word frequency as the average of each word in an idiom phrase. This is problematic because the number of function words across idiom phrases was not controlled. Idiom phrases without function words (e.g., last straw) will have lower average word frequency than idiom phrases with function words (e.g., rock the boat), even if the content words are of the same frequency. Consequently, reading times for high and low familiarity idiom phrases cannot be directly compared. Another potential problem with Cronk et al.’s (1993) study is that they used average reading time of all words in an idiom phrase as the dependent measure. Average reading time per word reflects processing of the idiom phrase as a whole, not the individual words. Average reading time per word was used as the dependent measure in spite of the fact that sentences were presented word-by-word, so access to the reading times of individual words was possible. The problems in Cronk et al.’s (1993) study make it uninformative about reading time for individual words. The current study will correct these problems in an effort to determine the role context, familiarity, and word frequency play in the processing of the final words in idioms.

G. The current study

The purpose of the current study was to examine the relationship between context, familiarity and word frequency in the processing of idiom final words. The research question being investigated is; does the inclusion of a word in an idiom phrase changes the way that word is processed? More specifically, are word frequency effects altered when words are read as part
of high or low familiarity idiom phrases?

The current study improves upon the methodology of Cronk et al. (1993) by manipulating the frequency of the final word of an idiom phrase and measuring the reading time of that final word using an eye tracker. The final words of idiom phrases were specifically chosen to study because there is strong evidence that the figurative meaning of highly familiar idiom phrases should be activated, or begun to be activated, before reaching the final word. Thus, activating the figurative meaning of a familiar idiom should facilitate processing of the final word relative to less familiar idioms. At minimum, the facilitation could reflect heightened activation of the final word, which facilitates lexical access of the word. At maximum, the facilitation could reflect readers being able to access the final word before actually reading the final word because the word is predictable/expected. In this case, the final word could be processed minimally just to confirm the expectation. Unlike Cronk et al. (1993), who used the average reading time of all the words in the idiom phrase as a dependent measure, measuring the reading times of the final words in idiom phrases allows me to draw more accurate conclusions about the way individual words in the idiom are processed.

The current study used an eye tracking methodology to monitor eye movements during reading. Eye tracking provides a measure of on-line processing that captures the series of fixations (periods during which the eyes come to rest and visual information is extracted) and saccades (periods during which the eyes are moving rapidly) during reading. Unlike the self-paced moving-window paradigm used by Cronk et al., eye tracking is able to capture this complex pattern of fixations and saccades naturally without any secondary responses, such as pressing a key to move from word to word. Eye tracking can be used to collect reading time measurements for the idiom final word as well as reading time measurements for the idiom...
phrase as a whole.

The specific reading time measurements that were analyzed and their definitions are outlined below. Figure 1, which contains a hypothetical fixation pattern on a sample sentence, provides further illustration of these reading time measurements.

**First fixation duration**: the duration (time) of the first fixation in an interest area. As seen in Figure 1, fixation 5 represents the first fixation duration on “fingers”.

**First pass reading time** (also called gaze duration when the interest area is a single word): the summed duration of all fixations that occurs within a specific region before the reader looks at a different interest area, such as the next word. As seen in Figure 1, the sum of fixations 5 and 6 represent the first pass reading time on “fingers”.

**Total reading time**: the summed duration of all fixations in the interest area for the entire trial. As seen in Figure 1, the sum of fixations 5, 6, and 8 represent the total reading time on “fingers”.

**First pass fixation count**: the number of fixations that occur within a specific region (called an interest area) before the reader looks at a different interest area, such as the next word. As seen in Figure 1, fixations 5 and 6 qualify as first pass fixations for the interest area “fingers”.

**Total fixation count**: the total number of fixations that occur within an interest area for the duration of the trial. As seen in Figure 1, there are three total fixations (fixations 5, 6 and 8) on “fingers”.

**Regression out count**: the number of times a reader leaves the region of interest and
returns to a previously read region (i.e., makes a right-to-left saccade). As seen in Figure 1, fixation 9 represents a regression from the interest area “fingers” to the previous context.

The research question driving this study is, does early access to the figurative meaning of a high familiarity idiom facilitate access to the final word of the idiom phrase relative to low familiarity idioms? In order to examine this question, I manipulated idiom familiarity (high vs. low), word frequency of the final word of the idioms (high vs. low), and context type (supports literal vs. figurative use of a phrase). Idiom familiarity was defined by how often native speakers of English report hearing or using the idiom on a regular basis, with high familiarity idioms (e.g., *slip through his fingers, hang by a thread*) being those which are often reported and with low familiarity idiom (e.g., *chew the fat, pulling up stakes*) being those which are not. Familiarity was defined based on normative ratings collected at UIC (described in the Methods section). Word frequency was determined using the Corpus of Contemporary American English (Davies, 2008). This yields four idiom conditions: (a) low familiarity idioms with high frequency final words (e.g., *chew the fat*), (b) low familiarity idioms with low frequency final words (e.g., *pulling up stakes*), (c) high familiarity idioms with high frequency final words (e.g., *slip through his fingers*), and (d) high familiarity idioms with low frequency final words (e.g., *hang by a thread*).

Context type (literal vs. figurative) was manipulated to determine if facilitation of the final word occurs regardless of whether the context supports a figurative or literal interpretation of the idiom phrase. Context was manipulated such that the three sentences preceding the idiom phrase supported either the literal interpretation of the phrase or the figurative interpretation of the phrase. For example, a literal context for *chew the fat* would refer to someone chewing the
fatty portion of a piece of meat. On the other hand, a figurative context would support the “gossip” meaning of the idiom phrase.

The eye movement measures were analyzed to determine whether reading a highly familiar idiom facilitates access to the idiom final word. Facilitation was defined as a reduction in reading time for idiom-final words in high-familiarity idioms relative to low-familiarity idioms. As described below, reduced reading time could reflect shorter duration fixations, fewer fixations, and fewer regressions out of the idiom final words. Importantly, this facilitation effect was expected to be larger for low frequency idiom-final words, leading to a smaller word frequency effect (smaller difference between low and high frequency words) in high-familiarity idioms relative to low-familiarity idioms (an interaction). Specific hypotheses for the idiom-final word are outlined below.

1. A main effect of idiom familiarity was predicted such that high familiarity idiom final words will be read significantly faster than low familiarity idiom final words. This reflects the expectation that earlier activation of the figurative meaning of high familiarity idioms will facilitate access to idiom-final words. This effect will be true for all reading time and fixation count measures, but the largest effect will be found for the total reading time measure.

2. A main effect of word frequency was predicted such that high frequency idiom final words will be read significantly faster than low frequency idiom final words. This is the well-documented word frequency effect. This effect is expected for all reading time measures, but the effect should be largest for total time.

3. A Word Frequency X Idiom Familiarity interaction was predicted. This interaction reflects the expectation that the difference between low and high frequency idiom
final words in low familiarity idioms will be larger than the difference between low and high frequency idiom final words in high familiarity idioms.

This interaction reflects the expectation that earlier activation of the figurative meaning of high familiarity idioms will facilitate access to idiom-final words combined with the expectation that idiom familiarity will benefit access to low-frequency words to a greater extent than high-frequency words for familiar idioms only. In other words, a smaller word frequency effect is expected in high familiar idioms than in low familiarity idioms. This effect is expected for all reading time and fixation count measures.

4. While the same Word Frequency X Idiom Familiarity interaction was expected in both the literal and figurative contexts, it may be the case that the interaction will be marginally larger in figurative contexts. This leads to the expectation of a Word Frequency X Idiom Familiarity X Context interaction. In both figurative and literal contexts, low frequency idiom final words in high familiarity idioms will be read more slowly than the high frequency idiom final words in high familiarity idioms, but the difference between high and low frequency words might be smaller in figurative contexts than in literal contexts.

Using an eye tracking methodology also allows for the recording of phrase-level reading time measurements (reading time for an entire idiom) as well as recording regressions from an idiom back to the context. The following hypothesis is for entire idiom phrases (phrasal analysis):

1. A main effect of idiom familiarity was predicted such that high familiarity idioms will be
easier to process than low familiarity idioms. This will result in (a) faster reading times for high than low familiarity idioms and (b) fewer regressions back to the context for high than low familiarity idioms.

This reflects the expectation that earlier activation of the figurative meaning of high familiarity idioms facilitates reading time of those idioms as a whole. This effect will be found in second run and total reading time as well as second run and total fixation counts (i.e., first fixation duration will not be analyzed because first fixation does not capture reading time an entire idioms).
II. METHODS

A. Participants

Forty undergraduates served as participants. Participants were recruited from Introduction to Psychology courses at the University of Illinois at Chicago and received compensation in the form of course credit. All participants were proficient English speakers (defined as having attended 10 or more years of English speaking school).

