1-1-2012

On the disambiguation of meaning: the effects of perceptual focus and cognitive load

Lynne Kennette
Wayne State University,

ON THE DISAMBIGUATION OF MEANING: THE EFFECTS OF PERCEPTUAL FOCUS AND COGNITIVE LOAD

by

LYNNE N. KENNETTE

DISSERTATION

Submitted to the Graduate School

of Wayne State University,

Detroit, Michigan

in partial fulfillment of the requirements

for the degree of

DOCTOR OF PHILOSOPHY

2012

MAJOR: PSYCHOLOGY (Cognitive)

Approved by:

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Advisor Date

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DEDICATION

For my very patient husband Lawrence, and all those who believed in me: my family, friends, and colleagues.

ACKNOWLEDGMENTS

It is with great appreciation that I acknowledge the assistance of my committee in completing this project. Dr. Lee H. Wurm, Dr. Patricia Siple, Dr. Margo Bowman, and Dr. Kate Paesani were all instrumental in the success of this project and provided valuable feedback on key issues. A special thanks to Lee Wurm for being a very patient advisor who has guided me throughout my graduate training, as well as the members of my mentoring committee for their sage advice.

I am also grateful to my labmates and colleagues for their support throughout this process. I'd like to specifically highlight the significant contributions of Michelle Beechler, Lisa Van Havermaet, Bibia Redd, Lucia Zhdanova, and Nichole Frank to my graduate school experience. I am also particularly grateful to D.A.D. (the "Excel Ninja") for his expertise; without him, data cleaning would have resulted in numerous sleepless nights and this project would have taken significantly longer to complete.

I would also like to extend a special thanks to my sister, Sr. Julie Daigle, and my amazing parents Denis and Judy Daigle, as well as to the Daigle and Poulin families, for a lifetime of support. *Un grand merci à vous tous pour votre soutien et votre encouragement au fil des années.*

Finally, this project would not have been possible without the ongoing support and encouragement of my *very* patient and loving husband Lawrence who has supported me during this very long process.

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Overview

Psychologists have been interested in human cognitive processing for centuries. Humans use language in numerous ways and through multiple modalities with impressive efficiency. As a result, we are constantly bombarded by language as we make our way through society, encountering billboards, flyers, and conversations. As such, understanding how cognitive processes allow us to attach meaning to linguistic stimuli is essential.

Sometimes, linguistic interactions are clear and result in effective communication, as intended by Grice (1975). Other times linguistic stimuli can be ambiguous. For example, in the absence of context, a word like *bark* might activate one of two very different concepts (related to either tree or dog). How is this type of ambiguity resolved? This question has prompted the present investigation. Various models have been proposed to explain how meaning is retrieved, and these make different predictions relating to ambiguity resolution. First, a very brief overview of word processing will be provided as background, followed by a discussion of two competing accounts of meaning retrieval: the exhaustive activation account and the selective activation account.

Although a large body of research already exists clarifying some aspects of the ambiguity resolution process, a much smaller body of research exists to explain how various cognitive contexts affect this process. There is empirical evidence of a small number of cognitive factors (such as reading ability (Gernsbacher & Robertson, 1995)) affecting the ambiguity resolution process. Ergo, to further probe the role of cognitive factors on the processing of ambiguous words and on the ambiguity resolution process, two manipulations will be introduced: focus and cognitive load. Empirical evidence for potential effects of focus and cognitive load will be explained and their potential theoretical relevance will be outlined. Finally, the proposed study will be described in detail and predictions will be enumerated.

Relevance

Exploring cognitive processing under various conditions helps us to better understand general processing and guides the generation or revision of cognitive models, which in turn may lead to further questions related to general cognitive processing. Thus, the motivation for the present series of experiments is to contribute to the current literature examining ambiguity resolution (and language processing more generally) and to fill an important gap in the literature, as it will attempt to explain how cognitive contexts such as working memory load and focus affect the process of ambiguity resolution.

There are numerous practical applications for the knowledge that will be obtained from the proposed studies and multiple branches of society may benefit from advancing our understanding in this area. Concretely, understanding how the human mind processes ambiguous information could help to inform computer models of language recognition (Miller, 2001) including those used specifically for the purpose of translation (e.g., software) and retrieving information (e.g., search engine searches). Since the users of these systems are humans, improvements within them can be achieved from a better understanding of how humans process information. Additionally, understanding many forms of humor is rooted in ambiguity (Bucaria, 2004; Ritchie, 1999) so those involved in marketing may be able to better target their audience for important campaigns such as obesity awareness or smoking-cessation programs by using information from resolving the issues related to ambiguity resolution. Finally, the areas of preventing or resolving misunderstandings may also benefit from this information, helping to inform policies and procedures related to law enforcement, border security, and many other areas.

Word Recognition

To engage in successful communication, interlocutors must cooperate in order to accept and retain the same meaning or implicature (Grice, 1975). Although Grice's principle of cooperation was originally for verbal communication, technological advances have resulted in an increasing number of "conversations" occurring in written form (e.g., email, text messaging). Additionally, more and more communicative exchanges are occurring with little to no sentence frames (e.g., texting using shorthand, or a series of keywords). In these situations, each word must be understood in the same way by both parties in order to successfully communicate a thought or idea. Briefly detailed in this section is how meaning is retrieved from within the cognitive system.

A question that comes up when considering meaning retrieval, however, is whether this process results in an exhaustive search, activating the entire realm of possible meanings when a word is encountered, or whether the retrieval process can be limited a priori by a certain criteria. This is the next question related to word processing that is explored.

Accessing Meaning

In order to understand the meaning of a given word, a mental representation for that word must be activated. During this process, related concepts (or nodes) are also activated. This meaning retrieval appears to be done relatively automatically, and with little cognitive effort (Rayner & Sereno, 1994). Even meanings of ambiguous words (embedded in disambiguating sentences) are purported to be retrieved by 550 milliseconds (Simpson, 1981).

By this point, it should be clear that an ambiguous word like *bark* has a common representation at both the orthographic and phonological levels, but different semantic representations. The more frequent the meaning, the stronger the connection from orthography or phonology to the semantic level. However, meaning selection is perhaps not as clear-cut as depicted here. More specifically, most words can be interpreted in a variety of ways, either because they have multiple meanings or because of the semantic context within which they are interpreted (e.g., puns and metaphors). For example, in order to understand the intended meaning of the statement *That defense lawyer is a shark*, features of both lawyer and shark must be activated (and remain active) in order to be integrated (Gernsbacher, Keysar, Robertson, & Werner, 2001). Models specifically developed to explain the processing of ambiguous words will be detailed in the next section.

Ambiguity and Ambiguity Resolution

There are various levels of ambiguity in language, but generally ambiguity is expressed as either structural or lexical (Bach, 1998). Structural ambiguity refers to a sentence that can be interpreted in more than one way based on its underlying structure (Bach, 1998). For example, the sentence “Slow men at work.” may be communicating that (1) men who are slow are at work or that (2) one should slow down because men are at work.

Lexical ambiguity, which is far more common, refers to the referent of a word being uncertain (Bach, 1998). In the case of word-level ambiguity, the most important distinction of theoretical interest relates to the number of entries purported to be in the mental lexicon: that is, the distinction between polysemy and homonymy (Meyer, 2005).

Polysemy vs. Homonymy

Polysemy is a single lexical entry with multiple related meanings. For example, *church* can refer to the building, institution or group of people, but there is a great deal of semantic overlap between these referents (Meyer, 2005). Similarly, the word *lip,* which has multiple meanings all referring to something similar in form or function to human lips, constitutes another example of polysemy (Klepousniotou & Baum, 2007). In a case such as this where the meanings are so closely related, an ambiguous word is said to make up a single entry in the lexicon.

Homonymy is a term that refers to two words with the same spelling and sound, but with different meanings (Klepousniotou & Baum, 2007; Meyer, 2005). For example, *bark* refers either to the outer layer of a tree or to the sound that a dog makes. Although words can be ambiguous in a variety of ways, the term ambiguity is used in the present paper to refer specifically to visual lexical ambiguity where a letter string has only one pronunciation and its multiple meanings are unrelated. This type of ambiguous word can be termed a homophonic homograph (e.g., Frost & Bentin, 1992) or more simply a homonym (e.g., Klepousniotou & Baum, 2007).

It is important to distinguish between polysemy and homonymy because there is evidence of processing differences (e.g., Klepousniotou, 2002; Klepousniotou & Baum, 2007). A speed advantage in a lexical decision task has been found for polysemous words but not homonymous words (Klepousnitou & Baum, 2007). This advantage suggests that polysemous words make up a single entry in the mental lexicon as there is no competition between multiple meanings and no ambiguity *per se* to resolve when the word is encountered (Klepousniotou, 2002; Klepousniotou & Baum, 2007).

Models and Mechanisms of Ambiguity Resolution

There are at least two general accounts that can explain what happens to the contextually inappropriate meaning of an ambiguous word: it is activated and a secondary process (e.g., suppression) is applied to reduce its activation; or it is not activated. These accounts of ambiguity resolution are described below.

Both Meanings are Activated. As the name implies, an exhaustive (or non-selective) access means that all possible meanings are initially activated in parallel. This initial activation is not influenced by external factors such as word frequency and context (Onifer & Swinney, 1981). In order to identify the meaning of a word, a secondary selection process of suppression (which is not automatic and thus requires cognitive resources) occurs post-lexically, using word-level characteristics such as the surrounding context.

There is strong evidence to support the existence of this type of dampening mechanism, specifically from reported semantic priming effects for both meanings of ambiguous words. In a study by Onifer and Swinney (1981), participants listened to sentences where the sentence context biased the ambiguous word to one of its meanings and, simultaneously, performed a visual lexical decision task. Facilitation (i.e., priming) effects were found for both interpretations of the ambiguous word during the lexical decision task- even the one that was not elicited by the sentence context (Onifer & Swinney, 1981). So, even the unintended meaning showed facilitation in spite of the contextual clues provided in the sentence, suggesting that, at least initially, context is not taken into account when retrieving meaning. The finding that all meanings are initially activated for ambiguous words appears to be a robust one, as this effect has also been shown to occur with words that are ambiguous cross-linguistically (Beauvillain & Grainger, 1987; de Groot, Delmaar, & Lupker, 2000). However, what remains unclear is how a meaning is selected and exactly what happens to the unselected meaning.

Another body of research has shown some evidence for a second mechanism (suppression) in meaning retrieval, whereby, although meanings are initially activated exhaustively, a secondary mechanism is applied to reduce the activation of the contextually inappropriate meaning. Gernsbacher's group (e.g., Gernsbacher, 1993, 1995, 1996, 1997, 2002; Gernsbacher & Faust, 1991a, 1991b, 1995; Gernsbacher, et al., 2001; Gernsbacher & Robertson, 1995; Gernsbacher & Shlesinger, 1997; Gernsbacher & St. John, 2002) has proposed the Structure-Building Framework as a general cognitive mechanism to account for comprehension. After both meanings are activated, the contextually inappropriate one is suppressed to below-baseline levels and only the appropriate meaning is retained. She proposes a three-step process to achieve meaning: laying a foundation, mapping additional information onto that foundation, and shifting to build new substructures. Additionally, the building of these meaning structures is guided by two mechanisms: enhancement (or activation) and suppression. More specifically, the foundation of the mental structure is formed by the initial activation at the time of presentation. Then, any new (and consistent) information is mapped onto this structure and related memory nodes are further activated. If the new information is inconsistent, then a new substructure is formed and the inconsistent information is suppressed as the information is judged no longer necessary or useful for comprehension.

According to this model, all potential meanings are initially activated, but this activation is later constrained (or suppressed) so that only the most active is incorporated into the mental structure. So, rather than proposing that a single meaning is selected by building up its activation, they propose an active mechanism that rapidly (albeit not immediately) suppresses the inappropriate meaning. Importantly, this mechanism necessitates cognitive resources to apply (i.e., it is not automatic). As it relates specifically to ambiguity resolution, the inappropriate meaning of the homograph would be suppressed while the appropriate meaning would be enhanced. However, Gernsbacher's group has studied this possibility almost exclusively at the sentence-level. It is not clear whether a similar mechanism operates in the absence of the sentence (i.e., whether this mechanism operates at the word-level).

Below-baseline activation of the alternate meaning of an ambiguous word has been reported in a number of studies (e.g., Gernsbacher, Robertson, & Werner, 2002). In this example, participants were shown sentences ending in an ambiguous word (e.g., *match*). For each sentence, the participants' task was to indicate if the sentence made sense. For each target sentence (e.g., *She lit the match.*), the previous trial was either a same-meaning prime (e.g., *She blew out the match.*), a baseline/neutral sentence (e.g., *She saw the match*.) or the alternative meaning (e.g., *She won the match.*). Congruent trials (same meaning) showed facilitation (i.e., a priming effect), with faster reaction times (RTs) and lower errors in making the judgment. Incongruent trials showed interference with below-baseline activation and more errors. This suggests that subsequent to activating a meaning in the first sentence, there is a cost to activating the alternate meaning. Since the activation of this alternative meaning is below the baseline measure, then activation alone is insufficient to account for this cost. This is therefore taken as evidence for the suppression of the inappropriate meaning for ambiguous words. Much of the evidence for suppression occurs in the context of a sentence, but there is some evidence for this type of secondary mechanism being used for meaning selection at the word level.

Simpson and Kang (1994) present evidence of this type of account in a word paradigm. In their task, participants first saw an ambiguous word as a prime (e.g., *bank*) followed by another word on which they had to perform a naming task. This second word could be related to one of the meanings of the prime (e.g., *stream*) or unrelated. In a subsequent trial, they were again shown the same ambiguous word (*bank*) but this time the naming task could be performed on the previously unelicited meaning of the homograph (e.g., *money*) or a control word. Simpson and Kang (1994) found that selecting one meaning during the first presentation results in slower naming times on the incongruent (i.e., opposite meaning) trial later on. Here, however, congruent trials did not yield facilitation (i.e., priming) and performance was no different from the control. This is somewhat concerning given that there is ample evidence that priming effects are robust and fairly long-lasting (for example, Gorfein (2000), found these effects after 19 intervening trials). Further, it is uncertain that a meaning was actually selected during the prime presentation, as a naming task does not require meaning retrieval (in this case, the slower naming times could be attributed to another source, such as an extraneous stimulus characteristic on which conditions were not matched (like imageability), since the published report does not specify on which word-level features the conditions were matched, if any). Still, this provides evidence supporting the possibility that a subsequent presentation of the alternate meaning of a homograph word may result in a reduction of activation at the word level.

Only the Appropriate Meaning is Activated. A selective search account proposes a constraint in the meaning retrieval process pre-lexically. Although activation initially builds up for all meanings, only one meaning is selected: the one that reaches a pre-determined activation threshold first. As such, meaning selection depends on the amount of activation a meaning receives, which depends on characteristics such as word frequency and context (Perfetti, 1999). High-frequency words, for example, would receive more activation than low-frequency words. Ambiguous words are typically responded to more slowly, and this is said to be a result of the competition that occurs between multiple meanings (Conklin, 2005); these meanings are activated serially, based on lexico-semantic factors such as frequency and context. In this way, individuals only have access to a single meaning, ideally the one that was intended (Glucksberg, Kreuz, & Rho, 1986).

Gorfein, Brown, and DeBiasi's (2007) Activation-Selection Model proposes that a simple activation mechanism (which is automatic and consequently requires no cognitive resources) is sufficient to account for meaning selection. They propose that meaning is based on a small number of attributes and that these attributes are activated based on two things: their weight in the network (which is based on our experience) and the external context. The higher the weight, the easier it is for that feature to be activated. Additionally, a contextually-appropriate attribute would be more easily activated than a contextually inappropriate attribute. These two factors guide the activation of meaning and thus are responsible for meaning selection. When the activation threshold is reached with these attributes for a given meaning, that meaning is selected. The activation of each of these attributes, however, is brief and transient and decays slowly over time.

When a homograph and a related attribute are presented together (e.g., the word pair *tree-bark*), attributes related to both of these (such as *leaf)* also get activated. This activation results in a re-weighting of these attributes, so that their activation becomes easier in the future. So, the selection of one of the meanings of a homograph ($bark_{tree}$) increases the weight of the attributes associated with that meaning (e.g., *leaf* and *tree*). If that same homograph is presented a second time (e.g., *bark*), there is an increased probability that those attributes will become activated again (because the weight of those recently activated features is now greater than before), and thus contribute to the activation threshold being reached for that same meaning of the homograph. As a result, the same meaning shows priming (i.e., higher activation) on the second presentation and less activation for the other meaning. So, in a paradigm where the homograph is repeated, only the appropriate meaning should be activated during the second presentation.

