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Memory for Non-Focal Words

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MEMORY FOR NON-FOCAL WORDS

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In two experiments a modified flanker paradigm was used to simultaneously present a focal word and an incidental non-focal word. The participants' task was to process the focal word in one of two conditions: naming aloud or a conceptual decision (concrete or abstract). The focal and non-focal words were either semantically related or not. Participants were instructed to direct their attention at the focal word. Furthermore, the presentation of the focal word was brief to reduce the possibility of eye movement to the non-focal word. Memory was measured with implicit and explicit memory tests. Evidence was found to suggest implicit memory traces were created for incidentally presented non-focal items, but explicit tests showed no sign of memory.

CHAPTER 1

Introduction

Memory is almost always measured for focal stimuli in a processing task. However, in exploring the environment or reading, for example, one rarely encounters a stimulus in isolation. The meaning of a focal stimulus may change if the surrounding, non-focal stimuli change (Schvaneveldt, Meyer, & Becker, 1976; Zeelenberg, Pecher, Shiffrin, & Raaijmakers, 2003). This change of meaning suggests that information from non-focal stimuli is processed along with focal stimuli. Moreover, demonstrations that non-focal stimuli influence the processing of focal stimuli based on a category relation between the two stimuli are often interpreted as simultaneous and automatic conceptual processing of the non-focal items (Eriksen & Eriksen, 1974; Gatti & Egeth, 1978). Even though non-focal stimuli are processed in service of the focal task, the question remains whether or not the conceptual processing of the non-focal stimuli leads to a "memory." Thus, the focus of the current study is to explore memory for non-focal stimuli as a result of conceptual processing of a focal stimulus.

Few studies have dealt with memory for non-focal stimuli in a direct way. Research has instead studied memory of non-focal stimuli from other indirect evidence such as interference or facilitation effects, inter-trial measures of repetition priming, negative priming, and semantic priming in the flanker paradigm (e.g., Duscherer & Holender, 2002; Fox, 1996; Lachter, Forster, & Ruthruff, 2004). In the flanker paradigm, a dichotomous category classification response is made for a target (i.e., focal word), and those responses are generally faster when a presented flanker (i.e., simultaneously presented, non-focal word) is from the same category as the target as opposed to when

the presented flanker is from the opposite category. The resulting phenomenon has come to be known as the *flanker compatibility effect.* Original flanker research used single letters as stimuli and produced fairly robust and consistent findings. Later research reported that semantic priming occurred for unattended words in the flanker position (Fuentes & Tudela, 1992; Gatti & Egeth, 1978). The compatibility effect was often interpreted as evidence that the flanker is automatically processed with the target in the classification decision task (Eriksen & Eriksen, 1974; Kahneman & Chajczyk, 1983; Mattler, 2005; Miller, 1988, 1991; Starreveld, Theeuwes, & Mortier, 2004; Ste-Marie & Jacoby, 1993; Wühr & Müsseler, 2005). Furthermore, these results challenged filter theories of attention and suggested that all stimuli encountered were automatically and simultaneously processed for semantic meaning regardless of selection for further processing (Eriksen & Eriksen, 1974; Gatti & Egeth, 1978; Miller, 1987).

Gatti and Egeth (1978) provided a demonstration of simultaneous processing of focal and non-focal stimuli. In this study the Stroop effect (Stroop, 1935) is combined with the flanker paradigm to determine if information from the non-focal position would influence the task to be performed with the stimulus in the focal position. In the Stroop paradigm, participants are presented the names of colors that are printed in colored ink and asked to say the color of the ink. The typical finding is that when the word and the color of the ink are the same (i.e., the word 'red' printed in red ink) participants experience little or no interference or difficulty in identifying the correct ink color. However, when the word and the ink are not the same (i.e., the word 'red' in green ink, for example) participants are more likely to say the printed word and not the color of the ink than when the two are the same. Furthermore, participants are significantly slower to

identify the correct color when the word and the ink are not the same. This finding is interpreted as evidence that both features of the stimulus (i.e., the meaning of the word and the identity of the ink color) are processed simultaneously. Gatti and Egeth showed participants a color patch in the focal position and a color word in black ink in the non-focal position. They reported that participants were slower to identify the correct color of the color patch when the non-focal word was incompatible and faster when it was compatible. The findings are interpreted as evidence that the entire visual display was processed for meaning and not just the focal color patch. The experiment in Gatti and Egeth is representative of the flanker literature that infers processing of the non-focal stimulus. That is, processing of non-focal stimuli is inferred because of the compatibility effect, not because of direct evidence of memory for this stimulus.