B. Design

The study employed a 2 (Familiarity: high, low) x 2 (Frequency of final word in idiom phrase: high, low) x 2 (Context: supports figurative meaning, supports literal meaning) mixed design. Familiarity and frequency of the idiom final word were manipulated within subjects whereas context was manipulated between subjects.

Results of the first norming study confirmed that high familiarity idioms ($M = 6.3$) are rated more familiar than low familiarity idioms ($M = 2.7$), $t (61) = -25.4$, $p < .05$. Frequency of the idiom final words was determined using the Corpus of Contemporary American English. High frequency final words refer to those words that occur 61 or more times per million words in the corpus (e.g., fingers, fat). Low frequency final words refer to those that occur 15 or less times per million words in the corpus (e.g., thread, stakes). The average frequency of idiom final words in the high frequency condition was 193 words per million and in the low frequency condition was 8 words per million. Context was manipulated such that the context preceding the idiom phrase either supported the figurative interpretation of the idiom phrase (figurative context) or the literal interpretation of the idiom phrase (literal context).
C. Materials

A series of norming studies were conducted to develop the stimuli. In the first norming study, idioms were normed on familiarity, knowledge, and literalness. Passages were then created that supported both the figurative or literal interpretations of familiar and unfamiliar idiom phrases. In the second norming study, norms were collected on the comprehensibility of the passages. Finally, in the third norming study, norms were collected in order to examine the predictability of the final word of an idiom phrase presented in context. These studies are described in detail below.

1. Norming Study 1. The primary objective of the first norming study was to establish familiarity, knowledge, and literalness ratings for a set of 204 idioms. Idioms were selected for inclusion in this study based on two criteria. First, there must be a viable literal interpretation. For example, the idiom phrase kick the bucket can convey both a figurative meaning (e.g., to die suddenly) and a literal meaning (e.g., to kick the pail). The idiom phrase give up the ghost, on the other hand, can convey a figurative meaning (e.g., to die), but cannot reasonably convey a literal meaning. Second, only idioms with nouns as their final words were selected to control for possible part of speech effects.

Sixty native English-speaking participants provided familiarity ratings (i.e., how often the word is heard or used in everyday conversation), knowledge ratings (i.e., how well the participant knows what the idiom means) and literalness ratings (i.e., how well can the phrase be used literally) for the 204 idioms presented in isolation (out of context). Ratings were made using a 7-point scale (1 = not at all familiar/not at all, 7 = very familiar/very well). Participants were also prompted to provide a definition for each idiom. See Appendix A for example norming
Results of the first norming study yielded 33 high familiarity idioms ($M = 6.3$) and 30 low familiarity idioms ($M = 2.7$) from the upper and lower quartiles that contained either high or low frequency idiom final words. Consistent with prior research (Raney & Rayner, 2003), high frequency words were defined as occurring 60 or more times per million words in the Corpus of Contemporary American English database (Davies, 2008). Low frequency was defined as occurring no more than 15 times per million words. These 63 idioms were chosen for passage development and further analysis.

2. Passage Development. For each of the 63 idioms chosen for passage development, two distinct passages were created: one passage was written with a three-sentence context that supported the figurative interpretation of the idiom phrase and a second version was written with a three-sentence context that supported the literal interpretation of the idiom phrase. For example, the context supporting the figurative interpretation of the high familiarity idiom phrase *slip through his fingers* is provided below (the idiom is underlined for ease of identification):

(1) Hal was a professional tennis player. His next match was the most important one of his career—if he won, he would qualify for a spot in the finals. He was in a similar position last year, but lost that match. He had seen it *slip through his fingers* before so he was worried. Hal could not wait to get on the court to prove himself.

Here the figurative interpretation of *slip through his fingers* has been instantiated by the prior context. It is clear that the passage is likening losing the previous tennis match to being unable to achieve a goal that Hal had set for himself. Conversely, the context supporting the literal interpretation of the idiom phrase *slip through his fingers* is:

(2) Hal took off his wedding ring before washing his hands in the sink. He tried to avoid
getting it greasy because it was hard to clean. His hands were still wet and a little slick when he went to pick up his ring. Hal let it *slip through his fingers* before he could catch it. The ring went down the drain of the sink.

Here the literal interpretation of *slip through his fingers* has been instantiated by the prior context. Hal’s wedding ring had literally slipped through his fingers and fell into the sink. Importantly, the figurative interpretation of *slip through his fingers*, or the inability to achieve a goal one has set for oneself, has not been instantiated. See Appendix B for additional examples.

Several criteria were taken into consideration during passage development. For example, passage length and structure were carefully controlled. All passages were 5 sentences in length and included a 3-sentence context, a sentence containing the idiom phrase, and a conclusion sentence. Passage length varied between 55-70 words with no more than 8 words difference between the literal and figurative versions for a given idiom set (e.g., the figurative and literal context condition). Further effort was taken to control the length of individual sentences within the passages. The 3-sentence contexts varied between 40-50 words with no more than an 8 word difference between the figurative and literal contexts for a given idiom phrase. Idioms varied in length from 2-7 words. Within the idiom phrase sentence, the number of words before the idiom phrase and immediately following the idiom phrase varied between 2-8 words with no more than 2 words difference between the literal and figurative conditions for a given idiom phrase. Additionally, each passage ended with a conclusion sentence that did not directly reference to the idiom phrase.

Further measures were taken to match the target words (the last word in each idiom) across conditions. Specifically, average target word length and word frequency were matched
across familiarity and context conditions. In addition, the word before and the word immediately following an idiom phrase were identical for the literal and figurative contexts for each idiom phrase (e.g., “Yoga can cause a big pain in the neck every now and then”, “Writing can be a big pain in the neck every now and then”). In this example the word “big” appears before the idiom phrase in each sentence and the word “every” immediately follows the idiom phrase in each sentence. This was done because the word length and frequency of the word before and after an idiom could influence the pattern of eye movements (e.g., whether the word before or after an idiom is fixated or skipped, and how long the word is fixated).

3. **Norming Study 2.** A second norming study was conducted to examine the comprehensibility of the passages and the effectiveness of the contexts in supporting the intended interpretation of the idiom phrases (see Appendix A for example norming materials). Forty participants read 63 passages containing idiom phrases that were used either figuratively or literally (i.e., participants did not see both the figurative and literal passages for a given idiom). Participants were asked to rate how difficult a passage was to understand and how well the idiom phrase fits in with the context. Ratings were made using a 5-point scale (1 = not at all difficult/not at all, 5 = very difficult/very well). Participants were also asked to rate their familiarity with the figurative usage of the idiom phrase, paraphrase the idiom phrase using the context provided, and rate how difficult it was to paraphrase the idiom phrase.

Several measures obtained in this study were used to remove potentially problematic passages. Passages receiving average difficulty ratings greater than two on a scale of 1 to 5 (with larger numbers indicating greater comprehension difficulty) were excluded from the study in order to limit the influence of comprehension problems on reading behavior. Sentences containing idiom phrases receiving average fit ratings below the mid-point (3) of the scale (with
larger numbers indicating greater fit with the prior context) were also excluded from the study.

Overall, the goal was to create passages that were rated as relatively easy to understand and with idiom phrases that fit in well with the preceding context. The results of the norming study confirmed this goal was met. Figurative passages were rated as easy to understand ($M = 1.3$) and the idiom phrases in the figurative passages were rated as fitting in well with the prior context ($M = 4.1$). Literal passages were also rated as easy to understand ($M = 1.5$) and the idiom phrases in the literal passages were rated as fitting in well with the prior context ($M = 3.8$). As expected, the results of this norming study also confirmed that low familiarity idioms were more difficult to paraphrase ($M = 2.3$) than high familiarity idioms ($M = 1.5$).

4. Norming Study 3. The third norming study was run to examine the predictability of the final word of idiom phrases in the figurative and literal contexts. Thirty-six participants read a figurative or literal context version of the 63 passages up to the idiom final word, which was presented as a blank space. Words following the idiom were not presented. For example, the figurative context of the idiom phrase *slip through his fingers* was presented in the following manner:

(3) Hal was a professional tennis player. His next match was the most important one of his career—if he won, he would qualify for a spot in the finals. He was in a similar position last year, but lost that match. He had seen it slip through his_______…

Participants were asked to fill in the blank with the word that they believed best completes the phrase and were asked to rate their confidence in their choice. See Appendix A for additional examples. As expected, the results indicate that, across figurative and literal contexts, the final words for high familiarity idioms were more predictable ($M = .75$) than for low familiarity
idioms ($M = .25$), as indicated by the average proportion of correct predictions of the idiom final word.