What is perhaps less evident from this account is what would be expected if a homograph were only presented once- would the weight of the attributes affect the retrieval of either homograph meaning in the absence of a second occurrence of the homograph. Gorfein (2001) did examine this kind of processing using balanced homographs in a semantic relatedness judgment task. Pairs of words were presented to participants who had to indicate whether the words in the pair were semantically related. In one experiment, the homograph was only presented once. On a particular trial (trial N), the homograph pair was presented (e.g., *seal-dolphin*). The critical pair (either *walrus-otter* or *glue-shut*) was presented 19 trials later. Facilitation occurred only on the congruent meaning (i.e., the animal meaning of *seal*). The alternate meaning of the homograph (the envelope meaning of *seal*), received no such facilitation and was no different from baseline on this same trial (N+19). In a different experiment, they presented both meanings of the homograph: one meaning (e.g., *seal-dolphin*) on a given trial (trial N) and the other meaning (e.g., *seal-envelope*), 9 trials later. On trial N +19, the critical stimulus was presented (either *walrus-otter* or *glue-shut*). In this experiment, priming was shown for both meanings on trial N+19, suggesting that both were still active. This can be interpreted as evidence against the existence of a suppression mechanism since both meanings were available, and neither had been suppressed.

Although there is evidence to support both accounts (selective and exhaustive), it may be the case that meaning selection is only achieved by applying the process of suppression in certain circumstances (e.g., when there are enough cognitive resources available; or when the preceding context allows for clear meaning selection), while other instances of ambiguity are resolved by using other means (e.g., word frequency). Examining ambiguity resolution when participants are under cognitive load and when the homograph is focused should help to further understand this process.

Focus

Linguistic focus has been defined in the literature as a mechanism that highlights the constituent that is the most important or that is emphasized (Birch & Garnsey, 1995). Similarly, Chomsky (1971) defined focus as placing an element of the sentence in the spotlight. It has been suggested that linguistic focus is a mechanism used by a speaker to bring the interlocutor's attention to the salient aspect or aspects of the message being conveyed (Birch & Garnsey, 1995). Most definitions of focus also suppose that focusing an element results in a more detailed representation of that element, and consequently in better understanding (Langford & Holmes, 1979). It has also been argued that focus is *the* linguistic characteristic that allows for the comprehension of written or spoken discourse, given our limited memory capacity (Birch & Garnsey, 1995).

Ferreira, Bailey, and Ferraro (2002) have proposed the Good-Enough Model of Representation. Good-enough representation suggests that people only include as much detail in their mental representations as is necessary for the task at hand (Ferreira, Bailey, & Ferraro, 2002). Linguistic focus increases the detail of the representation, so it appears that focusing results in a more detailed representation in memory (A. J. S. Sanford, Sanford, Filik, & Molle, 2005). Sturt, Sanford, Stewart, and Dawydiak (2004) suggest that when not in focus, a change to a semantically similar word might not be noticed (e.g., the word *cap* in a sentence is changed to the word *hat*); but at a finer level of representation (such as when the word is focused), it is much easier to detect these changes. A. J. S. Sanford, Sanford, Molle, and Emmott's (2006) results are also in line with Sturt et al.'s (2004) account. They found that a crude (or good-enough) level of representation is only further specified for items that are in focus. So, without deeper processing resulting from focusing constructions, a good-enough representation will remain (Ferreira, et al., 2002). That is, people will engage in shallow processing unless there is reason to further process a part of the input (Ferreira & Patson, 2007; A. J. Sanford & Sturt, 2002).

Linguistic focus has been shown to have important effects on processing. For example, Singer (1976) and McKoon, Ratcliff, Ward, and Sproat (1993) have found an advantage in memory for focused nouns. Faster retrieval (Birch, Albrecht, & Myers, 2000; Birch & Garnsey, 1995) and greater attention (McKoon, et al., 1993) for focused words have also been reported, with these effects being demonstrated in both written and spoken language, and focusing has been shown to result in better retention of surface information in sentences (Birch & Garnsey, 1995). Conversely, unfocused words are processed with less detail, which may lead to increased processing errors (Baker & Wagner, 1987; Bredart & Docquier, 1989; Bredart & Modolo, 1988; Hornby, 1974). These types of within-language focus effects appear to be robust and independent from the task (Birch & Garnsey, 1995).

Types of Focus

Focusing your attention on a particular stimulus (or a subpart of the encountered stimulus) can be achieved by numerous focusing structures. Lexical and syntactic focus can be achieved by using a variety of lexical markers such as the indefinite *this* that lexically marks the focused noun (Birch, et al., 2000) and syntactic structures such as clefting. For example, it-cleft constructions (e.g. *It was the*…) and there-insertion (e.g. *There was this*…) are syntactic structures that bring focus to a noun in the context of a sentence (Birch, et al., 2000). Similar syntactic focusing structures are also present in many languages (Féry, 2001). Evidence for this was reported by Kennette, Wurm, and Van Havermaet (2010), who found that it-cleft constructions produced focus effects both within and across languages. A limitation of this type of focusing manipulation is that it can only be used in the context of a sentence. Since the stimuli of the present studies are words and not sentences, a method of focusing a single word outside of the context of a sentence must be used.

For the purpose of this dissertation, focus refers to perceptual focus. To perceptually focus a word, visual characteristics can be manipulated. Perceptual focusing methods modify the text to be encountered, making the target word visually different from the other word or words presented. Examples of these characteristics include text size, text color, font, and font style (**bold**, *italic*, underline, UPPERCASE). Recently, A. J. S. Sanford et al. (2006) used italicized text to produce focusing effects (though this was applied in sentences) and reported that when participants encountered an italicized word, they were able to make finer distinctions in meaning, such as between the words *cap* and *hat*. The present inquiry examines the effect of perceptual focus on ambiguity resolution. It appears that few (if any) researchers use focusing structures outside the context of sentences, even though focus by way of visual characteristics lends itself well to word-level investigations.

Cognitive Load

Definition

Cognitive load refers to the amount of cognitive resources (i.e., working memory (WM) resources) being occupied by a task or other processing of stimuli. For example, working on a complex math problem without any external aids would have higher load than a simpler mathematical problem because it requires the manipulation of larger amounts of information in WM. Performing two tasks simultaneously would have a similar effect− this increases the load on WM and is typically how WM load is manipulated by researchers. Performance on many cognitive tasks can be predicted by WM measures (Unsworth, Heitz, Schrock, & Engle, 2005). This issue will be discussed in greater detail later.

There are individual differences in "baseline" WM span (i.e., the total amount of cognitive resources available to an individual) and this capacity may also be influenced by other factors such as expertise (Ericsson & Staszewski, 1989). Experts have been shown to have increased functional WM capacity for information within their area of expertise, but show no such advantage when they recall items that are not within this area (Ericsson & Staszewski, 1989), suggesting perhaps increased proficiency in handling or chunking information within their area of expertise.

Load Effects on Performance

When completing a task, adding a secondary task requires the use of some additional available cognitive resources, thus increasing the load. This typically results in an impairment in performance (Baddeley & Hitch, 1974). Under increased cognitive load, performance suffers; information is processed more slowly and less accurately than under normal conditions. Increased WM load has even been shown to affect higher-order tasks such as reading, learning, and reasoning (Baddeley, 1992; Daneman & Carpenter, 1980; Engle, 2002).

Darley, Klatzky, and Atkinson (1972) presented participants with a series of letters, of which one was selected for a memory probe task where they had to identify whether the selected letter was part of the presented list. Increasing cognitive load from 1 to 5 letters in the memory set resulted in a linear increase in RTs and higher error rates. These data support the notion that cognitive load is a construct that can be actively manipulated in a laboratory setting.

More recently, Kossowska (2007) showed differences in negative priming effects for low-short-term memory (STM) capacity vs. high-STM capacity individuals. STM is the storage subcomponent of WM, which additionally contains the attentional component of processing (Cowan, 1988). STM and WM are strongly correlated (r = .68) though separate constructs (Engle, Tuholski, Laughlin, & Conway, 1999). Negative priming is somewhat different from the ambiguity resolution process that is of interest here, but examining negative priming may shed some light on relevant cognitive processes and how they might be affected by load. In a negative priming paradigm, participants are explicitly instructed to ignore a given part of the presented stimulus. Negative priming is said to occur when a stimulus that was previously ignored is later presented in a position that requires a response and that response is delayed. Such a delay could be due to below-baseline activation (i.e., suppression). In Kossowska's (2007) study, a reliable negative priming effect was only found in high-STM individuals. In addition, the effect was reduced under cognitive load, presumably because load decreased the efficiency of the "ignoring" mechanism. Thus, negative priming seems to need cognitive resources much like suppression does, and when fewer of these resources are available, the effect is diminished. The most parsimonious account of cognitive processing would suggest that the same mechanism(s) operate for both the negative priming reported by Kossowska and the reduction in activation found in the ambiguity resolution literature, especially given the assumption that both of these processes require the use cognitive resources (i.e., are not automatic). However, because one phenomenon requires explicitly ignoring an alternate stimulus while the "ignoring" in the other case is a by-product of meaning selection, these effects may stem from two distinct mechanisms that simply share a cognitive resource pool. Interested readers may also see Engle (2002) for a recent discussion of the effects of cognitive load as it relates to higher-order processes.

The Present Study

Overview

The rationale for the present investigation is to expand our current understanding of language processing, specifically as it relates to ambiguity resolution. Of equal importance, the present investigation will attempt to fill in an important gap in the literature, as few studies have examined how cognitive contexts (such as increased cognitive load and perceptual focus) affect ambiguity resolution.

Previous researchers have used various techniques to investigate the process of ambiguity resolution, but generally congruent conditions (the same meaning is presented in both presentations/timepoints) have led to facilitation, and incongruent conditions (different meanings at both presentations) have led to either interference (e.g., Gernsbacher, et al., 2002), priming (e.g., Onifer & Swinney, 1981), or no effect at all (McNamara & McDaniel, 2004). Each component of the present study will be described in greater detail in order to orient the reader to the rationale behind the choices made here and the selection of the proposed paradigm.

Research Questions

This series of studies was designed to answer the following research questions:
1- Is there only one process (activation) involved in ambiguity resolution at the word-level or does evidence exist to support a secondary process (suppression)?
2- Will increasing the depth of processing (by using perceptual focus) result in differences in the ambiguity-resolution process and as a result may contribute to answering Question 1 (e.g., more pronounced processing differences)?
3- If there is evidence of a secondary process, to what extent might cognitive load affect its use? That is, does ambiguity resolution require the use of cognitive resources such that taxing the system will result in processing differences?

Paradigm

In order to examine the processes involved in ambiguity resolution the task used must give the researcher control over which meaning of the homograph is elicited and then assess the availability of each of the homograph's meanings. As such, there are at least two ways of assessing the processing of ambiguous words: presenting the homograph twice or only once (Gorfein, 2001).

The first class of paradigms presents the homograph more than once to examine the state of the semantic system. In paradigms with two presentations of the homograph, the original presentation serves as an initial activation of a specified meaning of the homograph (typically in the context of a sentence) and the second presentation serves to assess the remaining activation of each of the meanings (often by way of a lexical decision task). Simpson and Adamopoulos (2001) showed participants a sentence with a homograph in it such as *The hungry calf ate the corn from a bucket*. This sentence was then followed by either a congruent sentence (e.g., *The farmer's calf won first prize at the fair.*) or an incongruent sentence (e.g., *The runner's calf hurt after he ran the race.*). The participants' task was to determine if the sentence made sense. Priming (faster responses) for related meanings and slower responses for unrelated meanings were found.

It is also possible to use this double presentation paradigm using only words. For example, in the Simpson and Kang (1994) paradigm described earlier, homographs primes (e.g., *bank*) were followed by a word that disambiguated the context in the first presentation (e.g., *stream*) and on a subsequent presentation this meaning was the same or changed (e.g., *money*). They found lower activation of the previously non-primed meaning, resulting in a delay in the retrieval of that meaning. That is, incongruent trials resulted in slowed processing. However, they did not find any priming effects. There is at least one possible reason for this, which will be addressed in the proposed study. It is conceivable that the prime word was processed too passively during its presentation to truly activate the desired meaning and lead to priming effects. Others (e.g., Mari-Beffa, Fuentes, Catena, & Houghton, 2000), have reported that passive activation of a prime (during a letter monitoring task, for example) results in lower priming effects, so this is a realistic possibility. The proposed study will require participants to actively process the prime and to select one of the homograph's meanings during the prime presentation. This will be accomplished by requiring a semantic judgment task on the pair of words used as the prime, which necessarily requires meaning activation.

The second class of tasks presents the homograph only once and then measures the access to the alternate meaning by using words of varying relations to the homograph. This second kind of paradigm has obtained more consistent results, with facilitation for congruent meanings and near baseline activation for incongruent meanings (Gorfein, 2001). For these types of paradigms, the activation of the desired meaning of a homograph and the assessment of the activation of both meanings is made with a single presentation of the homograph. This can be achieved using sentences such as *She heard the bark.* or word pairs such as *bank-money*. In a slight exception to this finding, however, Nievas and Mari-Beffa (2002) found both priming and a reduction in activation using words. They presented word pairs to elicit a particular meaning of the homograph (e.g., *bank-money*) using a relatedness judgment task to force meaning-selection. This task was then followed by a lexical decision task to either a related-meaning word (e.g., *save*), to the alternate meaning of the homograph (e.g., *lake*) or to an unrelated control (e.g., *cat*). Using this task, they reported overall facilitation for the congruent condition, and a dampening of activation for the incongruent condition. However, this effect was driven by the "slow but accurate" responders, whose performance differed significantly on congruent and incongruent trials. The other two strategy groups- fast but low accuracy, and those with a moderate speed and moderate accuracy- did not show any reliable differences from baseline in the incongruent trials (though priming was consistently found in the congruent condition), which is consistent with previous findings.

This single presentation of homographs outside of sentence contexts appears to be the most advantageous because it is less exigent to control extraneous variables at the word-level than at the sentence-level. Ergo, the present paradigm includes only a single presentation of the ambiguous word following a similar method to that of Neivas and Marì-Beffa (2002): each trial will consist of a relatedness judgment task immediately followed by a lexical decision task.

Different types of processing have been shown to occur at different times during semantic processing. For example, automatic processes occur up until stimulus onset asynchronies (SOAs) of approximately 150 ms, while meaning is retrieved at around 400 ms and more controlled processes such as ambiguity resolution have been shown to take between 750 ms and 1000ms. For this reason, the judgment task and the lexical decision task proposed in the present dissertation will be separated by 1000 ms in order to allow suppression to take place, if this mechanism is involved in ambiguity resolution at the word-level.

For stimuli, the present dissertation uses homonyms− words with one spelling and pronunciation but two unrelated meanings− rather than polysemous words. The rationale for this decision, detailed in an earlier section, is based most notably on the fact that the proposed model of polysemous representation suggests no competition between meanings (Klepousniotou, 2002). The literature is somewhat inconsistent about the terminology used when conducting ambiguity resolution research and some may have combined these two types of words without taking into account their processing differences (as discussed in Klepousniotou, 2002).

In everyday linguistic encounters, context (whether environmental or linguistic) is one way to disambiguate an originally ambiguous word (Dixon & Twilley, 1999; Klepousniotou, 2002; Miller, 2001; A. J. Sanford, 2002; Simpson, 1994; Tabossi, 1988). Dealing with ambiguous words in isolation makes it nearly impossible to know for certain which meaning is intended. There are, however, other factors that determine which meaning is retrieved, including written or spoken word frequency (Brysbaert & New, 2009; Kennette, et al., 2010; Roodenrys, Hulme, Alban, Ellis, & Brown, 1994), length (Balota, Cortese, Sergent-Marshall, Spieler, & Yap, 2004; Kennette, et al., 2010; Whaley, 1978), familiarity (Balota, et al., 2004; Gernsbacher, 1984; Stadthagen-Gonzalez & Davis, 2006; Tengi, 1998), orthographic neighborhood (Andrews, 1997; Grainger, Muneaux, Farioli, & Ziegler, 2005), and imageability/concreteness (Balota, et al., 2004; Burton, Krebs-Noble, Gullapalli, & Berndt, 2009; Stadthagen-Gonzalez & Davis, 2006; Whaley, 1978). It is important to note that some of these terms are used almost interchangeably in the literature (though many of them do covary, such as more familiar words are typically more frequent and/or more concrete). Gernsbacher (1984), for example, reports a strong relationship (r = .81) between frequency and familiarity ratings. As such only length, frequency, orthographic neighborhood, and concreteness will be controlled in the proposed study.

Manipulations

In the standard iteration of the task (Experiment 1), participants will complete a set of two-part trials. The first part involves a relatedness judgment task on a word pair (which, on critical trials, includes an ambiguous word), followed immediately by a lexical decision task.