An example of direct evidence about memory for non-focal stimuli comes from Crabb and Dark (1999). They explored the extent that perceptual implicit memory requires attentional processing at encoding in order to create a memory trace. In their study, participants perceptually identified (i.e., said aloud) one of two off-center words that was randomly pre-cued. After 30 trials of two words each, participants completed word-stem completion and perceptual fluency tasks. Data from these tasks suggested an impairment in perceptual implicit memory performance for study words that were not identified. Crabb and Dark interpreted their results as demonstrating an attentional prerequisite to implicit memory. However, they did not explore the extent to which memory might persist for non-focal words that might have been perceptually identified. Their procedure was designed to assure that the focal word was overtly identified and that the non-focal word was not. This was done to make a strong argument that the non-focal

word had not been attended. In Crabb and Dark there was no decision to be made about the focal word; the participant merely had to say the focal word aloud. Crabb and Dark's task lacked the category classification task that is argued to recruit non-focal word information (Eriksen & Eriksen, 1974; Gatti & Egeth, 1978). In lacking this aspect, there was no need for the non-focal word to be relevant to the focal word task. Crabb and Dark's findings support the notion that a minimum of perceptual processing of a stimulus needs to occur before it can be encoded into memory. However, the results do not address the issue of memory for non-focal stimuli that have been processed in the context of a conceptually challenging focal task.

The results of Crabb and Dark coupled with criticisms of the flanker compatibility effect do, however, suggest two key considerations in evaluating memory for non-focal words. First, the central finding in Crabb and Dark was that there was no memory for words that had not been attended. Similarly, the major criticism of the flanker compatibility effect is that proper controls were not used to assure that an unattended stimulus was really not attended to by the participant (Lacther et al., 2004; Schmidt & Dark, 1998; Yantis & Johnston, 1990). For example, Schmidt and Dark indicated that research about flanker processing has relied on what they called the "intention equals attention" misconception and argued that merely instructing participants to not look at the flanker does not mean that flankers were ignored. They noted that stimuli in these experiments were often left in view of the participant until a response was made. This long presentation, it is argued, provided enough opportunity for participants to covertly perceive and attend to the flankers.

Lachter et al. (2004) suggested that all evidence of flanker processing is the result of failing to adequately control overt saccades or attention to the to-be-ignored stimulus. Attention to the to-be-ignored stimulus can be allocated either overtly or covertly. According to Lachter et al., it was this lack of control that allowed participants to identify flanking stimuli. Lacther et al. refer to three factors that may contribute to identification of the non-focal word. The first is a saccade to the non-focal word resulting in clear identification. The second and third factors are termed *leakage* and *slippage*. Leakage refers to a breakdown of attentional filters in theories such as Broadbent's (1958), which suggests that stimuli are selected for visual processing on the basis of perceptual information. Leakage occurs when the selectivity of the filter allows more than perceptual information about non-selected stimuli to pass further up the cognitive processing stream. Leakage could occur regardless of how tight the attentional focus is. Slippage refers more to the focus itself and occurs when attention is broadly applied to a group of stimuli. For example, broadening of the attentional focus could happen when multiple stimuli are initially perceived as one and regarded as a whole. Slippage may also happen when a non-focal stimulus captures attention away from the focal stimulus (Lacther et al., 2004).