5. Final Selection. Based on the three-norming studies, 40 idioms were chosen for use in the experiment. This produced: (a) 10 high familiar idioms that end with high frequency words, (b) 10 high familiar idioms that end with low frequency words, (c) 10 low familiar idioms that end with high frequency words, and (d) 10 low familiar idioms that end with low frequency words.

Several factors were considered in the final selection of idioms. Most important, word frequency and length of the final word in the idiom phrases (target words) were matched across conditions. In addition, knowledge and literalness ratings obtained from the first norming study, and passage difficulty, context fit and paraphrase ratings obtained in the second norming study were matched across experimental conditions.

Additionally, 40 filler passages were developed for use in this study. Filler passages contained no clearly idiomatic language and were of approximate equal passage length and difficulty to the experimental passages. In total, 80 experimental passages were created for use in the experiment. Finally, 40 true or false questions were created in order to monitor participants’ comprehension of the experimental and filler passages. In the case of the experimental passages, each question referred to a passage’s context, not to the idiom phrase.

D. Apparatus

The experiment was conducted using an Eye-Link 1000 eye-tracking system. The experiment and eye tracker were controlled using Experiment Builder software from SR Research. Passages were presented on a 17” flat panel monitor. Each passage was written in 20
point black Arial font, double-spaced, and presented on a white background. The visual angle of
the widest line of text was 30.5° of visual angle. To put this in perspective, there are 71 characters
and spaces in the widest line, which means one horizontal degree of visual angle equals
approximately 2.3 character positions for that line.

E. Procedure

Participants completed the experiment individually in a quiet room where they were
greeted and asked to read and sign a consent form. Participants were seated at a computer
monitor where they read instructions that explained how the texts were presented as well as the
procedures required to advance from screen to screen. If they did not have any questions, the
experimenter began adjusting the eye tracker.

Participants rested their heads on a chin rest and forehead rest to minimize head
movement while reading the passages. Any necessary adjustments for comfort were made. A
calibration procedure was run to ensure the eye tracker was accurately measuring the reader’s
eye movements. During the calibration, participants were asked to fixate a series of nine points
that were presented one at a time in a nine-point grid pattern on the monitor in a random order.
The amount of visual error from the actual and predicted fixation points was automatically
measured in degrees of visual angle. Participants must have had an average error of 0.5° or less
to be eligible to continue (approximately +/-1.5 characters). Recalibration and adjustments were
made if the average error exceeded 0.5°. The experiment began after the participants were
successfully calibrated.

Participants were given two practice passages to become familiar with the study.
Participants then began the 80 experimental trials. On each trial, participants read a passage at
their own pace. After reading the passage, participants were instructed to look at an “X” displayed on the lower right side of the screen, two lines below the last line of text, and then press a button on the controller when they were ready to move on to the next passage. Participants answered a true-false question after half of the passages. Participants answered the questions using a handheld controller, pressing “A” for true and “B” for false.

After completing the eye-tracking portion of the experiment, participants completed several questionnaires and tests. First, participants completed a Language History Questionnaire (LHQ). The LHQ was designed to collect information on participants’ language background in order to determine their English language proficiency as well as determine whether they were bilingual. The LHQ asked participants to list their native language(s), the number of years they have been speaking English, and provide self-reported proficiency ratings for English and other languages. Next, participants were asked to complete a 30-item vocabulary test by choosing the best answer among five alternatives. The vocabulary test, developed by Raney and used in several prior studies (Minkoff & Raney, 2000; Therriault & Raney, 2007), was included as a quick measure of comprehension ability. Previous studies have demonstrated a moderate correlation between this vocabulary test and comprehension ability (r = .40 to .52). Lastly, participants were given a list of the idioms presented during the experiment and asked to rate their familiarity with the idioms on a 7-point scale. Participants were then thanked for their participation and debriefed.
III. RESULTS

Two sets of analyses were performed. The first set was based on fixation measures for entire idiom phrases. I refer to these as phrase level analyses. These included first pass duration, first pass fixation count, total time, and total fixation count. For the phrase level analysis, separate 2 (Familiarity: High vs. Low) x 2 (Context: Figurative vs. Literal) mixed analyses of variance (ANOVA) were performed for the various reading time and fixation count measurements. Because word frequency was only controlled for the target words (idiom final words), frequency cannot be included as a factor in the phrase level analyses. Analyses are presented based on subject (F1) and item (F2) means, with the exception of first pass measurements. Item analyses of first pass measurements could not be performed because the eye movement analysis program does not output data based on the phrase level, but only by the word level. Item (F2) analyses can be performed for total time and total fixation count because these can be obtained by summing across words in an idiom phrase. A statistical significance level of .05 was maintained throughout the analysis.

The second set of analyses was based on fixation measures for the final word of the idiom phrase. I refer to these as target word analyses. These included first fixation duration, first run duration (also called gaze duration), total time, first run fixation count, total fixation count, and regression out count. Separate 2 (Familiarity: High vs. Low) x 2 (Frequency: High vs. Low) x 2 (Context: Figurative vs. Literal) mixed analyses of variance (ANOVA) were performed for each reading time and fixation count measure. Analyses are presented based on subject (F1) and item (F2) means.
A. Phrase Level Analyses

Mean reading time measurements of the idiom phrase were analyzed and can be found in Table 1. The first pass reading time ANOVA revealed a significant main effect of familiarity, $F1(1,38) = 39.9$, $MSE = 5194.9$, $p < .05$, $\eta^2_p = .51$, with mean reading times for high familiarity idiom phrases ($M = 487$ ms) being 102 ms faster than low familiarity idiom phrases ($M = 589$ ms). No main effect of context was found, $F1(1,38) = .63$, $MSE = 26711.7$, $p = .43$, $\eta^2_p = .02$, which indicates that reading times were similar when phrases were used figuratively or literally. No interaction was found, $F1(1,38) = .31$, $MSE = 5194.9$, $p = .58$, $\eta^2_p = .00$.

The total reading time ANOVA also revealed a main effect of familiarity, such that high familiarity idiom phrases ($M = 627$) were read 250 ms faster than low familiarity idiom phrases ($M = 867$). This effect was significant both by subjects, $F1(1,38) = 93.6$, $MSE = 12391.9$, $p < .05$, $\eta^2_p = .71$, and by items, $F2(1,36) = 15.5$, $MSE = 73932.6$, $p < .05$, $\eta^2_p = .29$. No main effect of context was found ($F1(1,38) = .63$, $MSE = 62943.5$, $p > .40$, $\eta^2_p = .02$; $F2(1,36) = 2.3$, $MSE = 16920.3$, $p = .14$, $\eta^2_p = .06$). No interaction was found ($F1$ and $F2 < 1.0$, all $p$s $>.50$, all $\eta^2_p$s $=.01$).

Mean fixation counts for the idiom phrase were also analyzed and can be found in Table 1. The first run fixation count revealed a main effect of familiarity, such that low familiarity idiom phrases ($M = 2.9$) were fixated on 0.4 times per word more than high familiarity idiom phrases ($M = 2.5$), $F1(1,38) = 158.9$, $MSE = .03$, $p < .05$, $\eta^2_p = .81$. No main effect of context was found, $F1(1,38) = .19$, $MSE = .29$, $p > .60$, $\eta^2_p = .01$. A significant Familiarity x Context interaction was found, $F1(1,38) = 4.6$, $MSE = .03$, $p < .05$, $\eta^2_p = .11$. High familiarity idiom phrases used in a figurative context ($M = 2.5$) were fixated an equal number of times as high
familiarity idiom phrases used in a literal context ($M = 2.5$). Low familiarity idiom phrases used in a figurative context ($M = 3.0$) were fixated .1 times per word more than low familiarity phrases used in a literal context ($M = 2.9$). A contrast test revealed that this difference was not significant, $F_{\text{contrast}} (1, 38) = 3.9, ns$.

Analysis of total fixation count revealed a main effect of familiarity, such that low familiarity idiom phrases ($M = 3.9$) were fixated 1.0 times per word more than high familiarity idiom phrases ($M = 2.9$). This effect was significant both by subjects, $F1 (1, 38) = 107.1, \text{MSE} = .18, p < .05, \eta_p^2 = .74$, and by items, $F2 (1, 38) = 11.9, \text{MSE} = 1.6, p < .05, \eta_p^2 = .24$. No main effect of context was found ($F1$ and $F2 < 1.0$, all $p$s > .50, all $\eta_p^2$s = .00). No interaction was found ($F1$ and $F2 < 1.0$, all $p$s > .50, all $\eta_p^2$s = .01).