During a second iteration of this task (Experiment 2), focus will be manipulated. During this manipulation, the context word that accompanies the ambiguous word will be focused. Specifically, focus will be induced by using uppercase text.

The third and final iteration of the proposed experimental paradigm (Experiment 3) will manipulate cognitive load during the completion of the task. Cognitive load will be manipulated by introducing a 5-digit number before the beginning of each loaded trial and requiring participants to recall this number at the end of the trial.

Hypotheses[1]

No predictions are made with respect to the judgment task as these judgments serve only to bias the meaning that is selected. Ergo, the hypotheses presented below rely solely on the analyses of the lexical decision data.

1) Evidence for priming and some form of suppression is expected.

Both the Activation-Selection (Gorfein, 2001) and the Structure-Building (Gernsbacher, 1997) accounts of meaning selection predict facilitation (i.e., priming) for congruent trials, but where they differ is in their prediction for performance in the incongruent trials.

Results are expected to be in line with Gernsbacher's Structure-Building Framework by demonstrating evidence of suppression. From this full suppression account, performance in the incongruent condition is expected to be slower than the baseline (i.e., control condition). However, weaker evidence of suppression may also be found, indicated by a reduction in priming in the incongruent condition (i.e., partial suppression). This would be evidence of suppression since an exhaustive activation account attests that both meanings of the homograph are originally activated (and thus a reduced priming effect would still support a suppression

[1] A pilot study was conducted to guide some of these hypotheses.

account). Results like these have been reported using a word paradigm similar to the one employed in the present dissertation (e.g., Gadsby, Arnott, & Copland, 2008).

In support of Gorfein's Activation-Selection account, the activation-only account predicts little to no activation of the incongruent meaning. This is because context (word pair in the judgment decision) quickly activates the appropriate meaning to its selection threshold and so no priming should be evident for the incongruent meaning. As such, baseline-level activation for the incongruent condition would support this account. This is similar to the findings of Gorfein (2001) in the seal-dolphin study described earlier.

2) Perceptual focus is expected to result in deeper processing.

Ferreira et al's (2002) account of Good-Enough Representation supposes that deeper processing only occurs when additional attention is given to the processing of a word. As such, there are at least two possible outcomes for the focus manipulation in the present experiment: focus may lead to slower RTs; or focus may lead to faster RTs. Each of these possibilities will be discussed in turn.

The Activation-Selection Model predicts faster RTs under focus and priming only in the congruent condition (as was the case with hypothesis 1). Evidence for a performance advantage under focus was presented earlier, which showed that focusing one's attention on a given word results in more complete (i.e., deeper) processing of that word (A. J. S. Sanford, et al., 2006), which is analogous to more activation. Focus would activate more features (deeper processing), and so the activation threshold would be reached sooner under focus. For unfocused items, participants would engage in Good-Enough processing.

The Structure-Building Framework, on the other hand, would predict slower RTs in the focused condition and priming for both the congruent and incongruent conditions. In this view, the additional processing resulting from focusing requires cognitive resources. As such, full suppression should not be seen in the incongruent condition because insufficient resources would remain to apply the mechanism. Instead, priming should be evident in the incongruent condition.

3) The addition of cognitive load is expected to interfere with the application of suppression.

If meaning selection in ambiguous words is an automatic, or passive, process that does not require cognitive resources, then, even under load, no changes in performance are expected since there should be no competing for cognitive resources. This would be in line with an Activation-Selection account. Priming effects in the congruent condition should not be affected by any additional cognitive load, since priming is well-established as an automatic process and thus does not require cognitive resources. There is, however a possibility that reaction times in each condition may be slightly slower under load due to task switching costs (remembering the number and typing it in, or just making the judgment and lexical decisions). Of importance, each condition should be equally affected by the load manipulation. That is to say that the incongruent, control, and congruent conditions should not be differentially affected by load.

If meaning selection is an active process, however, then performance should be significantly affected, especially in the incongruent condition. RTs (overall) should be longer under cognitive load because, from a Structure-Building Framework, meaning selection requires cognitive resources (Gernsbacher, 1993). Such a decline in performance under increased cognitive load has been demonstrated in numerous studies (e.g., Daneman & Carpenter, 1980; Engle, 2002). Additionally, suppression should not occur under load because of insufficient resources, so priming should be evident in the incongruent condition under load.

Measuring the WM capacity may additionally shed some light on the question of whether retrieving the meaning of an ambiguous word is automatic (i.e., does not require cognitive resources) as suggested by Gorfein and colleagues' Activation-Selection account, or whether it is cognitively demanding as purported by Gernsbacher's Structure-Building account. For the present set of studies, the Aospan task, which uses letters and simple math problems to gauge memory span, will be used (this task will be described in detail in the Materials section). The Structure-Building Framework would predict a stronger effect of load for low-Aospan participants (because they have fewer cognitive resources to start off) and on incongruent trials, as outlined above. The Activation-Selection Model would predict that conditions would not be differentially affected by Aospan.

The present dissertation examines these questions in three experiments. In Experiment 1, a standard version of the experiment is administered, manipulating the congruency of the homograph meaning (congruent, incongruent) and comparing performance in these conditions to a baseline control condition. Experiment 2 additionally manipulates perceptual focus and Experiment 3 adds cognitive load by way of a digit recall task.

CHAPTER 2 PRELIMINARY STUDY 1A: WORD ASSOCIATIONS

Objective

The traditionally used word association norms (e.g., Twilley, Dixon, Taylor, & Clark, 1994) are quite old, and related to this, the participant population available at Wayne State University is less homogeneous than that on which the norms are based. Mainly for these reasons, new word associations were obtained from the local student population.

Method

Participants

There were a total of 101 participants who provided word associations in this experiment. All were Wayne State undergraduate students taking at least one Psychology course. Participation was rewarded with extra credit which the student could apply to any Psychology course that allowed it.

Materials

Homographs were selected from published sources including Twilley, Dixon, Taylor, and Clark (1994) and Rodd, Gaskell, and Marslen-Wilson (2002). Words for which more than two meanings were elicited with little effort on the part of the researcher were removed. Duplicate words were also removed, resulting in 220 homograph words.

Procedures

Participants signed up for this online study via Wayne State's research participation system (SONA). Participants were instructed to type in the first word that came to mind for each of the words in the list, and not to worry about proper spelling.

Results and Discussion

Responses were screened by participant and revealed no obvious deviations from expectations (e.g., no participant responded with the same word throughout or constantly made irrelevant responses). Obvious typographical errors (e.g., doctior) were corrected by the researcher and made up only a small proportion of the collected responses. Words with less-obvious typographical errors or those that could not be deciphered were discarded. For each homograph, participants' responses were categorized as related to either of the two meanings or, if this could not be determined (because of an ambiguous response or uncertainty as to the relationship between the given word and either targeted meanings), to an "other" meaning. Identical responses were then counted and rank-ordered to obtain the best associates for each homograph. Words with more than 10% of responses in the "other" were discarded. This is especially important because if a word elicits more than the two intended meanings or if there is a chance that the meaning of that word is ambiguous in any unexpected way (e.g., *bat* often elicited a response of *man* for 'Batman'), the proposed manipulation may be unsuccessful.

The two most frequently-occurring associates for each of the homograph's two meanings were retained. There were a few exceptions to this, however. If the most associated response was a homograph or an ambiguous word, or if the associate referred to a brand name, then the next most frequent associate was retained. In some instances, no words were elicited during the association task related to one of the meanings (e.g., the doctor meaning of *quack*). In these cases, the most commonly occurring associate in the literature was used. Finally, some associates were provided for more than one homograph. These homographs were discarded unless another associate with approximately equal frequency was provided. This resulted in 54 homographs, each with 4 associated words: 2 for each meaning.

CHAPTER 3 PRELIMINARY STUDY 1B: STIMULI

Objective

Working from the words obtained from Preliminary Study 1a, a new set of stimuli was created. The primary objective was to ensure that target groups were equal on characteristics such as length, frequency, orthographic neighborhood size, and concreteness. These variables are described in the Materials section below. Concreteness ratings are available from MRC Psycholinguistic Database (Coltheart, 1981) but because many of the critical stimuli were not available there, these ratings were obtained from the student population.

Method

Participants

One hundred Wayne State University undergraduates provided concreteness ratings for the words. Again, participation was rewarded with extra credit that the student could apply to any Psychology course that allowed it.

Materials

The entire set of words presented included all of the words retained from Study 1a (homographs and associates) and several hundred unrelated words. These unrelated words were rated in order to be matched to the critical stimuli. Approximately 950 words were presented to participants.

The characteristics described below were obtained in order to match the stimuli across the three conditions (congruent, incongruent and control). Length refers to the number of characters in the grapheme and was calculated using the Length feature of Excel. HAL word frequencies (Lund & Burgess, 1996) are based on a corpus of 131 million words. As published in Balota et al. (2007) the English Lexicon Project (ELP) has HAL frequencies ranging from 0 to 23,099,033 (*M*=10,778.67; *SD*=192,226.37).

Orthographic neighborhood size refers to the number of orthographic neighbours of a given target word. An orthographic neighbour is a word that can be created from the target word by changing only one letter with all other letters remaining in their original positions (Coltheart, Davelaar, Jonasson, & Besner, 1977).

Procedures

Ratings were obtained online and participants signed up through the research participation system. Participants were asked to rate the concreteness of the entire set of words in one sitting that was divided into multiple blocks. The order of both block and words within each block was randomized. Participants were provided with a definition of concreteness prior to beginning the rating task. This definition was based on the one provided by on www.chompchomp.com (Simmons, 2010), a grammar website intended to be also easily understood by students. The definition provided to participants was:

> A word that is concrete will typically register on your 5 senses (hearing, smell, taste, touch, sight). *Puppy* is an example of a concrete noun because you can see it, touch it, smell it, etc. A word that is abstract will typically not be detectable by the senses. An example of an abstract noun is *bravery*: it has no color, size, shape, sound, odor, flavor, or texture- it has no quality that you can see, hear, smell, taste, or touch. You will provide a rating for each word you see from 1 (*very abstract*) to 10 (*very concrete*).

Results and Discussion

Obtained ratings were thoroughly screened by examining frequency counts and distributions. Subsequently, 20 participants were discarded for various violations such as severe range restriction (e.g., most or all ratings were between 3 and 6) or skewness (e.g., most or all ratings were 10), bimodal distributions (e.g., most ratings were either 3 or 6) or completely flat distributions (e.g., each number was used with equal frequency to rate the items). This high discard rate can be partly explained by the difference between online and in-person participation whereby students are less likely to perform as well online (Barenboym, Wurm, & Cano, 2010). The remaining values were averaged and used for the analyses described below. Concreteness ratings were transformed to normalize them (reflection and square root). Satisfactory normality was confirmed subsequent to this transformation by visual inspection of histograms and Q-Q norm plots.

The data obtained from this preliminary study (and Preliminary Study 1a) were used to create and match the stimuli used in the present series of experiments. The conditions of interest in these studies are the Congruent, Incongruent, and Unrelated conditions. In each trial, participants are shown a homograph paired with a word related to one of its meanings. On this word pair, participants perform a semantic judgment task. After a 1000 ms delay, they are shown a single word on which they perform a lexical decision task. These lexical decision responses are the primary focus of this investigation.

There are three types of trials: Congruent (where the meaning elicited in both tasks is the same), Incongruent (where the two meanings differ), and Control (where the meaning in the lexical decision is unrelated to either meaning of the homograph). Words in these three conditions were matched so that they did not differ in length ($F(2,159) = .310$, $p = .734$), logged frequency ($F(2,159) = 1.560$, $p = .213$), number of orthographic neighbors ($F(2,159) = 1.186$, $p = .308$), and the transformed ratings ($F(2,159) = 1.575$, $p = .210$). Additionally, the words that are paired with the homograph during the judgment task (i.e., those that activate the appropriate meaning and the unrelated controls) were also matched to each other so that they did not differ on length (*F*(2,159) = 1.40, *p* = .250), logged frequency (*F*(2,159) = 2.06, *p* = .131), number of orthographic neighbors (*F*(2,159) = 1.11, *p* = .331), and transformed concreteness ratings (*F*(2,159) = 2.025, *p* = .135).

Some studies have also reported differences between nouns and verbs in lexical decision times (e.g., Rösler, Streb, & Haan, 2001; Tyler, Russel, Fadili, & Moss, 2001). These results can sometimes be attributed to imageability differences between word classes (Bird, Howard, & Franklin, 2000). To ensure that this possible difference in response times to nouns and verbs will not affect group performance in the present experiments, the critical stimuli used in the lexical decision task contained approximately equal proportions of nouns (Dominant 76%; Subordinate 72%, and Unrelated 74%) and verbs (Dominant 15%; Subordinate 17%, and Unrelated 17%) with other word classes making up the remaining cases. Lexical decision nonwords were also matched to their word counterparts on length (*t*(268) = .335, *p* = .738) and number of orthographic neighbors (*t*(268) = .707, *p* = .480).

CHAPTER 4 EXPERIMENT 1

Objective

The purpose of Experiment 1 was to assess whether a dampening of activation occurs during the ambiguity resolution process and whether this process is active (i.e., requires cognitive resources). For each trial, participants were first shown a word pair− in critical trials, the first word was a homograph and the second provided context to elicit meaning selection for that homograph (e.g., *spade- ace*) or an unrelated control word. On this word pair, participants made a relatedness judgment to indicate whether the words were semantically related. Following this response, another letter string appeared, on which participants performed a lexical decision. The critical items used for the lexical decision task were either related to the same meaning of the homograph presented in the previous judgment trial, related to the other meaning of the homograph presented in the judgment trial, or not related to either meaning (a baseline or control condition). Congruent and incongruent trials (different homograph meanings between the two tasks in the trial) were compared to the baseline/control condition.

Method

Participants

Participants were recruited through Wayne State University's Psychology Research Participation System (SONA). Participants were given extra credit for their participation. A total of 63 participated: 12 males (19%) and 51 females (81%). Ages ranged from 18 to 41 (M = 20.70). Their Aospan (Automated Operation Span) scores ranged from 3-75 items (M = 43.08); this measure will be described in detail below.

Materials

Computer. A set of 3 laptop computers were used to present the experiment to participants. Each computer had a 12-inch color monitor, a keyboard, and built-in mouse. Each computer was running Windows XP and was located inside a sound-attenuating booth to cancel out noise and minimize distractions. Inquisit v.3.0.5.0 (*Inquisit*, 2011) was used to program and run this experiment. Computers were all on mute and the resolution and other display properties were the same on all machines.

Stimuli. The stimuli from Preliminary Study 1b were divided into 6 experimental versions, resulting in each of the 54 homographs occurring in each of the 3 conditions: congruent, incongruent, and control. Each homograph was presented in lowercase (except in the focus condition, which will be described in the Procedure section of Experiment 2) and appeared only once in each list. Each participant was presented with 2 lists for a total of 270 trials. In each list, there were 135 trials divided into critical stimuli (n = 54) and fillers (n = 81). Critical trials consisted of 20 congruent, 20 incongruent, and 14 control trials. There were two types of fillers: some were "no" response fillers to offset all of the "yes" responses of the critical trials for the lexical decision task (i.e., 54 unrelated word pairs with nonwords for the lexical decision task); the others are "no" response fillers to offset all of the "yes" responses of the critical trials for the judgment task (i.e., the 54 nonword items above plus an additional 27 unrelated word pairs with an unrelated word for the lexical decision task). The breakdown of trial types is displayed in Table 1.

Although repetition of items would allow for greater statistical power given the small number of items available, it may not be ideal. Because each homograph was seen twice by participants it is not certain whether a few dozen intervening trials and a WM task (Aospan) would be enough to negate any possible priming effect in the present study. In an ideal scenario, one would want an exactly equal proportion of related and unrelated filler items in the judgment task and an equal number of words and nonwords in the lexical decision task. The closest match possible was a 60:40 split (where 40% of trials in the judgment task were related and 40% of the lexical decision tasks were nonword). The necessity for this imperfect proportion was determined in part by the complexity of the task (having to alternate between the judgment and lexical decision tasks within each trial) and also the maximum number of trials during which participants would perform optimally. There is ample evidence that students' attention spans are between 15 and 20 minutes (Hoover, 2006; Johnstone & Percival, 1976; Middendorf & Kalish, 1996). Based on this, the present methodology was developed so that each section of the experiment (i.e., each block of trials and the Aospan task) would take approximately 15-20 minutes to complete. In order to have a fully balanced experiment, an additional 27 fillers in each of the 2 blocks would have had to be added where the words were related in the judgment task and the lexical decision is on a nonword. This would have increased participants' total number of trials to almost 330; it doesn't seem reasonable to expect participants to diligently participate in that many trials. Numerous researchers have reported effects of biased lists for strategy use on a number of tasks (e.g., Bodner & Mulji, 2010; Frost, Katz, & Bentin, 1986; Klapp, 2007; Tweedy, Lapinski, & Schvaneveldt, 1977), but these differences have typically been shown for a far more extreme bias (e.g., 80:20) than the one found in the present dissertation.