These examples of the debate about processing of non-focal items illustrate a central difficulty in studying memory for non-focal items: the definition of "unattended." On one end of the debate, flanker effect research has defined a stimulus as unattended when it was not included in the instructions to attend and not required to complete a focal task. At the other end, attention research has defined a word as unattended when no aspect of cognitive processing is applied to it. In the current research, non-focal words

were considered as *less-attended* and focal words as *more-attended.* This decision was based on the notion that the focal word was the focus of a cognitive task in the presence of a potentially distracting stimulus (i.e., the non-focal word). It has been asserted that words within one degree of a focal word cannot be excluded from identification (Eriksen & Hoffman, 1973; Eriksen & St. James, 1986; Gatti & Egeth, 1978; Miller, 1991). However, in the presence of a demanding focal task, such as making a semantic decision, attention to a non-focal word is arguably less than that of the focal word.

Lachter et al.'s (2004) summary on the role of attention in cognitive processing suggests three strategies to allow enough attention to both the focal and non-focal words. In the first strategy, the duration of the stimulus display plays an important role. The duration of the exposure can limit how much attention is permitted to the outer regions of the visual view. Lachter et al. suggest that it takes ~100 ms to identify a word, ~50 ms to shift attention, and another 100 ms to read a second word. They also reported priming for off-center words when the visual display was 110 ms or 165 ms but not 55 ms. Lachter et al. suggested that this priming is due to a shift of attention that allowed the participant at least minimal perceptual identification of the non-focal word (i.e., slippage or leakage).

A second strategy to achieve the correct balance of processing on the non-focal word is to present it close enough to the focal word so that it can be viewed by the central part of the eye that is most sensitive to detail. Non-focal words within one degree of the focal word are more likely to be included in processing and identification (Eriksen & Hoffman, 1973; Eriksen & St. James, 1986; Gatti & Egeth, 1978; Miller, 1991). Lachter et al. (2004) reported that a non-focal word in close proximity to a focal word is likely to attract some attention.

Lastly, priming research uses backward masking as a means of disrupting iconic memory for briefly presented primes in order to methodologically control the duration of a presented word (Fuentes & Tudela, 1992; Lachter et al., 2004; Shaffer & LaBerge, 1979). Delayed masking of non-focal stimuli, in the current paradigm, will allow attention to iconic memory (e.g., Sperling, 1960). According to Lachter et al. (2004) 250 ms is enough time to shift attention to the afterimage and perceive the non-focal word. Delaying a 50 ms mask by 150 ms will allow slippage or leakage to the non-focal word but not focused attention. Full and natural visual processing of the non-focal stimulus should increase the chance that it will be encoded for memory. Note, again, that the purpose is not to inhibit attention but to control a central processing task over the focal word while allowing any excess attentional resources to spill over to the non-focal words without saccades.

The second key consideration in evaluating non-focal word memory was the need for a focal task that accomplished two things. First, a focal task (e.g., making a decision) was needed that sufficiently engaged the majority of cognitive resources. Ostensibly, any remaining resources could then be used to process non-focal word information that might provide clarification of the focal task. Second, in the context of a brief presentation the focal task requires the participant to maintain visual focus on the focal word long enough to complete the task. This decreased the likelihood that participants shifted focus to the non-focal word.

The central goal of the second key consideration in the current study was to manipulate the conceptual processing of the focal task and semantic relation between the focal and non-focal words. It may be that memory for the non-focal word is a function of

its relevance to complete a focal task and to the level of conceptual processing involved in completing this task. Crabb and Dark (1999), for example, were not concerned with non-focal word processing under conditions in which the two words presented were related or when the task was conceptually challenging. Thus, their findings should not be considered the final word about memory for non-focal words. Two studies have demonstrated the importance of the semantic relation between words and the conceptual nature of the focal processing task. Whittlesea and Jacoby (1990) and Hughes and Whittlesea (2003) found that when a processing task was more conceptually challenging and when the stimuli were semantically similar (i.e., relevant), that recent or nearby stimuli were used to aid completion of the focal processing task. First, Whittlesea and Jacoby demonstrated the importance of semantic association between word pairs in repetition priming. In their study, two words were serially and briefly presented. Immediately after the presentation of the second word the first word was presented again (e.g., GREEN-PLANT-GREEN). Participants had to say aloud the repeated first word as quickly as possible. Afterwards, they were asked to verify the identity of the second word. The word pairs (e.g., GREEN – PLANT) were either semantically related or unrelated. (Whittlesea and Jacoby's convention of calling semantically related words as relevant and non-semantically related words as non-relevant will be followed throughout the rest of this paper.) Also, the second word was presented either in all upper case or in mixed case letters (perceptually degraded). Repetition priming effects of the first word were increased when a relevant, perceptually degraded word appeared between the first word and its repetition (e.g., GREEN-pLaNt-GREEN). According to Whittlesea and Jacoby, semantic information from the first word is recruited to help make sense of the