The results of the phrase level analysis mirror what has been found in previous studies—longer reading times for low familiarity idiom phrases compared to high familiarity idiom phrases. Additionally, as in previous studies, no effect of context was found. That is, idiom phrases presented in a literally supportive context were read as fast as idiom phrases presented in a figuratively supportive context.

### B. Target Word Level Analyses

Mean reading time measurements of the idiom final word were analyzed and can be found in Table 2. The first fixation duration ANOVA revealed a significant main effect of familiarity such that the final words of high familiarity idiom phrases ($M = 208 \text{ ms}$) were read 23 ms faster than the final words of low familiarity idioms phrases ($M = 231 \text{ ms}$). This effect was significant both by subjects, $F1 (1, 38) = 21.9, \text{MSE} = 945.1, p < .05, \eta_p^2 = .37$, and by items, $F2 (1, 36) = 8.2, \text{MSE} = 1151.6, p < .05, \eta_p^2 = .19$. Importantly, the main effect of word frequency
was not significant by subjects, $F_1 (1, 38) = 1.3, \text{MSE} = 701, p = .27, \eta^2_p = .03$, or by items, $F_2 (1, 36) = .59, \text{MSE} = 1151.6, p = .45, \eta^2_p = .02$. Additionally, the main effect of context was not significant by subjects, $F_1 (1, 38) = 0, \text{MSE} = 3893.7, p = .99, \eta^2_p = .00$, or by items, $F_2 (1, 36) = .05, \text{MSE} = 968.1, p = .82, \eta^2_p = .00$. None of the interactions approached significance (all $F_1$ and $F_2 < 1.0$, all $p$s > .35, all $\eta^2_p$s < .03).

The first run duration (gaze duration) ANOVA revealed a significant main effect of familiarity such that the final words of high familiarity idiom phrases ($M = 228$ ms) were read 32 ms faster than the final words of low familiarity idiom phrases ($M = 260$ ms). This effect was significant both by subjects, $F_1 (1, 38) = 22.8, \text{MSE} = 1784.7, p < .05, \eta^2_p = .38$, and by items, $F_2 (1, 36) = 7.9, \text{MSE} = 2061.1, p < .05, \eta^2_p = .18$. There was a significant main effect of word frequency by subjects, $F_1 (1, 38) = 12.4, \text{MSE} = 1574.6, p < .05, \eta^2_p = .25$, and by items, $F_2 (1, 36) = 5.0, \text{MSE} = 2061.1, p < .05, \eta^2_p = .12$. High frequency final words ($M = 233$ ms) were read 22 ms faster than low frequency final words ($M = 255$ ms). The main effect of context was not significant by subjects, $F_1 (1, 38) = .39, \text{MSE} = 2363.9, p = .53, \eta^2_p = .01$, or by items, $F_2 (1, 36) = .29, \text{MSE} = 1317.9, p = .59, \eta^2_p = .01$. No interactions reached significance (all $F_1$ and $F_2$ <1.20, all $p$s > .25, all $\eta^2_p$s < .01).

The total reading time ANOVA revealed a main effect of familiarity such that the final words of high familiarity idiom phrases ($M = 258$ ms) were read 85 ms faster than the final words of low familiarity idiom phrases ($M = 343$ ms). This effect was significant both by subjects, $F_1 (1, 38) = 58.1, \text{MSE} = 4885.6, p < .05, \eta^2_p = .60$, and by items, $F_2 (1, 36) = 15.0, \text{MSE} = 7382.6, p < .05, \eta^2_p = .29$. A main effect of word frequency was also found that was significant by subjects, $F_1 (1, 38) = 7.4, \text{MSE} = 3999.2, p < .05, \eta^2_p = .16$, but not by items, $F_2 (1, 36) = 2.1, \text{MSE} = 7382.6, p = .15, \eta^2_p = .06$. High frequency final words ($M = 287$ ms) were
read 27 ms faster than low frequency final words ($M = 314$ ms). The main effect of context was not significant by subjects, $F1 (1, 38) = 1.0$, MSE = 10499.2, $p = .32$, $\eta_p^2 = .03$, or by items, $F2 (1, 36) = .70$, MSE = 2947.8, $p = .41$, $\eta_p^2 = .02$. No interactions reached significance (all $F1$ and $F2 < 1.8$, all $ps > .20$, all $\eta_p^2$s < .05).

Mean fixation counts for the idiom final word were also analyzed and can be found in Table 3. The first run fixation count ANOVA revealed a main effect of frequency, such that low frequency final words ($M = 1.2$) were fixated 0.08 times more per word than high frequency final words ($M = 1.1$). This effect was significant both by subjects, $F1 (1, 38) = 13.1$, MSE = .03, $p < .05$, $\eta_p^2 = .26$, and by items, $F2 (1, 36) = 9.2$, MSE = .02, $p < .05$, $\eta_p^2 = .20$. No other main effects or interactions reached significance (all $F1$ and $F2 < 2.0$, all $ps > .15$, all $\eta_p^2$s < .06).

The total fixation count ANOVA revealed a main effect of familiarity, such that the final words of low familiarity idiom phrases ($M = 1.6$) were fixated .18 times more per word than the final words of high familiarity idiom phrases ($M = 1.3$). This effect was significant both by subjects, $F1 (1, 38) = 40.9$, MSE = .09, $p < .05$, $\eta_p^2 = .52$, and by items, $F2 (1, 36) = 9.1$, MSE = .12, $p < .05$, $\eta_p^2 = .20$. Additionally, there was a main effect of frequency, such that low frequency final words ($M = 1.5$) were fixated .08 times more per word than high frequency final words ($M = 1.4$). This effect was significant by subjects, $F1 (1, 38) = 6.7$, MSE = .09, $p < .05$, $\eta_p^2 = .15$, but not by items, $F2 (1, 36) = 2.2$, MSE = .12, $p = .15$, $\eta_p^2 = .06$. The main effect of context was not significant by subjects, $F1 (1, 38) = .99$, MSE = .16, $p = .33$, $\eta_p^2 = .03$, or by items, $F2 (1, 36) = 1.1$, MSE = .04, $p = .29$, $\eta_p^2 = .03$. No interactions reached significance (all $F1$ and $F2 < 1.3$, all $ps > .30$, all $\eta_p^2$s < .04).
The regression out count ANOVA revealed a main effect of familiarity, such that there were 0.09 more regressions out of low familiarity idiom phrase final words ($M = .22$) than out of high familiarity idiom phrase final words ($M = .13$). This effect was significant both by subjects, $F_1 (1, 38) = 11.5$, MSE = .03, $p < .05$, $\eta^2_p = .23$, and by items, $F_2 (1, 36) = 19.0$, MSE = .01, $p < .05$, $\eta^2_p = .35$. Additionally, there was a main effect of frequency, such that there were 0.05 more regressions out of low frequency final words ($M = .20$) than high frequency final words ($M = .15$). This effect was significant both by subjects, $F_1 (1, 38) = 6.9$, MSE = .02, $p < .05$, $\eta^2_p = .15$, and by items, $F_2 (1, 36) = 8.2$, MSE = .01, $p < .05$, $\eta^2_p = .19$. A Familiarity x Frequency interaction was found. This interaction approached significance by subjects, $F_1 (1, 38) = 3.7$, MSE = .02, $p = .06$, $\eta^2_p = .09$, and reached significance by items, $F_2 (1, 36) = 4.3$, MSE = .01, $p = .05$, $\eta^2_p = .11$. Among low familiarity idioms, contrasts tests showed there were more regressions out of low frequency final words ($M = .27$) than out of high frequency final words ($M = .17$), $F_{contrast} (1, 38) = 5.0$, $p < .05$. However, among high familiarity idioms, there were virtually no differences between the number of regressions out of low frequency final words ($M = .13$) and high frequency final words ($M = .12$). The main effect of context was not significant by subjects, $F_1 (1, 38) = .96$, MSE = .05, $p = .33$, $\eta^2_p = .03$, or by items, $F_2 (1, 36) = .18$, MSE = .02, $p = .68$, $\eta^2_p = .01$. No interactions reached significance (all $F_1$ and $F_2 < 1.0$, all $ps > .30$, all $\eta^2_p$s < .03).

Except for regression out counts, the predicted Familiarity x Frequency interaction was not found for any of the reading measurements. Additionally, the predicted Context x Familiarity x Frequency interaction was not found for any of the reading measurements. However, as seen in Table 2, the total time measurement yielded the expected pattern of results for idiom phrases presented in a figurative context. More specifically, within figurative contexts, low familiarity
idiom phrases with high frequency final words ($M = 336$ ms) were read 36 ms faster than low frequency final words ($M = 372$ ms). However, within high familiarity idioms, there was no apparent difference (3 ms) in reading times for low ($M = 265$ ms) and high frequency final words ($M = 262$ ms). In contrast, a standard word frequency effect was found for both low and high familiarity idiom phrases in literally supportive contexts. Within low familiarity phrases, high frequency final words ($M = 319$ ms) were read 24 ms faster than low frequency final words ($M = 343$ ms). Likewise, in high familiarity phrases, high frequency final words ($M = 231$ ms) were read 46 ms faster than low frequency final words ($M = 277$ ms).