WM Measure. The Aospan was used to measure WM capacity (Figure 1). Unsworth et al. (2005) have adapted the traditional experimenter-administered Ospan task into to an automated, mouse-driven, letter recognition version. In this version, letters are used rather than words because word knowledge or familiarity (i.e., word frequency) has been shown to influence the measure (Engle, Nations, & Cantor, 1990). Another advantage of the Aospan is that it uses each individual's mean time (+ 2.5 *SD*) for completing the practice math problem as the maximum time allowed to solve the math problems during the WM assessment portion of the task. The trial times out and considers it an error if the participant exceeds this time on a given math problem.

The Aospan is composed of four sections: a letter recognition practice block, a math problem solving practice block, a combined letter recognition and math problem practice block and the final test phase (which is again a combination of letter recognition and math problems). In the first section (letter recognition practice), two to three letters are shown one at a time (800 ms) and then a 12-letter matrix appears where each letter must be selected in the order in which it appeared. A button labelled "blank" is also provided so that if one letter is forgotten, the other letters are not recorded in the incorrect position. The second section (practice math problems) is used to familiarize participants with the type of math problems that will be shown during the experimental phase. A math problem is shown (e.g., (1*2) + 1 = ?) and participants are asked to calculate the answer and then to click on the mouse to indicate that they are done solving the problem. Following the presentation of each math problem, participants are shown a potential answer and asked to indicate whether this is the correct answer of the preceding problem ("true") or not ("false").

The final practice allowed participants to gain familiarity with the complete procedure that they would encounter in the final phase (the actual WM measure). Here, participants are shown a math problem, followed by the response prompt (potential answer and "true" and "false" buttons) and then a letter. A series of two to three sets are shown before requiring the recall of the letters via the 12-letter matrix. Following these three practice sets, the experimental set begins and follows the procedure of this third practice. In the test trials, the sets are longer than during the practice trials and range from three to seven items.

Participants are provided with detailed instructions during this task and provided an opportunity to ask questions at each stage. They are also instructed to complete the task as quickly as possible and to maintain an accuracy level of at least 85% on the math tasks. Feedback is provided for each trial (including the experimental trials) and during the critical set, a running mean accuracy is additionally displayed to participants.

At the conclusion of the task, the experimenter is presented with 5 scores: the absolute score (sum of all trials where all letters were recognized in the correct order), the total number correct (sum of all the correctly recalled letters in their correct position), the total number of errors on the math task and a breakdown of these errors: the number of errors that were “forced” because the upper time-limit was reached; and the number of accuracy errors, which are incorrect responses given on the math problems.

Procedures

Participants were tested individually in Industrial Acoustics Company sound-attenuating booths. After reading an information sheet, they were seated approximately 45 cm from the computer and the instructions for the task were read to them from the computer monitor, stressing the importance of completing the task as quickly and accurately as possible. Participants were informed that they would see two types of alternating trials: the first would be a word pair and the second a single word. When they saw a word pair, their task was to indicate whether the two words were related and when they saw the single word their task was to indicate whether it was a real English word. Both of these yes/no responses were to be indicated using the two mouse buttons with left meaning “no” and right meaning “yes.” These response prompts were displayed on the screen during the experiment. The experimenter remained nearby while the participants complete the 30 practice trials. If the participant had no questions, they were monitored from outside the booth (through a window) for the duration of the experiment. Figure 2 illustrates a trial.

After the first 135 trials, participants completed the demographic questionnaire (age, gender, handedness, major, and race/ethnicity) and the Aospan task, both of which were completed on the computer. Following these tasks, another 10 practice items were presented, followed by the other 135 trials.

Data Analysis

Data were analyzed using SPSS. Outliers were removed prior to conducting analyses. This accounted for 2.90% of the judgment RTs (below 400 ms and above 2.5 SDs above the mean) and 2.83% of the lexical decision RTs (below 250 ms and above 2.5 SDs above the mean). Data were normalized using a log (base 10) transformation. Subsequently, histograms and QQ plots of both distributions (Judgment and LD data) showed adequately normal distributions to proceed. Examining the means of each cell by block showed the same pattern (though Block 1 was a little slower and a little less accurate), so both blocks were combined for the reported analyses.

A repeated measures ANCOVA was the primary analysis used for RTs as well as for accuracy (Lunney, 1970). Any participant that had an empty cell (i.e., had no remaining responses in a particular condition subsequent to data cleaning) was excluded from the analyses. In this experiment, there were 2 such cases, reducing the total participants from 63 to 61. Responses to the semantic relatedness judgment task (RT and error) and to the LD task (RT and error) will be discussed, though RTs in the lexical decision task are the primary interest of the present investigation. Each set of analyses is described in turn below.

Results and Discussion

Lexical Decisions

Reaction Times. Only correct responses following a correct judgment response were included in the analyses. An analysis of covariance (ANCOVA) for Condition (control, incongruent, congruent) was conducted with Aospan score as the covariate (Table 2). Condition (F (2, 118) = 9.62, p < .001, $\eta_p^2 = .14$) was significant but the continuous covariate of Aospan score (F (1, 59) = .30, p = .586) was not.

All pairwise comparisons for Condition were significant using a Bonferroni correction.[2] There was evidence of priming since both the congruent and incongruent conditions were significantly faster than the control (t(60) = 7.97, p < .001; and t(60) = 5.49, p < .001, respectively). Additionally, RTs in the congruent condition were significantly faster than the incongruent condition (t(60) = 4.22, p < .001). These means are displayed in Table 3 and illustrated in Figure 3.

The priming obtained in the congruent and incongruent conditions is in line with performance advantages from a spreading activation account (Collins & Loftus, 1975), and supports an exhaustive account of meaning activation. Both the Activation-Selection account and the Structure-Building Framework predict this priming. Although there is no clear evidence of suppression as defined by Gernsbacher (below-baseline activation), since the control and incongruent condition were also significantly different from one another, one can speculate that the alternate meaning of the homograph was activated but that the activation was reduced or that the initial activation was not as strong as in the congruent condition. Experiments 2 and 3 may

[2] New significance cut-off value for p is now .016.

shed some light as to whether an additional mechanism was employed to reduce the activation in the incongruent condition.

Accuracy. Again, only responses following a correct judgment response were included in the analyses. An ANCOVA for Condition (control, incongruent, congruent) was conducted with Aospan score as the covariate (Table 4). Because the assumption of sphericity was violated, Table 5 shows the adjusted values (Huynh-Feldt; Leech, Barrett & Morgan, 2011). Means are displayed in Table 5. Condition (F (2, 103) = 3.69, p < .05, η_p^2 = .059) and Aospan score (F (1, 59) = 5.60, p < .05, η_p^2 = .087) were both significant. Pairwise comparisons[3] revealed significant differences between control and congruent (t(60) = 4.49, p < .001, with congruent being significantly more accurate), and incongruent and congruent (t(60) = 4.53, p < .001, with congruent being significantly more accurate). The difference between incongruent and control was not significant (t(60) = 1.22, p = .228). This pattern does mirror the RT data, with the best performance in the congruent condition, followed by the incongruent condition and the worst performance in the control condition. As such, there does not appear to be a speed-accuracy trade-off in these data.

To probe the effect of Aospan on accuracy, Aospan scores were divided following Gernsbacher and Faust's (1991a) procedure, which compares the top and bottom thirds of the distribution (high and low group, respectively) and sets aside those in the middle. The effect of Aospan was significant in this follow-up analysis (F (1, 33) = 4.32, p < .05, η_p^2 = .116) and showed significantly more accurate performance by the high-Aospan group (M = 97.93, *SEM* = .369) compared to the low-Aospan group (M =95.63, *SEM* = .813). This suggests that the process of ambiguity resolution is not completely automatic and hints at an effect of cognitive

[3] Bonferroni correction adjusted the p value to .016.

resources, supporting the necessity of a suppression mechanism for ambiguity resolution as per the Structure-Building Framework account.

Relatedness Judgments

Reaction Times. Since the congruent and incongruent conditions both contained the same items in the judgment task (i.e., the congruent or incongruent manipulation did not occur until the lexical decision task), they were combined into a “related” condition to compare to the control (now “unrelated”) condition. An ANCOVA was performed for this new Condition with Aospan score as the covariate. There was no significant effect of condition (F (1, 59) = .581, p = .449) or the Aospan covariate (F (1, 6457) = 10.47, p < .01, η_p^2 = .002). Although differences might be expected, with participants responding to related word pairs more quickly than to unrelated word pairs (e.g., Gadsby et al. (2008)), this difference did not reach significance. Means were in the expected direction for this possibility, however, with related words showing a faster mean reaction time (1110ms) than unrelated words (1123ms).

Accuracy. An ANCOVA was performed for Condition (related, unrelated), with Aospan as a covariate. Again, there was no effect of Condition (F (1, 59) = .426, p = .516) or Aospan (F (1, 59) = 2.05, p = .157) and no interactions were significant. The expectation of better performance for the related words did not reach significance in these data, but means were in the expected direction: related was more accurate (84.44%) than unrelated (82.62%). This, combined with the slightly faster RTs, suggests that there is a trend towards better performance for related words compared to unrelated words. Additionally, these data suggest that there is no speed-accuracy trade-off and that participants truly are following the instructions to respond as quickly and as accurately as possible.

CHAPTER 5 EXPERIMENT 2

Focus Effects Overview

It is possible that different levels of processing could result in different ambiguity resolution strategies. For example, deeper processing (rather than Good-Enough processing (Ferreira, et al., 2002)) of the context word in the pair could either serve to highlight the ambiguous nature of the homograph or result in an easier selection of meaning since that meaning would be more strongly activated. In this second experiment, uppercase letters were used to invoke perceptual focus and examine how lexical ambiguities are resolved.

Method

Participants

Participants were recruited through Wayne State University's Psychology Research Participation System (SONA). Participants were given extra credit for their participation. A total of 123 participated: 48 males (39%) and 75 females (61%). Ages ranged from 18 to 49 (M = 20.97). Their Aospan scores ranged from 0-75 items (M = 39.47).

Materials

The lists from Experiment 1 were used. Additionally, focus was manipulated so that the context word that accompanied the homograph could either be focused (uppercase) or not focused (lowercase). Across all lists, each homograph appeared as both focused and unfocused for each of the three conditions– congruent, incongruent, and control. This resulted in 12 experimental lists.

Procedures

The same procedures described in Experiment 1 were followed. A focused trial is illustrated in Figure 4.

Data Analysis

Data were analyzed using SPSS. Outliers were removed prior to conducting analyses. This accounted for 3.66% of the judgment RTs (below 400 ms and above 2.5 SDs above the mean) and 2.98% of the lexical decision RTs (below 250 ms and above 2.5 SDs above the mean). Data were normed using a log (based 10) transformation. QQ plots and histograms showed adequately normal distributions to proceed. Examining the means of each cell by block showed the same pattern (though Block 1 was a little slower and a little less accurate), so both blocks were combined for the reported analyses.

A repeated measures ANCOVA was the primary analysis used for RTs as well as for accuracy (Lunney, 1970). All participants provided data for each condition (*N* = 123). Responses to the semantic relatedness judgment task (RT and error) and to the LD task (RT and error) will be discussed, though RTs in the lexical decision task are the primary interest of the present investigation. Each set of analyses is described in turn below.

Results and Discussion

Lexical Decisions

Reaction Times. Only correct responses following a correct judgment response were included in the analyses. An ANCOVA for Condition (control, incongruent, congruent) and Focus (focused, unfocused) with Aospan score as the covariate was conducted (Table 6 with Huynh-Feldt adjusted values where appropriate). Mean RTs are displayed in Table 7 and illustrated in Figure 5. The only significant effect was that of Condition (F (2, 242) = 6.99, p < .01, η_p^2 = .06). Pairwise comparisons for Condition (using the adjusted Bonferroni p of .016) showed evidence of priming for both the congruent and incongruent conditions. Control (*M* = 749, *SEM* = 11.72) was significantly slower than both congruent (*M* = 670, *SEM* = 9.66, *t*(122) =

10.91, $p < .001$) and incongruent ($M = 700$, $SEM = 10.32$, $t(122) = 5.63$, $p < .001$). Congruent and incongruent were also significantly different from each other ($t(122) = 4.14$, $p < .001$).

The results obtained here mirror those of Experiment 1 with priming for the congruent and incongruent conditions and different levels of activation in these conditions. Perceptually focussing the context word (i.e., deeper processing) did not result in significant differences in performance and suggest that employing such a structure does not alter the initial (and perhaps automatic) pattern of activation for homographs. Experiment 3 examines whether performance changes under cognitive load.

Accuracy. An ANCOVA for Condition (control, incongruent, congruent) and Focus (focused, unfocused) and with Aospan score as the covariate was conducted. Because the assumption of sphericity was violated for Condition, the Huynh-Feldt adjusted values are reported in Table 8 (Leech, Barrett, & Morgan, 2011). See Table 9 for means and SEMs. Condition was the only significant variable in the model (F (2, 242) = 7.63, $p < .01$, $\eta_p^2 = .06$). The control condition was the least accurate overall. This lower performance in the control condition mirrors the RT data and serves as further evidence that no speed-accuracy trade-off occurred. More generally, there was no effect of focus in these data either. No specific predictions had been made related to accuracy, though it seems intuitively pleasing that, like the RT performance, the accuracy results show the worst performance in the control condition, suggesting a slight advantage for processing words that are semantically related.

Relatedness Judgments

Reaction Times. An ANCOVA with Condition (related, unrelated) and Focus (focused, unfocused) and with Aospan score as the covariate. There were no significant effects or interactions. Again, the expectation might be that participants would respond to related words more quickly than unrelated words, agreeing with a spreading activation account (Collins & Loftus, 1975). The mean RTs obtained here are in line with what would be predicted by this account (related 1112ms ; unrelated 1119ms). Additionally, focused trials were expected to have longer RTs because of the need for deeper processing. The trend for these data are in that direction, with focused trials having longer reaction times (1121ms) than unfocused trials (1109ms), but again this is only a trend, and not a significant effect.

Accuracy. An ANCOVA with Condition (related, unrelated) and Focus (focused, unfocused) and with Aospan score as the covariate was performed. Condition (F (1, 121) = 10.27, p < .01, η_p^2 = .078) and Aospan (F (1, 121) = 4.22, p < .05, η_p^2 = .034) were the only significant effects. Participants responded to unrelated words significantly less accurately (*M* = 94.11, *SEM* = .994) than to related words (*M* = 97.55, *SEM* = .405). When the Aospan covariate effect was probed with an ANOVA using the top and bottom thirds of the distribution, this effect was no longer significant (p = .224), although those with low Aospan scores tended to be less accurate (*M* = 94.80, *SEM* = 1.20) than those with high scores (*M* = 96.86, *SEM* = 1.18). This trend in the data is in line with the idea that encountering (and ultimately resolving) an ambiguous word requires cognitive resources. This finding appears to give partial support to the Structure-Building Framework, since it posits the necessity to mobilize cognitive resources in order to apply the mechanism of suppression. The trend in the present data may be the initial stage of this increased requirement of cognitive resources.

CHAPTER 6 EXPERIMENT 3

Cognitive Load Overview

If ambiguity resolution requires cognitive resources (e.g., to apply suppression, as suggested by Gernsbacher's group), then one would expect performance to suffer under cognitive load. To examine this possibility, this experiment added a secondary task of remembering a 5-digit number while performing the task.

Method

Participants

Participants were recruited through Wayne State University's Psychology Research Participation System (SONA). Participants were given extra credit for their participation. A total of 124 participated: 35 males (28%) and 89 females (71%). Ages ranged from 18 to 46[4] (*M* = 21.67). Their Aospan scores ranged from 0-75 items (*M* = 40.43).

Materials

The same stimulus set was used as for Experiment 1. Before half of the trials, a 5-digit number was presented. This list of number stimuli was created using Excel's random number generation feature. Across all lists, each homograph appeared as both loaded and unloaded for each of the three conditions– congruent, incongruent, and control). Load was also added to half of the filler trials. This resulted in 12 lists.

Procedures

The procedure was similar to those of the previous two experiments. The only modification was related specifically to the addition of the load manipulation (illustrated in Figure 6). On the load trials, participants were shown a 5-digit number and asked to retain it

[4] One participant was removed based on age. The participant who was removed was 63 years old, which is clearly an outlier since the next oldest in this sample is 46. Further, doing so resulted in this sample mirroring those of the Focus and Standard versions.

until after the judgment and lexical decision task and recall it on a final screen. Unloaded trials had a blank screen in the place of the digits. The digits or the blank screen was displayed for 2000 ms. After the lexical decision task, a textbox appeared and remained on the screen until participants typed in the number or simply pressed "enter" if there was no number preceding the trial.