degraded stimulus. If the to-be-recruited word is relevant in guiding the ongoing search to find the identity of the degraded word, a repetition priming effect is found. Furthermore, Whittlesea and Jacoby contended that priming occurred in their study as a function of two factors. First, the perceptual ambiguity of mixed case letters serves as an indication that a more extensive search for the identity of the word is needed. Second, the initiation of this search includes making use of other resources in the environment that may be relevant in clarification of the word's identity. In this study, the resources needed to clarify the second word identity are provided by recent experience with a relevant word. The cognitive system recruits the meaning of the first word to narrow the search for the identity of the second. It is by this process of providing meaning to a problem that the prime is created.

The second demonstration of semantic effects on priming is Hughes and Whittlesea (2003). They reported long-term semantic priming for relevant words when the focal task was conceptually challenging as opposed to simple perceptual processing. They modified the typical inter-trial measure of priming to demonstrate that semantic priming can occur, on average, at a lag of up to 90 trials (twenty minutes). In the prime phase of Experiment 1B, participants were presented a word (prime) flanked by category labels (e.g., ANIMAL – LION – VITAMIN). In the probe phase, participants saw primed and unprimed words in a similar configuration. The flanking category labels were the same but the middle word (probe) was changed (e.g., ANIMAL – TIGER – VITAMIN). The participant indicated which flanking word was the correct category for the new middle word. Hughes and Whittlesea reported that participants were faster when the probe had been primed than when it was not. They contrast this finding with that of their

Experiment 1A. In this experiment, the prime phase presented only one word that participants named aloud. The probe phase of Experiment 1A, in which lexical decisions were made (i.e., determine if the item is a valid English word) for words that were semantically related to the words in the prime phase, did not result in any differences between primed and unprimed words. The authors argued that long-term semantic priming occurs when the "tasks require more extensive semantic processing" (p. 403). This long-term semantic priming constitutes memory because information is retained without any rehearsal over the span of several minutes. That is, memory research typically considers a stimulus as encoded into long-term memory when a maintenance strategy is no longer required to retain the information (e.g. Anderson, 1984; Atkinson & Schiffrin, 1968). This is important because a simple task like naming a word aloud might not create a situation in which the non-focal word is recruited to aid in the focal task and is thus only superficially processed (cf. Whittlesea and Jacoby, 1990). If the non-focal word is only superficially processed, it does not seem likely that a memory trace would be created for it.

However, the focal word may influence the level of information that is processed from the non-focal word if it is recruited to help classify the focal word. Consider the difference between two processing tasks. A simple task, like naming a word aloud, does not require in-depth semantic information to accomplish the task and relies more on data-driven processing. Elaborate semantic knowledge of the word is not necessary to accomplish a word naming task. For example, one may vocalize the word *car* without pondering its meaning. It may even be recognized on the basis of perceptual fluency (Jacoby & Dallas, 1981; Johnston, Dark, & Jacoby, 1985). On the other hand,

determining if a word is concrete or abstract does require inspection of the semantic detail and can be considered more conceptually driven. One must access more semantic information about what a car is to decide if it is concrete or abstract. The meaning of the non-focal word may be accessed in order to clarify what classification is appropriate for a focal word. This more elaborate semantic access of the non-focal word should, in turn, lead to better memory for non-focal words when focal word processing is more conceptual (e.g., Craik & Tulving, 1975; Jacoby & Dallas, 1981).