Because this interaction was predicted, further evaluation of the interaction was performed. Separate 2 (Familiarity: High vs. Low) x 2 (Frequency: High vs. Low) within-subjects analyses of variance were performed for the literal context and figurative context means for all of the reading time measurements. The first fixation duration ANOVA for the literal context revealed significant main effects of familiarity, $F (1, 19) = 12.5$, MSE = 1081.7, $p < .01$, $\eta_p^2 = .40$, but no effect of word frequency, $F (1, 19) = .01$, MSE = 648.9, $p = .91$, $\eta_p^2 = .00$. The gaze duration ANOVA for the literal context revealed a significant main effect of familiarity, $F (1, 19) = 8.9$, MSE = 1833.7, $p < .01$, $\eta_p^2 = .32$, and word frequency, $F (1, 19) = 22.2$, MSE = 752.8, $p < .01$, $\eta_p^2 = .53$. The total time ANOVA for the literal context revealed a significant main effect of familiarity, $F (1, 19) = 24.1$, MSE = 4967.1, $p < .01$, $\eta_p^2 = .56$, and word frequency, $F (1, 19) = 8.7$, MSE = 2821.4, $p < .01$, $\eta_p^2 = .32$. The predicted Frequency x Familiarity interaction did not reach significance in first fixation duration, gaze duration or total time (all $Fs < 1.0$, all $ps > .50$, all $\eta_p^2$s < .03). In sum, all separate analyses of the literal context revealed results consistent with the results of the combined analyses.

The first fixation duration ANOVA for the figurative context yielded significant main
effects of familiarity, $F(1, 19) = 9.4$, MSE $= 808.4$, $p < .01$, $\eta^2_p = .33$, but no effect of word frequency, $F(1, 19) = 2.0$, MSE $= 753.2$, $p = .17$, $\eta^2_p = .01$. Additionally, the analysis of figurative contexts yielded significant main effects of familiarity in gaze duration, $F2(1, 19) = 14.3$, MSE $= 1735.6$, $p < .01$, $\eta^2_p = .43$, and total reading time, $F2(1, 19) = 34.6$, MSE $= 4804.1$, $p < .01$, $\eta^2_p = .65$. The predicted Frequency x Familiarity interaction did not reach significance in first fixation duration, gaze duration or total time (all $F$s $< 2.0$, all $ps > .25$, all $\eta^2_p$s $< .10$). Interestingly, the analysis of figurative contexts did not yield significant main effects of word frequency in gaze duration, $F2(1, 19) = 1.9$, MSE $= 2396.5$, $p = .18$, $\eta^2_p = .09$, or in total reading time, $F2(1, 19) = 1.5$, MSE $= 5177.0$, $p = .24$, $\eta^2_p = .07$. This was inconsistent with the combined analysis, which found main effects of word frequency for all later occurring processing measures. Overall, the results of these separate analyses suggest differences between figurative and literal usages of idiom phrases in measures that include multiple fixations on the target word (gaze duration and total time). These measures reflect more later occurring processes than does first fixation duration. While word frequency affects later occurring processing measures in literal usages of idiom phrases, it does not appear to play a significant role in early or late processing measures in figurative usages of idiom phrases.

Overall, the results of the target word analyses revealed generally reliable familiarity effects for most measures: final words of high familiarity idiom phrases were read faster than final words of low familiarity idiom phrases. Importantly, there was no frequency effect in first fixation duration. Frequency effects only appeared for target word measures that reflected multiple fixations on the target, such as first run and total time. The predicted Familiarity X Frequency X Context interaction was not significant in any of the reading time measurements. This indicates that the frequency effect was not reliably different for familiar idiom phrases than
for unfamiliar idiom phrases within figurative and literal contexts.

The predicted difference in frequency effects was found for idiom phrases presented in a figuratively supported context. That is, the frequency effect appears to be larger in familiar idioms (36 ms) than in unfamiliar idioms (3 ms). However, this pattern of results did not reach statistical significance. The lack of significant Familiarity X Frequency interactions indicates that there is much variability in the means across participants and items. This is reflected by the low statistical power for the interaction (observed power = .25).
IV. DISCUSSION

A. Phrase Level Analyses

One goal of the current study was to examine the role of context and familiarity on the processing of idiom phrases as a whole. The results show no reading time or fixation count differences between the figurative and literal usages of idiom phrases. This finding is consistent with the results found in Siyanova-Chanuturia et al. (2011). The results also show a main effect of familiarity such that high familiarity idiom phrases were read significantly faster than low familiarity idiom phrases. These results are consistent with prior research demonstrating processing differences between high and low familiarity idiom phrases in a meaningfulness classification task (Libben and Titone, 2008), as well as reading time studies (Schweigert, 1985). Larger familiarity effects were found in total time reading measurements versus first pass reading time, which indicates that low familiarity idiom phrases require more second-pass fixations (rereading) than were needed for high familiarity idioms. Second-pass fixations are often associated with later-occurring integrative processes, such as integrating the meaning of an idiom with the context (Rayner et al., 2012).

B. Target Word Level Analyses

The primary goal was to examine the relationship between context, familiarity and word frequency in the processing of the final word of an idiom phrase. More specifically, the current study aimed to determine whether inclusion of a word in an idiom phrase changes the way that word is processed by examining word frequency effects. In the following discussion, I review the results as a function of word frequency, familiarity, context and interactions between these factors.
1. **Word Frequency.** High frequency words are processed faster than low frequency words (Inhoff & Rayner, 1986; Monsell, 1991; Rayner, 1998). This reflects facilitation of early word processing, such as lexical access, and later-occurring word processing, such as integration with context (Rayner et al., 2012). Thus, changes in word frequency effects reflect changes in how a word is processed.

One of the most important findings was that there were no word frequency effects for first fixation duration. This provides evidence that word processing changes when a word is the final word of an idiom phrase. First fixation duration, gaze duration, and total time all reflect early- and later-occurring word processing, but first fixation duration reflects less of the later-occurring processes because it does not include multiple fixations. Given that the word frequency effect is an indicator of lexical access, eliminating the word frequency effect for first fixation duration indicates that some aspect of the word’s initial lexical access has changed. This is consistent with previous research that has demonstrated a reduction or elimination of the word frequency effect in tasks that did not require full access of the target word from the lexicon (Rayner and Raney, 1996; Scarborough, Cortese and Scarborough, 1997). The present research shows that the frequency effect can be eliminated in a task that does require complete lexical access.

All other reading time and fixation count measures yielded a main effect of word frequency. Given that first fixation duration did not show a frequency effect, the frequency effect must be limited to refixations (e.g., the second fixation for words that are fixated twice) and second pass fixations (e.g., a second reading following a regression). Refixations and regressions are thought to reflect higher-level processing, such as integrating a word into its context (Rayner et al., 2012). The lack of frequency effects in first fixation duration combined with the presence
of frequency effects in total time and total fixation count support the conclusion that high frequency final words are easier to integrate with the context than are low frequency words.

2. *Familiarity*. As predicted, there were strong familiarity effects. All reading time measures and most fixation count measures yielded main effects of familiarity such that the final words of high familiarity idioms were processed faster and received fewer fixations than those of low familiarity idioms. Familiarity effects are strongly supported by the literature (e.g., Schweigert, 1985; Libben & Titone, 2008).

Why does the familiarity of the phrase affect the processing of the final word of the idiom phrase? In short, the idiomatic meaning should be activated earlier during processing of high familiarity idioms, thus leading to greater facilitation effects for final words in high familiarity idiom phrases. The idiomatic meaning of a low familiarity idiom is not likely to be activated until the conclusion of the idiom. Thus, no such facilitation is present for the final words of low familiarity idiom phrases.

By examining the different reading time and fixation count measures more closely, one can learn more about the role of familiarity in the processing of idiom final words. There were familiarity effects for first fixation duration, first pass duration, and total time. There was no familiarity effect for first run fixation count. Thus, for first run measurements, it appears that longer fixation durations on low familiarity final words is driving the main effect of familiarity, not the number of fixations. There was, however, a main effect of familiarity for total fixation count. For total time, which includes refixations and regressions back to the target word, it appears that an increase in both the number and duration of fixations on low familiarity final words is driving the main effect of familiarity.
3. **Context.** As predicted, there was no main effect of context for any of the reading time or fixation count measures. This is consistent with past research that has found similar processing times for literal and figurative uses of an idiom phrase (Siyanova-Chanturia et al., 2011; Estill & Kemper, 1982). The supports the conclusion that the speed of processing of the final word of an idiom does not appear to differ as a function of the context in which that phrase is used. This does not mean that the *manner* of processing is the same for literal and figurative uses of idiom phrases, only that the speed of processing is similar. Processing of the literal usages of idiom phrases should proceed computationally. Processing of idiom phrases could proceed computationally until the reader has identified the idiom (as in the configuration hypothesis) or idiom phrases could be retrieved as a single unit (as in the lexicalization hypothesis).