Data Analysis

Data were analyzed using SPSS. Outliers were removed prior to conducting analyses. Outliers accounted for 3.75% of the judgment RTs (below 400 ms and above 2.5 SDs above the mean) and 3.64% of the lexical decision RTs (below 250 ms and above 2.5 SDs above the mean). Following log (base 10) transformations, both distributions appeared normal when inspecting the QQ plots and histograms. Examining the means of each cell by block showed the same pattern (though Block 1 was a little slower and a little less accurate), so both blocks were combined for the reported analyses.

A repeated measures ANCOVA was the primary analysis used for RTs as well as for accuracy (Lunney, 1970). Only trials where the correct number was recalled were used. The rationale behind this decision is that this is the only way to know for certain that participants were actually trying to remember the number and thus ensure the success of the manipulation. Any participant with an empty cell subsequent to data cleaning was excluded from the analyses. In this experiment, there were 44 such cases, reducing the total participants from 121 to 77[5].

A discussion of this and possible explanation for the large number of participants that were removed from these analyses will be attempted in the next chapter. Responses to the semantic relatedness judgment task (RT and error) and to the LD task (RT and error) will be

[5] In a parallel analysis, 23 of the 44 deleted subjects were recovered (those that were only missing 1 condition mean). This was done by replacing the missing mean with the cell mean, but this analysis did not shed any additional light on the research questions posed.

discussed, though RTs in the lexical decision task are the primary interest of the present investigation.

Results and Discussion

Lexical Decisions

Reaction Times. Only correct responses following a correct judgment response were included in the analyses. An ANCOVA for Condition (control, incongruent, congruent) and Load (load, no load) with Aospan score as a covariate was conducted (Table 10, with the Huynh-Feldt values where appropriate). Means are displayed in Table 11 and Figure 7. None of the main effects or two-way interactions was significant, but the 3-way interaction between Condition, Load, and Aospan was significant (F (2, 150) = 4.05, $p < .05$, $\eta_p^2 = .051$).

To further examine the significant 3-way interaction obtained in these analyses, ANOVAs were run separately for the top and bottom thirds of the Aospan distribution. This revealed that the high-span participants were driving these effects as nothing was significant in the low-Aospan participants (Figure 8, top panel), though the RTs trended in the expected direction, with loaded trials taking longer than unloaded trials and the slowest performance occurring in the control condition. Although no significant effects emerged, it can be seen in Figure 8 that the low-Aospan group (top panel) had higher RTs overall than the high-Aospan group (bottom panel), as would be expected. In the high-Aospan analysis, both Load (F (1, 28) = 6.67, $p < .05$, $\eta_p^2 = .323$) and Condition (F (2, 28) = 6.33, $p < .01$, $\eta_p^2 = .311$) are significant. For the main effect of load, means are in the expected directions with no-load trials being significantly faster (M = 712 ms, SEM = 41.29) than loaded trials (M = 809 ms, SEM = 48.70). For the main effect of Condition, no pairwise comparisons were significant after the Bonferroni correction (using the new p cut-off of .008). However, examining the means, both congruent (M

= 715 ms) and incongruent (M = 710 ms) appear much faster than Control (M = 855 ms). These differences likely did not reach significance because of the much smaller N in this analysis, since only one third of the data are used to probe the significant 3-way analysis.

Additionally, there is a marginally significant Load x Condition interaction (F (2, 28) = 3.17, p = .058, η_p^2 = .184). It is likely that this effect did not reach significance because of the reduction in sample size, which resulted from Aospan being divided into thirds and this analysis only using the top third. Looking at this interaction, the effect of cognitive load seems especially evident in the control condition (Figure 8, bottom panel). Under no load, RT patterns mirror previous versions (Experiment 1, and 2) with control having the longest RTs. Under load, this pattern also holds, however the control condition is 150 ms slower than either congruent or incongruent, a far greater different than the difference seen in Experiments 1 and 2. Said differently, the priming found in the congruent and incongruent conditions may serve as a protective factor for the effect of load in individuals with larger working memory capacity (i.e., high-Aospan group).

Accuracy. An ANCOVA for Condition (control, incongruent, congruent) and Load (load, no load) with Aospan score as a covariate was conducted (Table 12). Means and SEMs are displayed in Table 13. There were no significant effects, but the trend of the means does seem to mirror the results of the other experiments, with greatest accuracy in the congruent condition, and lowest accuracy in the control condition. This suggests there is no speed-accuracy trade-off in this experiment, either. Furthermore, there was very little difference in accuracy between loaded and unloaded trials (96% and 95%), suggesting that the load manipulation did not affect accuracy in the lexical decision data.

Relatedness Judgments

Reaction Times. An ANCOVA for Condition (related, unrelated) and Load (load, no load) with Aospan score as a covariate was conducted. No main effects or interactions were significant. Generally, however, participants responded to no-load trials faster (1406 ms) than to loaded trials (1539ms). This trend makes sense given that in the loaded trials, working memory is engaged in retaining the multi-digit number that was recently presented. Because of this difference, the resulting relatedness decision does not appear to be entirely automatic. Although the Structure-Building Framework makes no predictions about specifically when cognitive resources begin to be engaged in the resolution process (i.e., when the suppression mechanism begins to be applied), the trend found here related to slower responses in the loaded trials might indicate that the suppression process begins quite soon after the word is encountered.

Accuracy. A Condition (related, unrelated) by Load (load, no load) ANCOVA with Aospan score as the covariate was conducted. There were no significant effects, though the means did show a trend in the expected direction with unrelated words being less accurate (M = 94.15, SEM = 1.63) than related words (M = 97.18, SEM = .844). This trend is intuitively pleasing, as it appears to indicate that the spreading of activation between related words provides an advantage in the processing of these words. Again, it appears that focus had little effect on accuracy (no load 95%; load 96%).

CHAPTER 7 GENERAL DISCUSSION

The overall reaction times were much faster for the lexical decision task compared to the judgment task: Standard- 716 ms vs. 1116 ms; Focus- 607 ms vs. 1115 ms; Load- 807 ms vs. 1473 ms. This global difference makes sense given that the word/nonword distinction in the lexical decision task is less subjective than the related/unrelated decision in the judgment task.

The judgment task data infrequently showed significant effects, but a semi-consistent finding was of better performance (either RT or accuracy) for related words compared to unrelated words. This is consistent with an account in which related items benefit from a performance advantage due to spreading activation (Collins & Loftus, 1975). However, even though the data do show consistent trends in this direction, since most of these effects were not significant, it is not possible to make strong conclusions from these results. I therefore turn to a discussion of the lexical decision RTs, which are of primary interest for this study.

Is There One Process (Activation) or Two (Suppression)?

The results provide partial support for Hypothesis 1, which predicted priming and some form of suppression. The RT data in all three experiments show consistent evidence of priming in both the congruent and incongruent conditions. Priming was expected for the congruent items from a spreading activation account (Collins & Loftus, 1975) and according to both the Structure-Building Framework and the Activation-Selection account. Past research (e.g., Onifer & Swinney, 1981) has also reported priming for both meanings of a homograph compared to a baseline control. Of perhaps greater importance, however, is that congruent and incongruent reaction times were also significantly different from one another (except for in the load experiment, which was predicted). This suggests that the initial automatic activation of these semantically related words was reduced in the case of the incongruent words. This result is consistent with an exhaustive account of meaning activation followed by a secondary mechanism (such as suppression). These results provide some support for Gernsbacher's Structure-Building Framework in that partial suppression was found. Although there was no evidence of full suppression (below-baseline activation), there was less priming in the incongruent condition than the congruent condition suggesting some suppression of the alternate homograph meaning. Gorfein's Activation-Selection account predicts no activation of the incongruent meaning; since priming was found in most of the experiments reported herein, the results appear to refute this account. Further support for the Structure-Building Framework came from the lack of suppression found under load. This is because, under load, cognitive resources are allocated to the secondary (i.e., digit) task, resulting in too few resources remaining to apply suppression to the unintended meaning. As such, under load, suppression did not occur.

Overall, the literature consistently reports some kind of disruption in the representation of the inappropriate meaning of a homograph. However, Gorfein (2001) reported that paradigms using a single presentation of the homograph (as was the case here) frequently report near baseline performance whereas two presentations tend to show below-baseline performance (i.e., clear suppression). However, in the Load version, congruent and incongruent were no different from one another, suggesting that under this increased need for cognitive resources (the additional requirement in some of the trials of remembering the number and also, perhaps, task-switching costs), there aren't enough cognitive resources remaining to apply suppression to the inappropriate meaning, which is why it was not significantly different from the congruent condition.

Additionally, previous empirical research related to Gernsbacher's Structure-Building Framework focused primarily on sentence contexts rather than on word-pair presentation as was done here. There might not be a clear or full suppression effect (i.e., below-baseline RTs for the incongruent condition) because without the stronger context provided by a sentence, the full mechanism of suppression may not be necessary for meaning selection. In such cases, meaning selection may occur based on other factors such as frequency, or both meanings may remain partially active even after the selection of a meaning. Evidence for this last possibility (that both meanings may remain partially activated when a word is used as context) is reflected in the consistent finding of priming in the incongruent condition. As such, evidence in support of the Structure Building Framework was provided, to varying degrees, in each of the three experiments.

Does Perceptual Focus Affect Ambiguity Resolution?

The second hypothesis, which predicted perceptual focus would result in deeper processing, was not supported by the data. Specifically, results did not indicate faster activation times for perceptually focused words or priming only for the congruent condition, as expected from an Activation-Selection account. Additionally, the Structure-Building Framework's prediction of slower reaction times for focused items and priming for both congruent and incongruent meanings were not entirely supported.

In the Focus version, responses to focused items were only slightly slower than to unfocused items (though this difference was not significant). However, processing appeared to mirror results of the Standard experiment and did not lead to different processing during the ambiguity resolution task. As such, one might conclude that perceptually focusing the context of an ambiguous word does not provide processing advantages during the resolution process, nor does it hinder this process. However, it is also possible that perceptual focus may not have been a strong enough manipulation to require additional processes and a stronger focus manipulation (e.g., syntactic focus) may be required to find significant effects.

Does Cognitive Load Affect Ambiguity Resolution?

The data provide evidence in support of the third hypothesis, which predicted that increasing cognitive load would interfere with the application of suppression. Increasing the processing requirements by adding cognitive load resulted in longer RTs. This slower performance was expected if the ambiguity resolution process was not entirely automatic, and therefore required cognitive resources, as is the case when suppression is applied. This finding is counter to the predictions of the Activation-Selection Model, which proposes that processing is automatic and thus should not be affected by an increase in cognitive load. Aospan also seemed to have an effect on performance in the Standard and Load versions, with better performance by the high-Aospan group, so that these participants with more cognitive resources performed either more accurately (Standard) or faster (Load).

In the Load version, Aospan score was an important variable. Specifically, those with low-Aospan scores (thus fewer cognitive resources) had higher RTs in all three conditions than those with high-Aospan scores. The Structure-Building Framework predicts a larger effect for low-Aospan participants, though it further predicts that the incongruent condition would be especially affected by load, which it was not. Additionally, participants with high-Aospan scores (many resources) were only affected by load in the control condition. This confirms that the priming observed in the congruent and incongruent conditions is automatic and, unlike the mechanism of suppression discussed above, activation does not require additional cognitive resources.

Taken together, these results support Gernsbacher's proposal that a second mechanism is required for ambiguity resolution and that this secondary mechanism requires cognitive resources. So, although the activation mechanism responsible for the observed priming effects is automatic and does not require cognitive resources, the ambiguity resolution process requires more than activation alone: ambiguity resolution appears to also require some form of suppression and this suppression process does make use of cognitive resources.

Because load affected performance, the Activation-Selection Model is not supported. Instead, these results are more in line with the Structure-Building Framework, which purports that cognitive resources are required to apply suppression in the ambiguity-resolution process.

An Updated Conceptualization of Word-level Ambiguity Resolution

The results of these three experiments together point to a slightly different conceptualization of the process of ambiguity resolution than what is currently available in the literature. Specifically, they suggest that partial suppression is occurring, rather than the full suppression proposed by Gernsbacher's group. How this occurs may not be as straightforward as her framework would suggest.

For example, in the case of *bark*, the tree meaning is suppressed but the semantic representation of the concept of tree remains accessible, because it is only weakly related to the word *bark*. Only the tree meaning of *bark* is suppressed as it relates to that particular word (i.e., the link between the nodes, and not the nodes themselves). As such, when the homograph is encountered again, that previously inappropriate incongruent meaning is difficult to access. This explains why the finding of below-baseline activation (i.e., suppression) only consistently occurs in dual-presentation paradigms. With a single presentation of the homograph, although the "tree" meaning of *bark* may have been suppressed (i.e., that pathway), the concept of "tree" itself has not been suppressed, so that encountering the word *leaf* does not result in suppression, even though it relates to the suppressed meaning. The lower activation in the incongruent condition compared to the congruent condition results from the reduction in activation since that pathway is now much weaker. In this way, activation and suppression may follow different rules. Figure 9 illustrates this proposal.

This modified conceptualization, therefore, can explain why dual-presentation paradigms (presenting the homograph twice to assess meaning activation) find suppression effects whereas single presentation paradigms typically do not. When the original encounter is focused, both of the homograph's meanings are more strongly activated, and, in an attempt to fully process the stimulus, this activation may also spread to nearby nodes such as "leaf" and "cat", increasing the strength of those connections as well. Under load, the pattern would be similar to the one illustrated in Figure 9 for the automatic process of activation (congruent condition), though for the additional task of "suppressing" there are too few cognitive resources to efficiently complete this task, so responses to the incongruent trials are slowed down.

It wouldn't be very adaptive to fully suppress all access to a given meaning, even for a relatively short period of time. This sentiment has been echoed by others such as Allport (1987) and Nievas and Marì-Beffa (2002). The cognitive system may need to rapidly respond to some ignored concept to successfully perform a task in the near future. So it wouldn't make evolutionary sense to completely limit the access to a given concept by fully suppressing it and not having alternate routes to activating that meaning. This seems particularly fitting given the preference given to responses to words with high "danger" ratings (Wurm, 2007). Humans are programmed to be able to respond quickly to words, and evolutionarily adaptive words (those that are useful or dangerous) are processed more quickly. For example, in a lexical decision task using words that had previously been rated for how dangerous they were for human survival, Wurm (2007) showed that words rated high on dangerousness (e.g., *blade, lion, thief*) were responded to faster, likely stemming for the evolutionary need to avoid danger in order to survive. This preferential lexical access for words high on danger ratings has also been found in memory experiments where a similar argument for the adaptive advantage of "dangerous" words is also made (interested readers may refer to Nairne's (2010) chapter on adaptive memory).

Limitations and Future Directions

One limitation of the present paradigm is that the design of the stimuli was not perfectly orthogonal (i.e., where each possible combination of stimulus and response was presented). For example, critical relatedness judgment pairs were never followed by a nonword on the lexical decision task. This design shortcoming does not appear to have affected the present results. Gadsby et al. (2008) used a similar paradigm with a fully orthogonal stimuli set and results agreed with the present findings for the Condition variable: the longest lexical decision RTs were in the control (or unrelated) condition, followed by the incongruent condition and the fastest RTs were found in the congruent condition.

Another possible limitation is the greater number of participants who had to be deleted from the Load analyses (because of missing data) compared to the Standard or Focus versions. One possible explanation for this difference is that participants in this version of the experiment differed in some way from the other two. This was examined as a possibility and no differences were found in Aospan score or age (Table 14 and Table 15, respectively). The full range of scores was represented in the Aospan task (0 to 75) and similar age ranges and means were obtained in all three versions.

Another possibility is that this is a byproduct of the much larger number of trials that had to be removed (i.e., because the number was not correctly recalled). However, most of the missing data occurred in the unloaded trials, so this does not appear to be a plausible explanation. This is, of course, contrary to what would be expected, given that cognitive load should result in a decrease in performance. If we assume that performance by low-span participants mirrors that of someone under increased cognitive load, then Kossowska's (2007) recent findings about negative priming might be able to provide a partial explanation. She reports that low-span individuals can temporarily increase performance to match that of high-span individuals, but a reduction in this "boosted" performance occurs over time: at first, performance was no different from high-span individuals, because those with low spans are able to use up their "reserve" of cognitive resources. However, once these reserves were used up, performance was reduced and low-span individuals performed worse than high-span individuals. Although this appears to be a promising avenue to pursue for explaining the present difference, Kossowska's study only had 18 trials in each block, so these effects may not be very long-lasting. Future research should replicate the present experiments in order to better evaluate the plausibility of this explanation as it pertains to ambiguous words. Furthermore, functional neuroimaging or ERP studies could be used to further clarify the ambiguity resolution process. For example, the N400 of an ERP, which has been attributed to meaning retrieval, might be used to shed some light on when a meaning is selected for an ambiguous word and if the pattern of meaning-selection might suggest the presence of a secondary mechanism.