It has been noted that achieving a compatibility effect requires that the non-focal word be relevant to the focal task. Whittlesea and Jacoby (1990) demonstrated that words semantically related to the focal word are more relevant in completing the focal task. In the current study, non-focal words were considered relevant when they are semantically related to the focal word. One caveat of including semantically related stimuli is a potential increase in responding to non-focal words in a memory test due to recognizing the conceptual similarity to the focal word. For example, if at test a participant sees the word "beach" that was presented as a non-focal word to the focal word "ocean" during the study portion of the experiment, it is possible that "beach" may be mistakenly "remembered" simply because of its semantic association with "ocean." In order to tease out item-specific information for non-focal words from general concept information, lures were used at test to measure the degree to which semantic association with the focal word influenced inaccurate memory performance for non-focal words.

Controlling attention and manipulating stimulus relevance and the focal processing task (i.e., naming aloud or concrete/abstract decision) allows an exploration of a possible interaction between non-focal word memory performance and the focal

processing task. Using the flanker task as a method of study presentation should allow partial attention to the non-focal words. The critical aspect of attention allocation in the current procedure will be to create a primary and central processing task that must be accomplished within a period of time that is too short to allow any saccades to the non-focal words but long enough to allow slippage or leakage of attention. This characteristic should allow participants to allocate some portion of attention to the non-focal word while accomplishing the focal processing task. The result is a divided attention paradigm in which the majority of attention is allocated to the focal word. The remaining attention (i.e., the attention resources that are not required to accomplish the focal task) is, ostensibly, allocated to processing the non-focal word. According to the findings reported by Crabb and Dark (1999), implicit tests of memory should be sensitive to non-focal words that receive enough attention to be perceptually identified. All conditions in the current project employ this divided attention strategy. Once words have been presented to participants in this manner, memory for the non-focal words may be directly measured through administration of implicit and explicit memory tests.

In the current study, two experiments were conducted to examine implicit and explicit memory for non-focal words. Implicit memory is thought to rely on automatic and perceptual processing without intent to retrieve an item. Explicit memory requires purposive, conceptual processing and the intent to retrieve an item from memory (Roediger, Weldon, & Challis, 1989; Schacter, 1987). Because the word stimuli in the current study were presented and studied in a variety of perceptual and conceptual levels, memory was measured with tests that are differentially sensitive to implicit and explicit memory.

In summary, by adjusting the parameters of the flanker paradigm it was expected that memory for non-focal words would depend on two factors. These factors were the relevance between focal and non-focal word and the level of conceptual processing required to complete the focal task. The focal task was either a low-level of conceptual elaboration (i.e., naming aloud) or a high-level of conceptual elaboration (i.e., concrete/abstract decision). These manipulations allowed exploration of the central question posited in this paper: whether or not any memory for the non-focal words can be established. The experiments were designed to allow some attention to be allocated to the non-focal words during the focal processing task. It was expected that the controls in the experiments would allow minimal amount of attention and would result in evidence of memory for non-focal words. Given the findings that conceptual information may be included in perceptual processing (cf. Whittlesea & Jacoby, 1990), a dissociation between explicit and implicit memory for non-focal words was expected. That is, the severe restriction of attention to the non-focal word would reduce conceptual processing that typically leads to explicit memory. The dissociation was expected, however, to be a function of focal/non-focal word relevance and the level of the focal processing task. Planned comparisons were used determine to what extent non-focal word relevance and the conceptual level of the focal processing task would lead to improved implicit and explicit memory performance for non-focal words.

CHAPTER 2

Experiment 1

This experiment was designed to investigate two things. The first goal was to determine if an implicit memory trace would be created for non-focal words. Secondly, Experiment 1 explored whether or not implicit memory for non-focal stimuli would be influenced by manipulations of stimulus relevance and the focal processing task. This would provide additional information about the parameters that contribute to implicit memory for non-focal words. Theories about memory typically associate perceptual information with implicit memory and conceptual information with explicit memory (Roediger et al., 1989; Schacter, 1987). However, given the findings of Whittlesea and Jacoby (1990) and Hughes and Whittlesea (2003), it may be that an implicit memory is dependent on how meaningful the stimulus is to the current cognitive task.