4. **Interactions.** Except for regression out counts, none of the reading time or fixation count measures yielded the predicted interaction between Familiarity and Frequency, nor was there a 3-way interaction between Familiarity, Frequency, and Context. Recall that a Familiarity X Frequency interaction was expected. Specifically, I expected to find a reduced word frequency effect among high familiarity idioms relative to low familiarity idioms. Access of high familiarity idiom final words was expected to be facilitated due to earlier access to the idiomatic meaning. Access of low familiarity idiom final words was not expected to be facilitated because the idiomatic meaning of these expressions is often not accessed until reaching the final word. Not finding a significant Familiarity x Frequency interaction suggests that being part of a high familiarity idiom phrase is not enough to override the word’s lexical properties.

Interestingly, analysis of regression out counts yielded a significant Familiarity X Frequency interaction. Regression-out counts reflect the number of regressions from the idiom
final word to prior words in the idiom or to words in the context. Among high familiarity idioms, virtually no differences were found between the number of regressions out of low frequency final words and high frequency final words. This supports the conclusion that being part of a high familiarity idiom phrase facilitates processing of idiom final words, such that both high and low frequency words require less effort to integrate that word into the prior context. This is not the case with low familiarity idiom phrases where low frequency final words require more regressions back to the prior context than high frequency final words. Among low familiarity idioms, low frequency final words require more integration with the prior context than high frequency final words. Overall, this pattern of results suggests that when the final word of an idiom phrase is not facilitated, lexical features of the word, such as word frequency, are an important feature in determining the difficulty of integrating of that word into the prior context. More broadly speaking, this pattern of results also suggests a change in lexical access for high familiarity idiom final words.

Total reading time was the only measure that came close to producing a 3-way interaction between context, familiarity, and frequency. While not significant, the pattern of means is akin to what was predicted. For high familiarity idioms presented in a figurative context, the word frequency effect was almost eliminated (only 3 ms difference between high and low frequency final words). All other conditions showed clear word frequency effects (ranging from 24 to 46 ms). This suggests that facilitation was strong enough to greatly reduce processing time of low frequency words in high familiarity idioms presented in figurative contexts. Additionally, this suggests a change in the difficulty of lexical access for high frequency idiom final words in high familiarity idioms in figuratively biased contexts. The lack of statistical significance can be attributed to low statistical power for the interaction (observed power = .25).
C. Future Directions

Some previous research has included a matched literal control condition (Estill & Kemper, 1982; Libben & Titone, 2008; Siyanova-Chanuturia et al., 2011). A matched literal control condition refers to a non-idiomatic phrase (*found the bucket*) that ends with the final word (*bucket*) of a matched idiom phrase (*kick the bucket*). In a broad sense, the inclusion of a matched literal control condition would allow me to examine whether the processing of the final word when it is included in an idiom phrase changes relative when it is included in a completely non-idiomatic phrase.

A matched literal control condition is not necessary for answering the research questions for the current study because changes in the word frequency effect demonstrate changes in word processing. However, a matched literal control condition would be beneficial in answering a number of related questions. One such question relates to the role of context in idiom processing. Previous research has found that figurative and literal usages of idiom phrases are at a processing advantage relative to a matched literal control (Siyanova-Chanuturia et al., 2011). This supports the conclusion that familiarity of the idiomatic phrase itself facilitates processing of the final word of the phrase regardless of whether the figurative or literal meaning is contextually supported. The inclusion of a matched literal control condition would allow me to investigate the degree of facilitation relative to matched controls.

D. General Discussion

The results of the current study cannot distinguish between the lexical representation hypothesis and the configuration hypothesis. Facilitated processing of the idiom final word could reflect a) the automatic retrieval of the figurative meaning of the idiom phrase from the lexicon
(as predicted by the lexical representation hypothesis) or b) an expectation about the conclusion of the idiom phrase (as predicted by the configuration hypothesis). The results support both theories.

The current study was not designed to test the differences between these two theories. However, these two theories could be evaluated by comparing the pattern of facilitation of individual words occurring earlier in the idiom phrase. Theoretically speaking, facilitation of words in the idiom phrase may occur as soon as the first word of the idiom according to the lexical representation hypothesis, which emphasizes the automatic retrieval of the figurative meaning from the lexicon. Adopting the configuration hypothesis, on the other hand, one would predict that facilitation of individual words in the idiom would occur only after the idiom key point, or the point at which the idiom has been identified as an idiom.

While the current study was not designed to distinguish between the lexical representation hypothesis and the configuration hypothesis, the findings offer some insight into the nature of idiom processing. In fact, the current study provides several important findings regarding the role of context, familiarity, and word frequency in the processing of idiom final words. As predicted, the speed of processing of idiom final words did not differ as a function of the context (figurative or literal) in which that phrase was used. Also as predicted, familiarity with an idiomatic phrase facilitated processing of the idiom phrase as a whole as well as the final word. This result was found in all reading time measurements, indicating the important role of familiarity in facilitating initial lexical access as well as semantic analysis and integration of the word within its context.

Additionally, the current study offers support for the idea that words are processed differently in idiom phrases. Lexical features, such as word frequency, do not appear to affect
initial lexical access of words from the lexicon. This suggests that the first fixation on the final word of an idiom phrase serves merely as a check to ensure that the predicted word is the expected word. Such a check might not require readers to fully access the meaning of the word from the lexicon. This finding is important because it is the first study that I am aware of to demonstrate that word frequency effects can be eliminated under normal reading conditions.

In later processing, word frequency of the idiom final word does affect the way that word is processed. Interestingly, when analyzing the results of the literal and figurative contexts separately, word frequency effects were only found in the literal contexts and not in the figurative contexts. This important finding suggests that the facilitation provided by the figurative context was enough to override the effect of lexical features. The results of these separate analyses are important for several reasons. First, they demonstrate the reduced impact of word frequency on the processing of idiom final words when those words are embedded within a context supportive of the phrase’s figurative meaning. Second, they demonstrate differences in the way literal and figurative uses of idiom phrases are processed. This is important because previous research has found no reading time differences between the literal and figurative uses of idiom phrases (Estill & Kemper, 1982; Siyanova-Chanuturia et al., 2011). In essence, the time needed to process figurative and literal meanings is the same even though the processes involved might be slightly different. This finding also demonstrates the importance of examining reading time of the whole idiom phrase as well as the individual words comprising the idiom phrase to gain the most complete understanding of the way idiom phrases are processed.

The question addressed by the current study was, does including a word as the final word of an idiom phrase change the way that word is processed? The evidence suggests that it does. Are these processing changes the result of being included in an idiom phrase? Or do these
changes in word processing extend to high frequency literal phrases, such as clichés (e.g., *conquer the world*). One line of research has indeed found that idioms and clichés enjoy similar processing advantages over their control expressions (Burt, 1992; Tabossi, Fanari & Wolf, 2009). The authors of these studies argue that it is familiarity with the configuration of words in the expression that leads to processing advantages not whether a phrase is a familiar figurative expression. This conclusion is tentative, however, because Burt (1992) and Tabossi, Fanari and Wolf (2009) used a classification task (e.g., Is this sentence a meaningful one?), which is post-access processing task that is very different from reading time. Examining natural reading time of words comprising idioms and clichés may yield differences in the way these two types of phrases are processed. One potential reason for differences between idioms and clichés is that individual words in idioms usually are not directly tied to the meaning of the phrase. For instance, the word *bucket* in the idiom *kick the bucket* does not contribute to the figurative meaning of the phrase (e.g., to die) whereas the word *world* does contribute to the meaning of the cliché *conquer the world*. The question of whether or not word processing changes are similar in highly familiar figurative and literal phrases must be addressed by future research.