Future studies should examine these findings in the context of sentences. Including both the focus and load manipulations should confirm the prediction that clear suppression would only be evident at the sentence-level. Additionally, this may shed some light regarding the strength of the focus manipulation and whether the sentence context would provide sufficient (syntactic or linguistic) focus to lead to deeper processing and perhaps differential processing of ambiguous words.

Additionally, cross-linguistic replication should be done to determine whether lexical ambiguity is resolved differently either across languages or within a language by bilinguals, whose cognitive system includes an additional level of complexity (the added representation of the second language). This would have implications for models of language processing as it would clarify whether similar mechanisms come into play for ambiguity resolution within and across languages. It is possible that bilingual participants would demonstrate differences that may be the result of generalized processing advantages of the bilingual cognitive system. Because bilinguals are constantly suppressing the “other language”, they can be thought of as expert suppressers, so they may be less affected by load.

These additional investigations may further assist in developing applied uses for this knowledge such as computer models for language comprehension, and improved technology for Google searches and online translators. The complexity of the human linguistic system is, in most cases, beyond our conscious awareness and so it is disappointing when a Google search results provide us with unrelated responses or when Babelfish inaccurately translates the text we input. It seems evident from these two examples that translation software and Internet search algorithms could still be greatly improved. The better we can understand how misunderstandings occur and how ambiguities are deciphered and resolved, the better these systems will be able to respond to human input. The restricted usefulness of these technologies at present limits communication and, tangentially, the evolution of human progress.

Concluding Remarks

A similar overall pattern was consistently found across all versions of the experiment, so it appears to be a real pattern. It appears that there is a secondary process requiring cognitive resources that comes into play to resolve word ambiguities. Perceptual focus did not affect ambiguity resolution, but additional cognitive load resulted in the inability to apply suppression for incongruent meanings. Although there is no clear evidence of suppression as defined by Gernsbacher's group (below-baseline activation in the incongruent condition), a consistent pattern emerges: there is a reduction in priming for incongruent compared to congruent, so it appears that the automatic activation is reduced by a suppression-like mechanism that also requires cognitive resources to apply. It also appears that whatever process is involved in ambiguity resolution does involve cognitive resources. Evidence for this came from the Load version as well as some trends and effects involving Aospan.

Previous studies have focused on the ambiguity resolution process in "normal" processing environments, with few giving any attention to alternate cognitive contexts. As such, the present work fills an important gap in the literature because it examines how cognitive contexts such as increased working memory load and perceptual focus affect the process of ambiguity resolution.

APPENDIX A TABLES

Table 1

Stimulus breakdown

	Condition	Judgment task (word pair)		Lexical decision
		Word 1	Word 2	
Critical Trials	Congruent	Homograph (e.g., spade)	Dominant (e.g., cards)	Dominant (e.g., ace)
		Homograph (e.g., spade)	Subordinate (e.g., shovel)	Dominant (e.g., ace)
	Incongruent	Homograph (e.g., spade)	Dominant (e.g., cards)	Subordinate (e.g., garden)
		Homograph (e.g., spade)	Subordinate (e.g., shovel)	Subordinate (e.g., garden)
	Control	Homograph (e.g., spade)	Dominant (e.g., cards)	Unrelated (e.g., blanket)
		Homograph (e.g., spade)	Subordinate (e.g., shovel)	Unrelated (e.g., blanket)
Fillers	Judgment fillers	Unrelated word (e.g., marina)	Unrelated word (e.g., perfume)	Unrelated word (e.g., leather)
	Lexical decision fillers	Unrelated word (e.g., identical)	Unrelated word (e.g., teen)	nonword (e.g., lale)

Table 2

Analysis of Covariance for Lexical Decision Reaction Time (ms)- Standard Experiment

Source	df	F	η_p^2	p
	Between subjects			
Aospan	1	0.30	.005	.586
Error	59			
	Within subjects			
Condition	2	9.62	.140	.000***
Condition x Aospan	2	0.72	.012	.489
Error	118			

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

Table 3

Means and SEMs for Lexical Decision Reaction Times (ms)- Standard Experiment

	Control	Congruent	Incongruent
Mean	757.23	676.85	712.49
SEM	22.27	16.75	20.60

Table 4

Analysis of Covariance for Lexical Decision Accuracy (% correct)- Standard Experiment

Source	df	F	η_p^2	p
	Between subjects			
Aospan	1	5.60	.087	.021*
Error	59			
	Within subjects			
Condition	1.75	3.69	.059	.034*
Condition x Aospan	1.75	0.69	.012	.486
Error	103.25			

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

Table 5

Means and SEMs for Lexical Decision Accuracy (% correct)- Standard Experiment

	Control	Congruent	Incongruent
Mean	95.32	98.52	96.24
SEM	0.79	0.34	0.48

Table 6

Analysis of Covariance for Lexical Decision Reaction Time (ms)- Focus Experiment

Source	df	F	η_p^2	p
		Between subjects		
Aospan	1	0.00	.000	.984
Error	121			
		Within subjects		
Condition	1.89	6.99	.055	.001**
Focus	1	1.61	.013	.207
Condition x Aospan	2	1.34	.011	.265
Focus x Aospan	1	0.38	.003	.541
Condition x Focus	2	1.02	.008	.363
Condition x Focus x Aospan	2	0.35	.003	.709
Error	242			

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

Table 7

Means and SEMs for Lexical Decision Reaction times (ms)- Focus Experiment

		Control	Congruent	Incongruent
Focused	Mean	742.92	683.57	704.41
	SEM	16.09	13.82	14.88
Unfocused	Mean	755.2	656.99	693.98
	SEM	17.08	13.45	14.35

Table 8

Analysis of Covariance for Lexical Decision Accuracy (% correct)- Focus Experiment

Source	df	F	η_p^2	p
		Between subjects		
Aospan	1	3.77	.030	.055
Error	121			
		Within subjects		
Condition	1.66	7.63	.059	.001**
Focus	1	0.14	.001	.710
Condition x Aospan	2	1.34	.011	.265
Focus x Aospan	1	0.12	.001	.727
Condition x Focus	1.91	0.03	.000	.968
Condition x Focus x Aospan	1.91	0.07	.001	.929
Error	242			

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

Table 9

Means and SEMs for Lexical Decision Accuracy (% correct)- Focus Experiment

		Control	Congruent	Incongruent
Focused	Mean	93.76	97.79	96.58
	SEM	1.04	0.41	0.90
Unfocused	Mean	94.45	97.30	96.24
	SEM	1.05	0.55	0.85

Table 10

Analysis of Covariance for Lexical Decision Reaction Time (ms)- Load Experiment

Source	df	F	η_p^2	p
Between subjects				
Aospan	1	1.13	.015	.291
Error	75			
Within subjects				
Condition	2	0.06	.001	.945
Load	1	0.15	.002	.704
Condition x Aospan	2	1.38	.018	.255
Load x Aospan	1	1.86	.024	.177
Condition x Load	1.88	1.95	.025	.149
Condition x Load x Aospan	2	4.05	.051	.019*
Error	150			

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

Table 11

Means and SEMs for Lexical Decision Reaction times (ms)- Load Experiment

		Control	Congruent	Incongruent
Load	Mean	917.07	794.71	833.09
	SEM	42.60	29.55	35.66
No Load	Mean	789.97	745.57	753.62
	SEM	25.06	21.79	21.50

Table 12

Analysis of Covariance for Lexical Decision Accuracy (% correct)- Load Experiment

Source	df	F	η_p^2	p
		Between subjects		
Aospan	1	0.71	.009	.402
Error	75			
		Within subjects		
Condition	2	1.29	.017	.277
Load	1	0.34	.004	.564
Condition x Aospan	2	0.78	.010	.461
Load x Aospan	1	0.00	.000	.961
Condition x Load	1.85	0.74	.010	.471
Condition x Load x Aospan	2	1.27	.017	.284
Error	150			

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

Table 13

Means and SEMs for Lexical Decision Accuracy (% correct)- Load Experiment

		Control	Congruent	Incongruent
Load	Mean	94.59	98.02	96.74
	SEM	1.73	0.73	1.27
No Load	Mean	93.71	96.34	96.16
	SEM	1.73	1.17	1.23

Table 14

A Comparison of Aospan Scores Across Versions

	Median	Mean	Quartile 1	Quartile 3	Minimum	Minimum
Standard	45	43.08	32	55	6	75
Focus	42	39.47	28	50.5	0	75
Load	42	40.43	28	51	0	75
Overall	42.5	40.59	28.75	52	0	75
Unsworth et al. (2005)	37.5	39.16	28	51	0	75

Table 15

A Comparison of Age Across Versions

	Mean	SEM	Minimum	Maximum
Standard	20.70	0.475	17	41
Focus	21.97	0.431	17	49
Load	21.67	0.472	17	46

APPENDIX B FIGURES

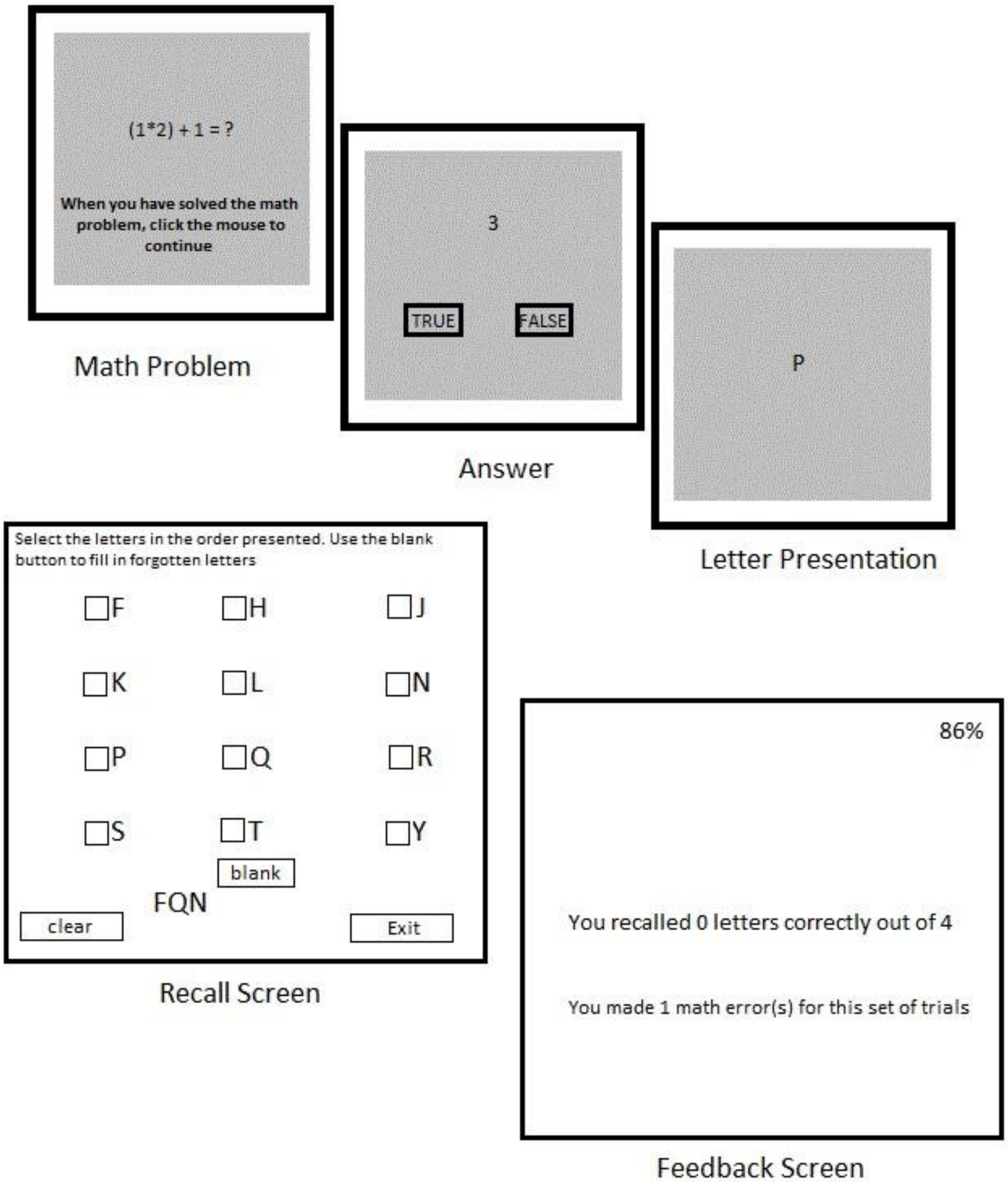

Figure 1. Aospan task. Adapted from Unsworth et al. (2005).

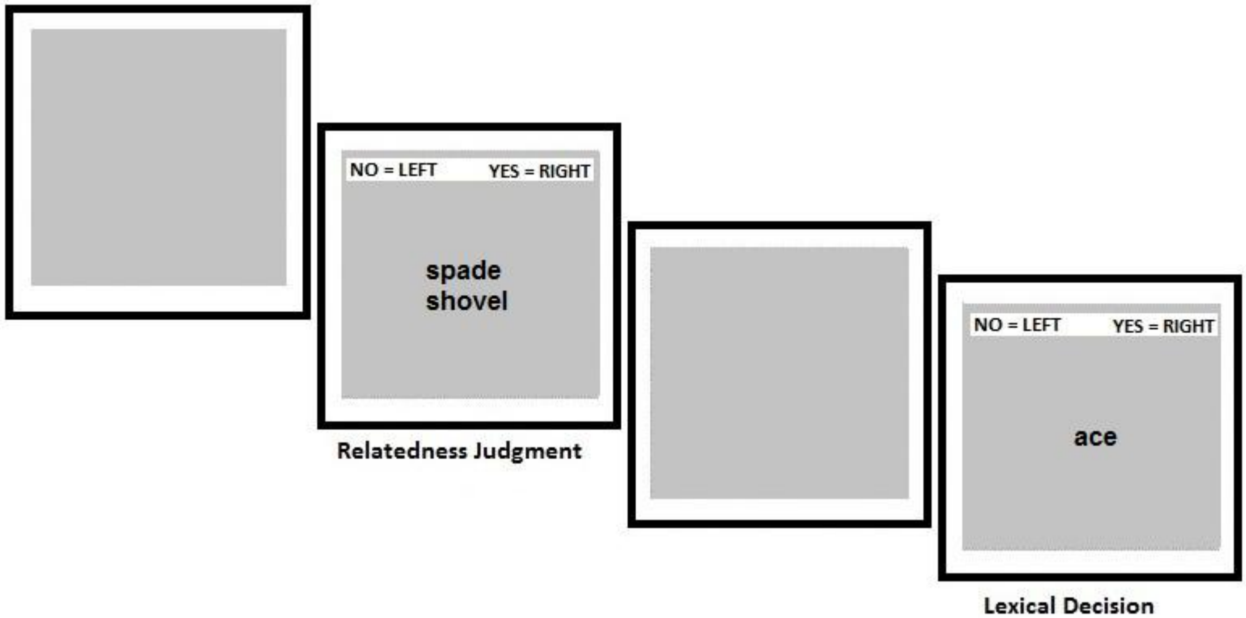

Figure 2. Standard display of experiment.