In this experiment, naming latencies for perceptually degraded words were used to measure implicit memory. Previous research suggests that perceptually degraded words that have been studied will be named faster than perceptually degraded words that have not been studied (e.g., Stone, Ladd, & Gabrieli, 2000). The main analyses were performed on non-focal and lure words in each relevance condition (i.e., semantically associated or non-associated) and in each focal processing condition (i.e., naming aloud or making a conceptual decision). It was anticipated that naming latencies for non-focal words would be faster than lures as a function of the relevance and the focal processing task. Furthermore, it was expected that the size of this effect would be largest when the non-focal word was relevant to a high-level conceptual focal processing task.

Method

Participants. There were 39 students from a southeastern university's participant pool that participated for partial fulfillment of course requirements. All participants were randomly assigned to the different conceptual processing conditions. There were 19 participants in the naming aloud condition and 20 in the concrete/abstract decision condition. All reported having normal or corrected-to-normal vision. Data collection was on an individual basis in a normally lit room.

Materials and Apparatus. A total of 208 words from the Kučera and Francis (1967) word norms from the range of 30 to 90 per million were used as stimuli. From these words, two sets of 26 triads were formed to create word stimuli that were either related or non-related. Both sets of triads consisted of a focal, a non-focal, and a lure word. In one set of triads, all three words were conceptually related (e.g., ROYAL – KING – QUEEN). In the other set of triads, the non-focal words and lure words were conceptually related to each other but not to the focal word (e.g., JOINT – BEACH – OCEAN). The remaining 52 words served as un-related "new" words in the test phase.

Perceptually degraded stimuli were created to measure implicit memory. Degraded stimuli were created by producing randomized patterns that obscure portions of test words. Three different randomized patterns were made and all of the test words were randomly assigned to one of these patterns to create the final perceptually degraded stimuli.

The stimulus presentation was controlled by E-Prime commercial software (Psychology Software Tools (PST), 2002). The stimulus display was on a standard CRT monitor with a resolution of 1024 by 786 pixels in Courier New 12-point font. All letters

were displayed in upper case in light gray on a black background. The focal word appeared just below the middle of the screen. The non-focal words appeared slightly above the middle of the screen. The viewing distance from the monitor was stabilized by requiring participants to place their chin in a chin rest. This resulted in a constant viewing distance of approximately 46 cm. At this distance, the height and width of each letter subtended approximately .44 degrees of visual field. The vertical distance between the focal word and the non-focal word was approximately .56 degrees of visual angle. This resulted in placing the non-focal word in a position to allow for maximal visual exposure during the initial fixation on the focal word.

Procedure. The experiment consisted of two phases: a study phase and a test phase. No mention of the memory test was made prior to the study phase. In the study phase, participants were instructed to focus their attention on the task requiring them to respond to the focal word. Care was taken not to give instructions specifically regarding the non-focal word. That is, all instructions were given in terms of the focal word. This was done in order not to give the participant any idea that interest was truly in the non-focal word. In the low-level conceptual condition, participants were asked to say the focal word aloud and in the high-level conceptual condition, participants were asked to determine if the word presented was concrete or abstract. Participants responded via a PST response box in a binary format (i.e., concrete or abstract) with their dominant hand. However, participants were instructed to respond as quickly and accurately as possible to the focal word. Responses to both tasks were recorded so that accuracy of test task could be evaluated. The participants were able to move at their own pace between trials (i.e., re-orient themselves to the instructions).

Each trial commenced with a "Ready" screen and the participant initiated the remainder of the trial on this screen by pressing a button to advance to the next trial with the non-dominant hand. Next, a fixation point was provided to assist the participant in directing attention to the location of the focal word. The fixation point was a less-than sign followed by a greater-than sign (<>) and lasted for 500 ms. The focal word and the non-focal word were displayed for 165 ms. After a 150 ms blank screen, a 50 ms visual mask was presented that consisted of three rows of X's. Finally, a blank screen remained until the participant made a response.

There was a practice session of twenty trials to acclimate participants to the task. The first half of the practice was done without the non-focal words. When the experimental trials started, participants were informed to continue doing exactly as they did in the practice and were encouraged to make sure that they performed the processing task on the focal word.