Even more broadly, the current study provides some evidence in favor of an interactive approach to language processing. In interactive models of language processing, higher-level contextual processes directly influence lower-level word processing (McClelland, 1987). This is in contrast to a modular approach to language processing in which each lower- and higher-level processes are performed serially or in parallel and do not interact with one another (Fodor, 1983). The current study clearly does not support a strict modular approach because higher-level contextual information, such as familiarity with a particular configuration of words and its usage (figurative or literal) influences the processing of individual words in the idiom phrase.
In summary, the current study supports several important findings regarding the role of context, familiarity, and word frequency in the processing of idiom final words. Specifically, the word frequency effect was eliminated in first fixation duration, indicating that some aspect of initial lexical access was changed. This supports the conclusion that familiarity with an idiomatic phrase facilitates early stages of word processing (first fixation duration). The current study also demonstrates that idiom familiarity facilitates early stages of word processing (first fixation duration) and later stages of word processing (e.g., total time, total fixation count). These results provide important information about the time course of facilitation of idiom final words. Taken together, the current study supports the general conclusion that inclusion of a word as a final word of an idiom phrase changes the way that word is processed.
V. REFERENCES


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TABLE I: Mean First Pass Time (in ms) and Fixation Counts, and Mean Total Time (in ms) and Fixation Counts and Standard Errors for Idiom Phrases as a Function of Context (Figurative, Literal) and Idiom Familiarity (High, Low)
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TABLE II

Mean First Fixation Duration, First Run Time, and Total Time (in ms) and Standard Errors for Idiom Final Words as a Function of Context (Literal, Figurative), Idiom Familiarity (High, Low) and Idiom Final Word Frequency (High, Low)
<table>
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<td>1.3 (.04)</td>
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<tr>
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<td>1.1 (.03)</td>
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<tr>
<td>Literal</td>
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<td>1.1 (.04)</td>
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<td>1.2 (.03)</td>
<td>1.1 (.04)</td>
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</tbody>
</table>

**TABLE III**

*Mean First Run, Total, and Regression Out Counts as a function of Context (Literal, Figurative), Familiarity (High, Low), and Word Frequency (High, Low)*
Figure 1. Sample sentence with hypothetical fixation pattern.

He had seen it slip through his fingers before.

Definition of terms

Forward fixations (1, 2, 3, 4, 5, 7, 10)

Refixation of “fingers” (6)

Regression to “fingers” (8)

First fixation of “fingers” (5)

Second fixation of “fingers” (6)

Third fixation of “fingers” (8)

First pass (gaze duration) for “fingers” (5, 6)

Second pass for “fingers” (8)

Dwell time (total time) for “fingers” (5, 6, 8)

First pass for the region “slip through his fingers” (3, 4, 5, 6)

Second pass for the region “slip through his fingers” (8, 9)

Note: Numbers represent sequence of fixations
APPENDICES
APPENDIX A

Norming Study 1

Section I. Below is a list of idioms. Your task is to (1) rate your familiarity with each idiom, (2) rate how well you know what each idiom means, (3) provide a definition of each idiom, and (4) rate how easily the idiom can be understood literally.

Example 1: THAT SHIP HAS SAILED.

Rate your familiarity with the idiom.

Not at all familiar 1 2 3 4 5 6 7 Very familiar

Rate how well you know what the idiom means.

Not at all 1 2 3 4 5 6 7 Very well

Define the idiom in your own words ________________

_____________________________________________________________________

_____________________________________________________________________

How easily can the words in the idiom be understood literally (e.g., a ship has sailed off somewhere)?

Not at all 1 2 3 4 5 6 7 Very well

Norming Study 2

Instructions: Read each passage carefully and then answer the corresponding questions in the question booklet. Below you will find three example passages and their answers:

1. Lucy’s husband, Bill, had been recently laid off from his job. Lucy, who hadn’t worked in 10 years, went back to work. Bill was surprised at how quickly Lucy had been able to find a job. Now she was bringing home the bacon. Bill really wanted a new job.

How difficult was the passage to understand?

Not at all difficult 1 2 3 4 5 Very difficult

How well does the underlined phrase fit in with the prior sentences?

Not at all 1 2 3 4 5 Very well

Rate your familiarity with the underlined phrase.

Not at all familiar 1 2 3 4 5 Very familiar

Summarize the underlined phrase in your own words __________

Making money for the family

How difficult was it to summarize the underlined phrase?

Not at all difficult 1 2 3 4 5 Very difficult
Norming Study 3

Instructions: On the following pages you will find a series of incomplete passages. Each passage contains three complete sentences and one incomplete sentence. Read each passage carefully and, on the corresponding answer sheet, fill in the incomplete sentence with the word that best completes that sentence and fits in with the prior context. Additionally, you will be asked to judge how confident you are in your decision.

Below you will find three example passages and their answers:

1. Lucy’s husband, Bill, had been recently laid off from his job. Lucy, who hadn’t worked in 10 years, went back to work. Bill was surprised at how quickly Lucy had been able to find a job. Now she was bringing home the _____...

1. ____Bacon_______ Not at all confident 1 2 3 4 5 Very confident
APPENDIX B

Low Familiarity, High Frequency

Figurative: Jessica and Liz had not seen each other in a few weeks. They had a lot of things to catch up on. Jessica could not wait to tell Liz that their mutual friend was pregnant and wanted to tell Jessica about her new job. They met at a coffee shop and chewed the fat almost the entire afternoon. It was great to see each other.

Literal: Jessica and Liz decided to splurge one night at the most expensive restaurant in town. They both ordered several cocktails, an appetizer, and the most expensive dinner available, the steak dinner. Jessica was surprised because the steak did not look very lean. Jessica cut off some steak and chewed the fat almost the entire way through. Jessica spit it out and asked for a refund.

Low Familiarity, Low Frequency

Figurative: Lauren had lived in the Chicago area her entire life. When she was offered a job in Los Angeles, Lauren didn't know if she should take it. Her friends and family were in Chicago and she was nervous about moving and starting over. Lauren realized that pulling up stakes was harder than she thought. Lauren ended up loving her new life in Los Angeles.

Literal: Lauren loved to go camping with her boyfriend Fred. This was their fifth summer in a row going camping together in Yellowstone National Park. Every year Fred let Lauren pack up the tent since Fred always puts the tent together at the beginning of the trip. Lauren realized that pulling up stakes was harder than she remembered. The camping trip was always a success.

High Familiarity, High Frequency

Figurative: Hal was a professional tennis player. His next match was the most important one of his career—if he won, he would qualify for a spot in the finals. He was in a similar position last year, but lost that match. He had seen it slip through his fingers before so he was worried. Hal could not wait to get on the court to prove himself.

Literal: Hal took off his wedding ring before washing his hands in the sink. He tried to avoid getting it greasy because it was hard to clean. His hands were still wet and a little slick when he went to pick up his ring. Hal let it slip through his fingers before he could catch it. The ring went down the drain of the sink.

High Familiarity, Low Frequency

Figurative: A formerly war-torn country was at a turning point—would its former leaders accept democracy or fight to retain power? The recent election had many citizens worried. The newly elected President vowed to turn things around, but the previous leader was still reluctant to give up power. Peace and democracy sometimes hang by a thread in such troubled countries. The next few days were critical.

Literal: My favorite coat is at least eight years old, but it still fits me like a glove. It is the perfect coat for going out to dinner or for wearing to the grocery store. Unfortunately the coat is getting very old and starting to wear out. In fact, the coat’s buttons sometimes hang by a thread in a flimsy way. Replacing the buttons is easier than replacing the coat.
Approval Notice
Continuing Review

July 29, 2014

Gary Raney, PhD
Psychology
1054-B B.S.B.
M/C 285
Chicago, IL 60612
Phone: (312) 413-1314 / Fax: (312) 413-4122

RE: Protocol # 2006-0564
“Eye Movements and Reading”

Dear Dr. Raney:

Your Continuing Review was reviewed and approved by the Expedited review process on July 28, 2014. You may now continue your research.

Please note the following information about your approved research protocol:

Please submit an Amendment to add research personnel Andriana Christofalos and Felix Pambuccian once they have completed their training. They are not currently eligible to engage in research protocols submitted to the UIC IRB.

Please note that Investigator’s training for Nathaniel Shannon expired November 30, 2014 and training for Gary Raney will expire September 5, 2014 and they will not be eligible to engage in research protocols submitted to the UIC Institutional Review Board (IRB). All investigators and key research personnel involved in human subject research must complete a minimum of two hours of investigator training in human subject protection every two years. Please see the OPRS website for more information.