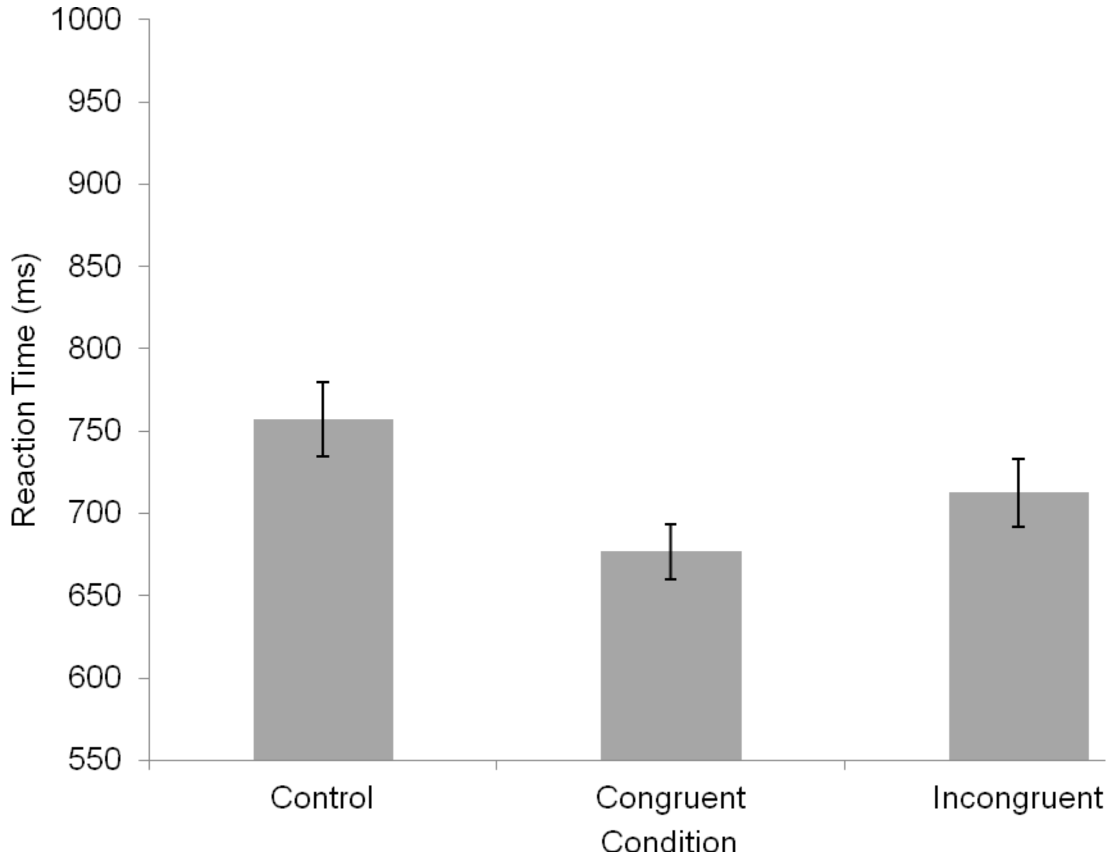

Figure 3. The effect of condition on lexical decision reaction times (ms). Error bars show SEMs.

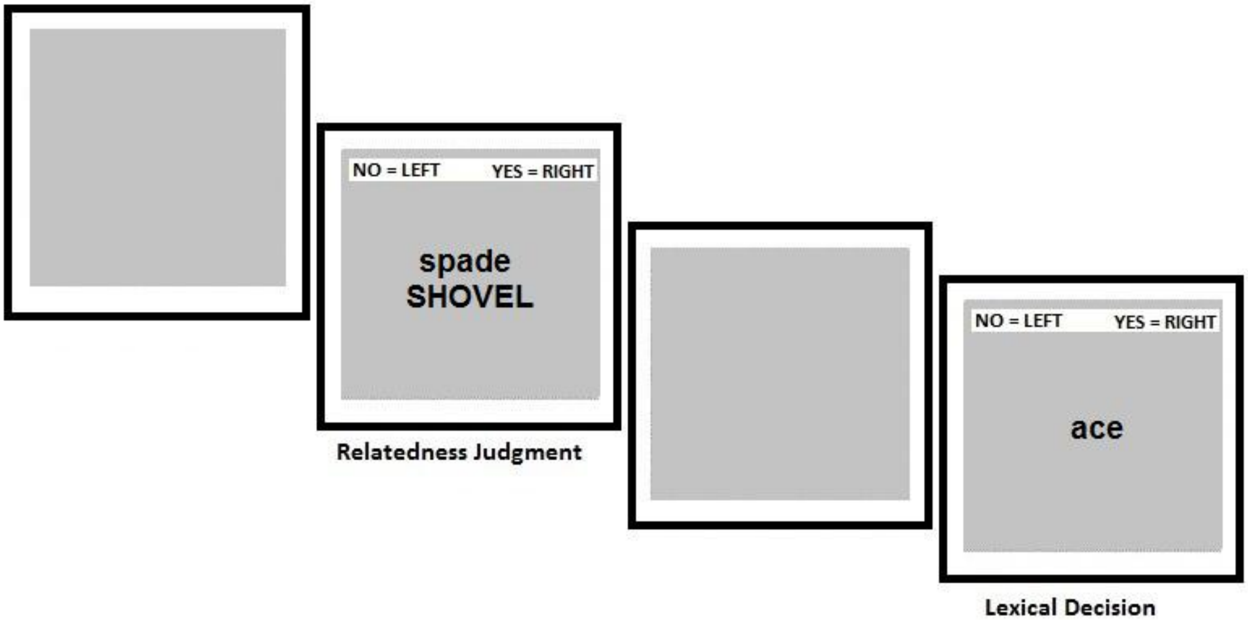

Figure 4. Focused display of experiment.

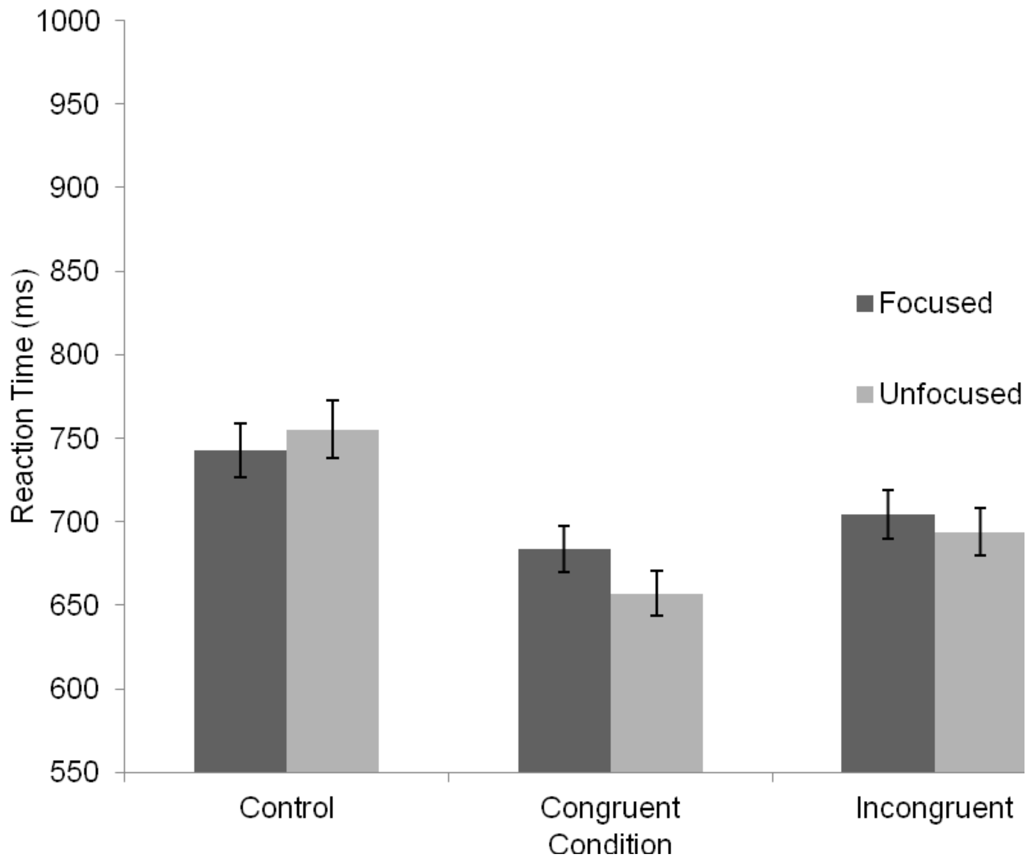

Figure 5. The effect of condition and focus on lexical decision reaction times (ms). Error bars show SEMs.

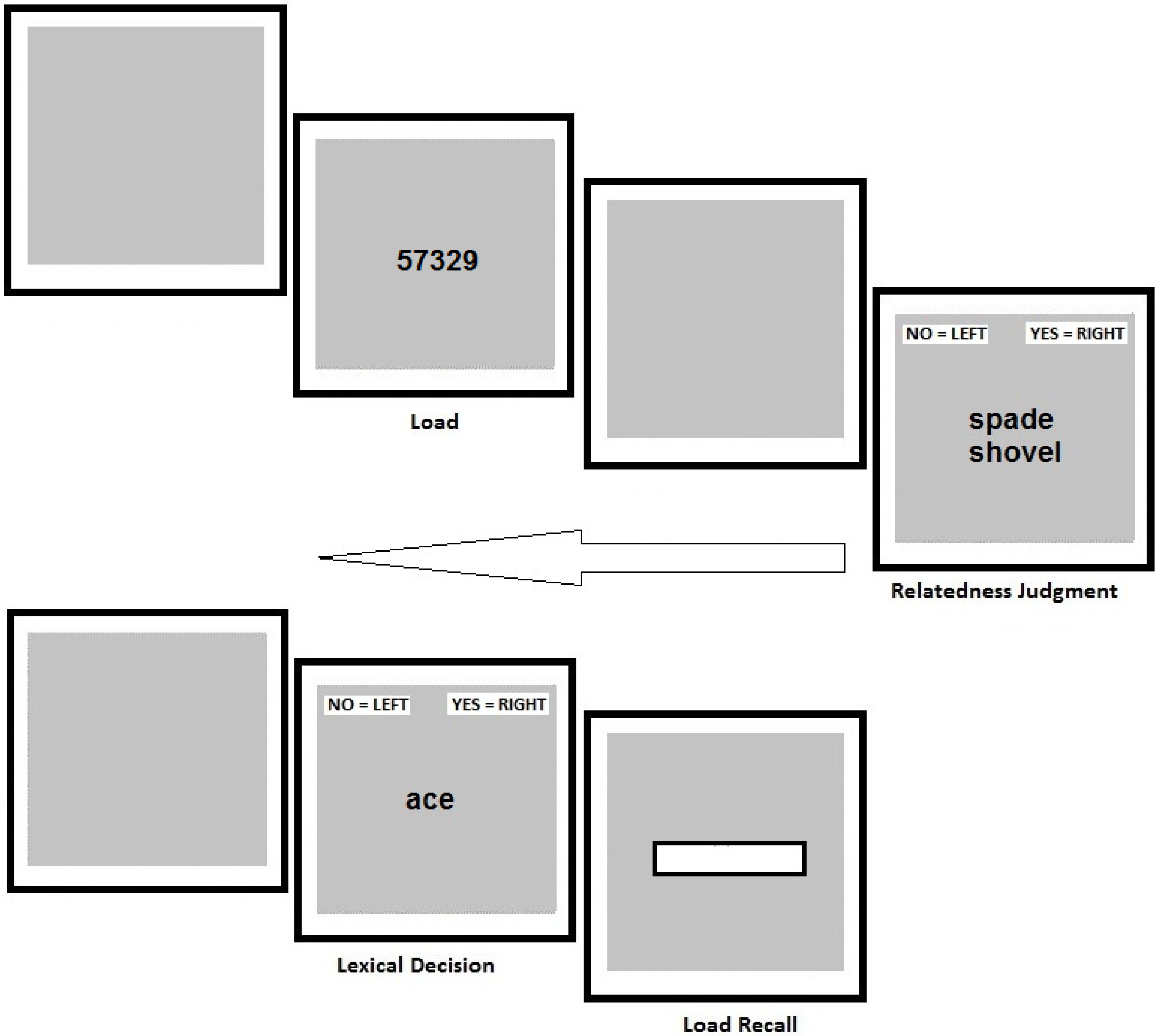

Figure 6. Memory load manipulation display of experiment.

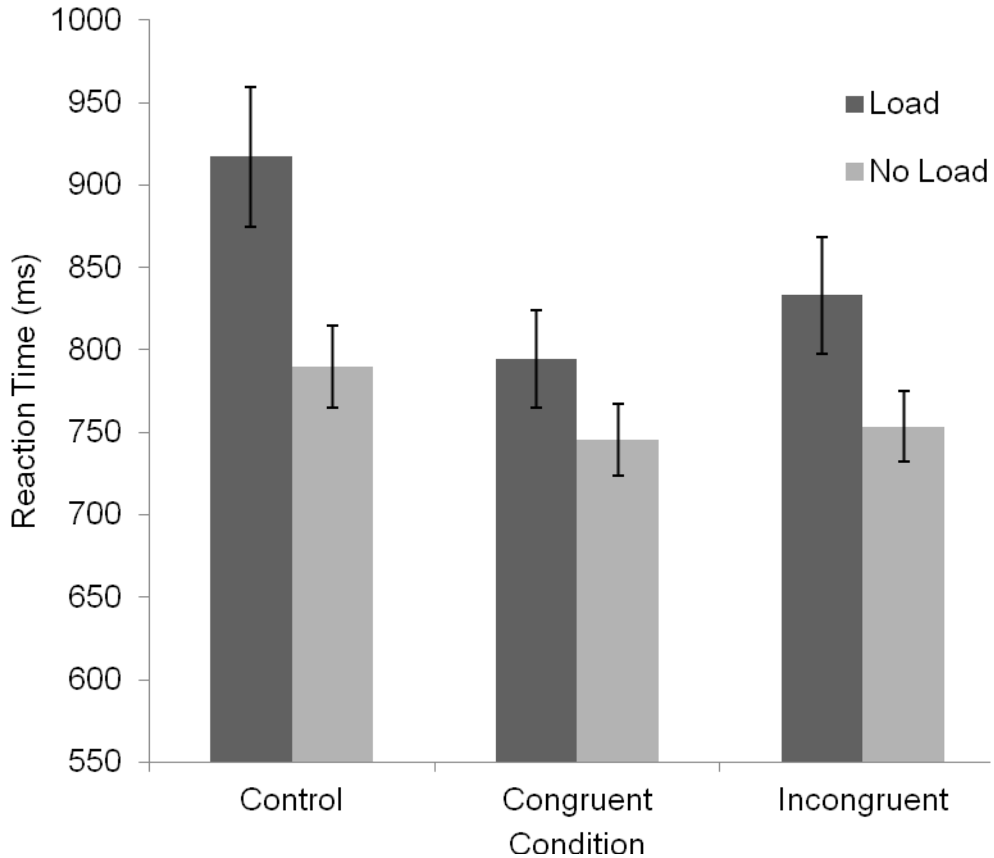

Figure 7. The effect of condition and load on lexical decision reaction times (ms). Error bars show SEMs.

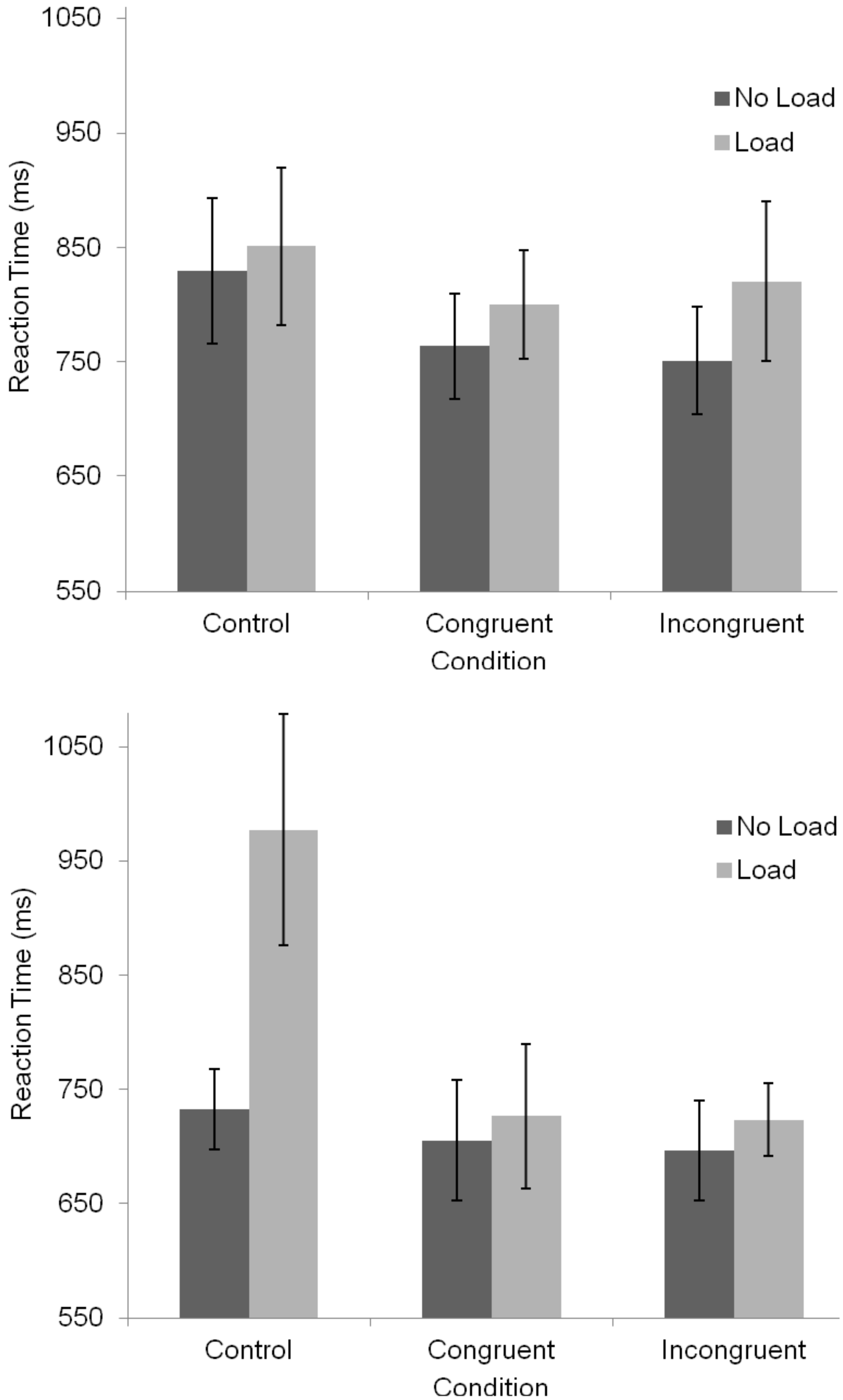

Figure 8. The interaction of condition and load on lexical decision reaction times (ms) for low-Aospan (top) and high-Aospan (bottom) groups.