The test phase was a memory test and followed completion of the presentation study trials with only enough time intervening to read the test instructions. Implicit memory was tested for all participants by measuring naming latencies for perceptually degraded words. Participants had control over the duration between each trial (again, to re-orient or blink their eyes). Also, they were instructed to respond as quickly and accurately as possible. Latencies were recorded with a PST voice key. The naming latency was recorded from the time the stimulus was displayed until the participant vocalized a response. Responses were recorded for an accuracy check. Participants were instructed against making extraneous sounds and inadvertently tripping the voice sensitive key.

Results and Discussion

Analysis was done only for naming latencies in which the participant correctly identified the perceptually degraded word. A total of seven percent of the trials across the conditions were lost. A manipulation check was also performed to be certain that participants understood and followed instructions given in the experiment. After the test phase participants responded to three questions (see Appendix A) about how much they paid attention to non-focal words. A single awareness score was calculated for each participant that was an average of the three questions. The minimum criterion score was set at 3 on a 7-point scale. A higher score indicates that a person was not trying to pay attention to the non-focal words. The mean individual score ($M = 6.30$, $SE_m = .12$) was significantly higher than the criterion score meaning that participants were not aware of or paying attention to the non-focal word, $t(34) = 27.32$, $SE_d = .12$.

The alpha level was set at .05 for all analyses. All naming latency data in this experiment were analyzed using the mean naming latency to identify perceptually degraded versions of non-focal and lure words in each condition. Two analyses were performed: a critical analysis and a comparison analysis. The critical analysis was done for non-focal and lure words. The comparison analysis was on the focal and new words. The means for each condition are shown in Table 1.

Critical analysis. The overall analysis was done with a 2 (processing type: naming aloud or concrete/abstract decision) x 2 (relevance: semantically associated or non-associated focal/non-focal pairs) x 2 (item type: non-focal or lure word) mixed-factor ANOVA on the naming latencies and did not reveal a significant three-way interaction, $F(1, 37) < 1$. However, one statistically significant two-way interaction was found in the

Table 1
Mean Reaction Time (ms) and Standard Errors for Item Type as a Function of Stimulus Relevance and Focal Task

		Item Type							
		Non-Focal		Lure		Focal		New	
Focal Task	Stimulus Relevance	Mean	SE	Mean	SE	Mean	SE	Mean	SE
								1592	105
Naming	Related	1822	164	1589	159	1704	151		
	Not-Related	1206	108	1523	128	941	66		
Conceptual decision	Related	1402	160	1275	155	1458	147		
	Not-Related	1079	106	1397	124	1036	64		

analysis. Relevance between the focal and non-focal word interacted with item type, $F(1, 37) = 47.78$, $MS_e = 32{,}219.96$. Planned comparisons for non-focal words between relevance conditions revealed that naming latencies for relevant non-focal words (M = 1,612, $SE_m = 115$) were slower than non-relevant non-focal words (M = 1,142, $SE_m = 76$, $t(38) = 4.09$, $SE_d = 114$). However, planned comparisons on naming latencies for relevant lures (= 1,432, $SE_m = 111$) were not significantly faster than non-relevant lures (M = 1,460, $SE_m = 89$, $t < 1$). If participants' responses were based on confusing test words with similar study words, responses to non-focal and lure words would have been similar. The difference in naming latencies for non-focal words, but not lures, suggests that specific item information (e.g., perceptual features or concepts, etc.) was acquired for the non-focal words.

Comparison analysis. While not the focus of theoretical concern, naming latency means of focal and new words will provide a benchmark against which to compare and

contrast performance for non-focal and lure words. The means are included in Table 1 for convenient comparison to non-focal and lure words. Naming latencies for focal words followed a similar pattern as non-focal words. That is, naming latencies focal words in non-relevant condition (M = 988, SE_m = 46) were significantly faster than focal words in the relevant condition (M = 1581, SEm = 106, $t(38)$ = 7.54, SE_d = 78). Naming latencies for new words (M = 1592, SE_m = 105) most resembled lures that were relevant in the naming task (M = 1589, SE_m = 159).