Approved Subject Enrollment #: 1000 (870 subjects enrolled)
Additional Determinations for Research Involving Minors: The Board determined that this research satisfies 45CFR46.404, research not involving greater than minimal risk. Therefore, in accordance with 45CFR46.408, the IRB determined that only one parent's/legal guardian's permission/signature is needed. Wards of the State may not be enrolled unless the IRB grants specific approval and assures inclusion of additional protections in the research required under 45CFR46.409. If you wish to enroll Wards of the State contact OPRS and refer to the tip sheet.
Performance Site: UIC
Sponsor: None
Research Protocol:

a) Eye Movements and Reading; Version 2; 11/28/2011

Recruitment Materials:

a) Eye movements and Reading recruitment flyer; Version 1; 11/28/2011
b) UIC Psychology Department Subject Pool

Informed Consents:

a) Eye tracking consent, 90 minutes, Paid; Version 1; 11/28/2011
b) Eye tracking consent, 60 minutes, Paid; Version 1; 11/28/2011
c) Eye tracking consent, 120 minutes, Paid; Version 1; 11/28/2011
d) Eye Tracking Consent, 120 minutes, Version 3, 10/19/2006
e) Eye Tracking Consent, 90 minutes, Version 3, 10/19/2006
f) Eye Tracking Consent, 60 minutes, Version 3, 10/19/2006
g) Eye Tracking Debriefing Form, Version 1, 9/1/2006

Parental Permission:

a) Waiver of Parental Permission granted per 45 CFR 46.116 for UIC Psych. Subject Pool

Your research meets the criteria for expedited review as defined in 45 CFR 46.110(b)(1) under the following specific categories:

(4) Collection of data through noninvasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving X-rays or microwaves. Where medical devices are employed, they must be cleared/approved for marketing. (Studies intended to evaluate the safety and effectiveness of the medical device are not generally eligible for expedited review, including studies of cleared medical devices for new indications.) Examples: (a) physical sensors that are applied either to the surface of the body or at a distance and do not involve input of significant amounts of energy into the subject or an invasion of the subject's privacy; (b) weighing or testing sensory acuity; (c) magnetic resonance imaging; (d) electrocardiography, electroencephalography, thermography, detection of naturally occurring radioactivity, electrotretinography, ultrasound, diagnostic infrared imaging, doppler blood flow, and echocardiography; (e) moderate exercise, muscular strength testing, body composition assessment, and flexibility testing where appropriate given the age, weight, and health of the individual.

(7) Research on individual or group characteristics or behavior (including but not limited to research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Please note the Review History of this submission:

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Please remember to:

➔ Use your research protocol number (2006-0564) on any documents or correspondence with the IRB concerning your research protocol.

➔ Review and comply with all requirements on the enclosure,
Please note that the UIC IRB has the right to seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

Please be aware that if the scope of work in the grant/project changes, the protocol must be amended and approved by the UIC IRB before the initiation of the change.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact OPRS at (312) 996-1711 or me at (312) 355-2764. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

Betty Mayberry, B.S.
IRB Coordinator, IRB # 2
Office for the Protection of Research Subjects

Enclosures:

1. **Informed Consent Documents:**
   a) Eye tracking consent, 90 minutes, Paid; Version 1; 11/28/2011
   b) Eye tracking consent, 60 minutes, Paid; Version 1; 11/28/2011
   c) Eye tracking consent, 120 minutes, Paid; Version 1; 11/28/2011
   d) Eye Tracking Consent, 120 minutes, Version 3, 10/19/2006
   e) Eye Tracking Consent, 90 minutes, Version 3, 10/19/2006
   f) Eye Tracking Consent, 60 minutes, Version 3, 10/19/2006
   g) Eye Tracking Debriefing Form, Version 1, 9/1/2006

2. **Recruiting Material:**
   a) Eye movements and Reading recruitment flyer; Version 1; 11/28/2011

cc: Michael E. Ragozzino, Psychology, M/C 285
CURRICULUM VITAE

Krista A. Miller

3236 N. Sacramento Ave.  Chicago, IL 60618
Voice: (630) 209-8970  Email: kmille47@uic.edu

EDUCATION

2011-present
University of Illinois at Chicago, Chicago, IL
Graduate Student
Ph.D., Psychology
Emphasis: Cognitive

2011-2015
University of Illinois at Chicago, Chicago, IL
M.A., Psychology
Emphasis: Cognitive
“The Role of Context, Familiarity and Word Frequency in the Processing of Idiom Final Words”
(Advisor: Dr. Gary E. Raney)

2005-2009
Lake Forest College, Lake Forest, IL
B.A., magna cum laude
Major: Psychology
Major: Philosophy
“I’m Hungry for Wax Fruit: An Exploration of the Non-Sequitur’s Communicative Value”
(Advisor: Dr. Matthew Kelley)

FELLOWSHIPS, AWARDS, AND HONORS

2009  Phi Beta Kappa
2009  Sigma Xi
2007  Psi Chi
2006  Lake Forest College Richter Scholars Summer Research Apprenticeship

RESEARCH EXPERIENCE

2014-present
Principal Researcher, Positive and Negative Irony Study
University of Illinois at Chicago
Supervisor: Dr. G. Raney
Duties: Responsible for all aspects of stimuli development and study design; Data collection.

2014-present
Research Assistant, Vocabulary and Reading Comprehension Study
University of Illinois at Chicago
Supervisor: Dr. G. Raney
Duties: Develop and norm vocabulary test for research involving reading comprehension.

2013-present
Research Assistant, Phonological Similarity Study
University of Illinois at Chicago  
Supervisor: Dr. G. Raney  
Duties: Assisted in developing study examining phonological similarity effects in native and non-native English speakers.

2011-present  
Lead Research Assistant, North American Norming Study  
University of Illinois at Chicago  
Supervisor: Dr. G. Raney  
Duties: Supervise data collection and data entry for a project designed to create a set of matched text passages in English, Spanish, and French; Supervise undergraduate research assistants.

2013-2014  
Principal Researcher, Idiom Familiarity and Word Frequency Study  
(Master’s Thesis)  
University of Illinois at Chicago  
Supervisor: Dr. G. Raney  
Duties: Responsible for all aspects of stimuli development, including writing and norming the materials; Designed the study using the Eye Link 1000 eye tracking system; Data collection; Data analyses; writing the report.

2012-2013  
Principal Researcher, Idiom and Conceptual Metaphor Study  
University of Illinois at Chicago  
Supervisor: Dr. G. Raney  
Example Duties: Responsible for all aspects of stimuli development, including writing and norming the materials; Learned how to operate and design a study using the Superlab programming software; Data collection; Analyzed the data using Microsoft Excel and SPSS.

2012-2013  
Principal Researcher, Humor and Ambiguity Study  
University of Illinois at Chicago  
Supervisor: Dr. G. Raney  
Example Duties: Responsible for all aspects of stimuli development and study design; Data collection; Analyzed the data using Microsoft Excel and SPSS.

2011-2012  
Principal Researcher, Idiom and Conceptual Metaphor Study: Eye-tracking  
University of Illinois at Chicago  
Supervisor: Dr. G. Raney  
Example Duties: Responsible for all aspects of stimuli development, including writing and norming the materials; Learned how to operate and design a study using the Eye Link 1000 eye tracking system; Data collection; Cleaned the eye tracking data; Analyzed the data using Microsoft Excel and SPSS.

TEACHING EXPERIENCE

2014-2015  
Teaching Assistant, Laboratory in Cognition and Memory  
University of Illinois at Chicago  
Supervisor: Dr. G. Raney  
Duties: Assisted students in the development of research project ideas in the field of cognitive psychology – provided assistance in idea formulation, study design, stimuli development, data analysis and interpretation; Graded assignments and papers; Held weekly office hours.
2012-2014
Teaching Assistant, Introduction to Research Methods in Psychology
University of Illinois at Chicago
Supervisors: Dr. E. Gobel, Dr. E. Behar, and Dr. V. Harmon
Duties: Led a weekly discussion section; Graded assignments and papers; Provided students with extra assistance and support when necessary; Held weekly office hours; Attended lectures.

2013
Teaching Assistant, Cognition and Memory
Supervisor: Dr. G. Raney
Duties: Graded assignments; Prepared and presented a lecture on Attention; Utilized CogLab online learning laboratory to supplement lecture materials; Held weekly office hours; Attended lectures.

2012
Teaching Assistant, Introduction to Psychology
University of Illinois at Chicago
Supervisor: Dr. Rosanova
Duties: Developed and led a weekly discussion section; Created weekly exams; Graded exams and papers; Provided students with extra assistance and support when necessary; Held weekly office hours; Attended lectures.

2011
Teaching Assistant, Laboratory in Cognition and Memory
University of Illinois at Chicago
Supervisor: Dr. B. Storm
Duties: Graded assignments; Provided feedback on project ideas; Prepared and presented a lecture on how to write a literature review.

PRESENTATIONS


INVITED PRESENTATIONS


DEPARTMENTAL AND UNIVERSITY SERVICE

2007-2008 Lake Forest College Psychology Department Student Academic Advisory Committee
Example Duties: Served as the liaison between faculty and the student body; Assisted in obtaining student feedback in a decision on a faculty member’s tenure.