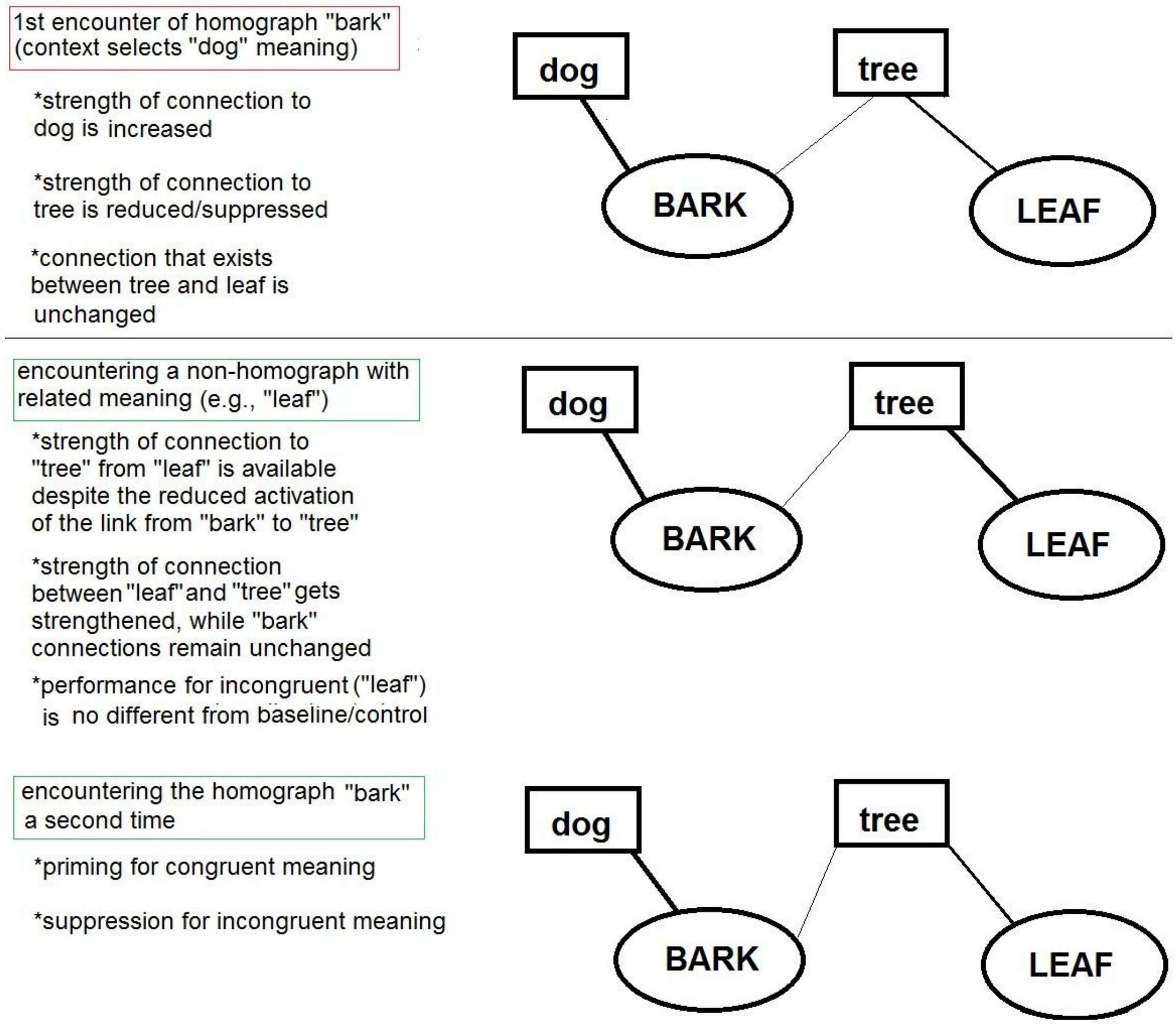

Figure 9. A possible conceptualization for the present results. Ellipses refer to words while boxes refer to concepts. Notice that there are multiple connections to “tree.”

APPENDIX C STIMULI (EXPERIMENTAL TRIALS)

Judgment Pair			Lexical Decision		
Homograph	**Meaning 1**	**Meaning 2**	**Meaning 1**	**Meaning 2**	**Control**
arms	hands	weapons	long	war	zebra
ball	base	dance	bounce	belle	sleep
bark	dog	tree	cat	stump	hour
battery	charger	abuse	power	assault	chubby
board	plank	certified	wood	directors	create
bulb	light	flower	lamp	tulip	strong
cable	television	wire	guy	cord	had
chest	pain	treasure	breast	trunk	prisoner
china	asian	cabinet	country	plates	cradle
coast	west	glide	sea	drift	bend
company	business	friends	corporation	visitors	about
count	numbers	dracula	math	royalty	bouquet
court	room	basketball	judge	volleyball	chevron
cricket	noisy	team	chirp	inning	reply
down	up	feather	low	pillow	kiss
ear	hear	corn	drum	food	come
fan	air	sports	cool	football	drawer
fence	picket	sword	gate	saber	poured
game	fun	bird	player	turkey	processed
grave	death	serious	cemetery	severe	whale
hard	soft	easy	rock	exam	beard
letter	mail	alphabet	opener	write	ashes
lobby	hotel	politics	entrance	government	alarm
lock	key	hair	door	bundle	finances
log	cabin	in	burn	out	import
miss	america	you	lady	sad	ask
mold	green	jello	fungus	clay	hold
mouse	trap	computer	cheese	pad	battle
novel	book	new	read	old	snake
organ	donor	piano	heart	church	vinyl
park	bench	car	swings	lot	more
patient	nurse	calm	hospital	wait	machine
pen	pencil	pig	ink	enclosure	village
pipe	line	smoke	plumbing	tobacco	love
pool	swim	table	summer	hall	beast
private	public	soldier	secret	army	rainbow
pupils	eye	student	dilate	teacher	branch

quack	duck	doctor	beak	fake	lunch
race	run	skin	fast	white	help
racket	tennis	noise	net	bang	knowledge
rare	unique	steak	unusual	meat	years
ring	wedding	phone	engagement	call	robin
ruler	measure	king	inch	dictator	boots
seal	animal	close	fins	envelope	expect
sentence	word	jail	period	penalty	spice
shed	tools	tear	barn	fur	teen
spade	cards	shovel	ace	garden	marina
staff	work	stick	employee	rod	danger
star	sky	actor	moon	movie	rubbing
temple	religion	head	pray	bone	hook
terminal	airport	illness	bus	end	surplus
toast	bread	champagne	butter	wine	toy
vault	money	jump	safe	pole	made
wave	ocean	hello	surf	bye	humor

APPENDIX D HIC APPROVAL FORMS

Stimuli norming:

WAYNE STATE UNIVERSITY

HUMAN INVESTIGATION COMMITTEE
101 East Alexandrine Building
Detroit, Michigan 48201
Phone: (313) 577-1628
FAX: (313) 993-7122
http://hic.wayne.edu

CONCURRENCE OF EXEMPTION

To: Lynne Kennette
Psychology
5057 Woodward Ave

From: Ellen Barton, Ph.D. S. Millis for / (ES)
Chairperson, Behavioral Institutional Review Board (B3)

Date: July 16, 2010

RE: HIC #: 0611810B3X
Protocol Title: Word Associations
Sponsor:
Protocol #: 1007008545

The above-referenced protocol has been reviewed and found to qualify for **Exemption** according to paragraph #2 of the Department of Health and Human Services Code of Federal Regulations [45 CFR 46.101(b)].

- Internet Information Sheet (dated 6/18/10)

This proposal has not been evaluated for scientific merit, except to weight the risk to the human subjects in relation to the potential benefits.

- Exempt protocols do not require annual review by the IRB.
- All changes or amendments to the above-referenced protocol require review and approval by the HIC **BEFORE** implementation.
- Adverse Reactions/Unexpected Events (AR/UE) must be submitted on the appropriate form within the timeframe specified in the HIC Policy (http://www.hic.wayne.edu/hicpol.html).

NOTE:

1. Forms should be downloaded from the HIC website at each use.
2. Submit a Closure Form to the HIC Office upon completion of the study.

Pilot:

WAYNE STATE UNIVERSITY

HUMAN INVESTIGATION COMMITTEE
87 East Canfield, Second Floor
Detroit, Michigan 48201
Phone: (313) 577-1628
FAX: (313) 993-7122
http://hic.wayne.edu

Association for the Accreditation of Human Research Protection Programs, Inc. Full AAHRPP Accreditation

NOTICE OF EXPEDITED APPROVAL

To: Lynne Kennette
Psychology
5057 Woodward Ave

From: Dr. Scott Millis S. Millis / ES
Chairperson, Behavioral Institutional Review Board (B3)

Date: April 29, 2011

RE: HIC #: 047911B3E
Protocol Title: Word Decisions
Funding Source:
Protocol #: 1104009674

Expiration Date: April 28, 2012

Risk Level / Category: Research not involving greater than minimal risk

The above-referenced protocol and items listed below (if applicable) were **APPROVED** following *Expedited Review* Category (#7)* by the Chairperson/designee *for* the Wayne State University Institutional Review Board (B3) for the period of 04/29/2011 through 04/28/2012. This approval does not replace any departmental or other approvals that may be required.

- Protocol Summary Form, received 4-26-11
- Internet Information Sheet, dated 5/18/11

- Federal regulations require that all research be reviewed at least annually. You *may* receive a *"Continuation Renewal Reminder"* approximately two months prior to the expiration date; however, it is the Principal Investigator's responsibility to obtain review and continued approval ***before*** the expiration date. Data collected during a period of lapsed approval is unapproved research and can ***never*** be reported or published as research data.
- All changes or amendments to the above-referenced protocol require review and approval by the HIC **BEFORE** implementation.
- Adverse Reactions/Unexpected Events (AR/UE) must be submitted on the appropriate form within the timeframe specified in the HIC Policy (http://www.hic.wayne.edu/hicpol.html).

NOTE:

1. Upon notification of an impending regulatory site visit, hold notification, and/or external audit the HIC office must be contacted immediately.
2. Forms should be downloaded from the HIC website at ***each*** use.

*Based on the Expedited Review List, revised November 1998

Final data collection:

WAYNE STATE UNIVERSITY

IRB Administration Office
87 East Canfield, Second Floor
Detroit, Michigan 48201
Phone: (313) 577-1628
FAX: (313) 993-7122
http://irb.wayne.edu

Full AAHRPP Accreditation

NOTICE OF EXPEDITED APPROVAL

To: Lynne Kennette
Psychology
5057 Woodward Ave

From: Dr. Scott Millis
Chairperson, Behavioral Institutional Review Board (B3)

Date: August 09, 2011

RE: IRB #: 078011B3E
Protocol Title: Word Decision Study
Funding Source:
Protocol #: 1108009995

Expiration Date: August 08, 2012

Risk Level / Category: Research not involving greater than minimal risk

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The above-referenced protocol and items listed below (if applicable) were **APPROVED** following *Expedited Review* Category (#7)* by the Chairperson/designee *for* the Wayne State University Institutional Review Board (B3) for the period of 08/09/2011 through 08/08/2012. This approval does not replace any departmental or other approvals that may be required.

- Revised Protocol Summary Form (received in the IRB Office 08/05/2011)
- Protocol (received in the IRB Office 07/21/2011)
- The request for a waiver of the requirement for written documentation of informed consent has been granted according to 45 CFR 46.117(1)(2). Justification for this request has been provided by the PI in the Protocol Summary Form. The waiver satisfies the following criteria: (i) The only record linking the participant and the research would be the consent document, (ii) the principal risk would be potential harm resulting from a breach of confidentiality, (iii) each participant will be asked whether he or she wants documentation linking the participant with the research, and the participant's wishes will govern, (iv) the consent process is appropriate, (v) when used requested by the participants consent documentation will be appropriate, (vi) the research is not subject to FDA regulations, and (vii)an information sheet directing the required and appropriate addition elements of consent disclosures will be provided to participants not requesting documentation of consent.
- Research Information Sheet (revision dated 08/05/2011)
- E-mail Recruitment Script
- Data collection tools: Stimuli (Words, Nonwords) and Ospan Memory Task

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- Federal regulations require that all research be reviewed at least annually. You *may* receive a *"Continuation Renewal Reminder"* approximately two months prior to the expiration date; however, it is the Principal Investigator's responsibility to obtain review and continued approval ***before*** the expiration date. Data collected during a period of lapsed approval is unapproved research and can never be reported or published as research data.
- All changes or amendments to the above-referenced protocol require review and approval by the IRB **BEFORE** implementation.
- Adverse Reactions/Unexpected Events (AR/UE) must be submitted on the appropriate form within the timeframe specified in the IRB Administration Office Policy (http://www.irb.wayne.edu//policies-human-research.php).

NOTE:

1. Upon notification of an impending regulatory site visit, hold notification, and/or external audit the IRB Administration Office must be contacted immediately.
2. Forms should be downloaded from the IRB website at each use.

*Based on the Expedited Review List, revised November 1998

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ABSTRACT

ON THE DISAMBIGUATION OF MEANING: THE EFFECTS OF PERCEPTUAL FOCUS AND COGNITIVE LOAD

by

LYNNE N. KENNETTE

August 2012

Advisor: Lee H. Wurm

Major: Psychology (Cognitive)

Degree: Doctor of Philosophy

Most research supports a non-selective (or exhaustive) account of activation whereby multiple meanings of a word are initially activated (as discussed in Degani & Tokowicz, 2009). But what happens to the non-selected meaning of an ambiguous word (e.g., bark) and how is the decision made to select one meaning over the other? A great deal of research by Gernsbacher and colleagues suggests that the non-selected meaning is "discarded" via active suppression, but a competing activation-only account is also proposed by Gorfein's research group. The present dissertation examines meaning-selection in ambiguous words using a word to elicit meaning context (rather than a sentence). Additionally, manipulations of perceptual focus (Experiment 2) and cognitive load (Experiment 3) were employed to examine these processes. Results support Gernsbacher's Structure-Building Framework (a suppression account) of meaning selection. An updated conceptualization of ambiguity resolution is proposed.

AUTOBIOGRAPHICAL STATEMENT

Lynne Kennette (née Daigle) was born in Windsor, Ontario, Canada. In 2005, she graduated with distinction from the University of Windsor, Windsor, Ontario, Canada with a double B.A. in Psychology (with thesis) and French Language and Literature. She received the Canadian Psychological Association's *Certificate for Academic Excellence* for her thesis entitled *Interlingual Homograph Recognition in French-English and English-French Bilinguals.* It was subsequently published in The New School Psychology Bulletin (2012) under the title *Interlingual Homograph Recognition by Bilinguals: A New Paradigm*.

She joined Wayne State University's doctoral program in 2005, and has worked under Dr. Lee H. Wurm. Her Master's thesis (2008) was published in the Mental Lexicon (2010) under the title of *Change Detection: The Effects of Linguistic Focus, Hierarchical Word Level and Proficiency*.

In 2008, she was awarded two distinctions for her outstanding teaching: the Psychology Department's *Laboratory Teaching Award*; and the Wayne State University *Garrett T. Heberlein Excellence in Teaching Award for Graduate Students (Laboratory Sections)*. In 2009, she was awarded the Psychology department's *Service Award* for her contributions to various departmental and university groups, including two terms as president of the Society for Integrative Experimental Psychology Research. In 2011, she was honored with a national teaching award, the *Wilbert J. McKeachie Teaching Excellence Award* from the American Psychological Association's Society for the Teaching of Psychology.

Her research interests include the basic processes involved in word recognition, bilingual word processing, and pedagogical instructional techniques.