Performance during the study session was also evaluated for evidence of the flanker effect. That is, naming latencies and decision times in the focal task may have been influenced by the non-focal word as a function of relevance and the focal task. The flanker effect was analyzed with a 2 (processing type) x 2 (relatedness) mixed-design ANOVA on reaction times to complete the focal task. The two-way interaction was not significant, $F(1,37) <1$. The between-subjects effects of processing type (i.e., naming aloud or conceptual decision) were significant, $F(1,37)$ = 58.23, MS_e = 64,114.50. However, this was to be expected because of the difference between the focal tasks. It is not surprising that participants who named the focal word (M = 319, SE_m = 41.08) were faster than those make a conceptual decision (M = 757, SE_m = 40.04). Failure to replicate the flanker compatibility effect with words suggested that the non-focal words may not have been processed along side focal words. However, this is clearly not the case because of the evidence of differential implicit memory performance for non-focal words in the relevant and non-relevant conditions.

Experiment 2

Explicit memory was tested by an old-new recognition test. It was anticipated that overall memory performance for non-focal words in a recognition test would be low. However, differential performance for non-focal words on a recognition test as a function of relevance and processing would indicate that non-focal stimuli were subjected to processing similar to that used for focal stimuli. If this is the case, recognition performance should be best when the non-focal word is relevant to a conceptually-processed focal word (cf. Whittlesea & Jacoby, 1990) and worst when the non-focal word is not relevant and the focal word is only named aloud. Poor non-focal word memory performance, despite relevance and processing manipulations, would indicate that processing non-focal stimuli does not yield the level of conceptual processing required for explicit memory. Recognition of lures was expected to be low and not to change as function of relevance and the focal task. Again, differing recognition performance for lures would indicate that participants confused lure words with focal words and were responding on the basis of category recognition and not item-specific information.

Method

Participants. There were 36 students from a southeaster university's participant pool that participated for partial fulfillment of course requirements. All participants were randomly assigned to the different conceptual processing conditions. There were 17 participants in the naming aloud condition and 19 in the concrete/abstract decision condition. All reported having normal or corrected-to-normal vision. Data collection was on an individual basis in a normally lit room.

Materials, procedure, and apparatus. The apparatus, study materials, and procedure to present words in the study phase in Experiment 2 were identical to those used in Experiment 1. During the testing phase, however, two major differences existed between the two experiments. First, an old-new recognition test was used to evaluate memory. Second, test phase responses were collected in binary format via a PST /response box.

Results and Discussion

A manipulation check was performed in Experiment 2 that was identical to the one in Experiment 1. In Experiment 2 the mean individual score ($M = 6.12$, $SE_m = .16$) was significantly higher than the criterion score meaning that participants were not aware or paying attention to the non-focal word, $t(34) = 19.67$, $SE_d = .16$. Also, two analyses were performed: a critical analysis for non-focal and lure words and a comparison analysis on the focal and new words.

Critical analysis. Means and standard errors of the proportions of correct responses for non-focal words and false alarms for lures are displayed in Table 2. The overall analysis was done with a 2 (processing type: naming aloud or concrete/abstract decision) x 2 (relevance: semantically associated or non-associated focal/non-focal pairs) x 2 (item type: non-focal or lure word) mixed-factor ANOVA on the proportion of "old" responses to both non-focal words and lures. The analysis did not reveal a three-way interaction, $F(1, 29) < 1$. A significant two-way interaction, however, did occur between item type and relevance, $F(1, 29) = 6.36$, $MS_e = .005$. Recognition for relevant non-focal words ($M = .21$, $SE_m = .02$) was not significantly different than non-relevant non-focal words ($M = .19$, $SE_m = .19$, $t(31) = 1.49$, $SE_d = .02$). False alarms for relevant lures were

Table 2
Mean Proportion Correct and False Alarms and Standard Errors for item as a Function of Stimulus Relevance and Focal Task

		Item Type							
		Non-Focal		Lure		Focal		New	
Focal Task	Stimulus Relevance	Mean	SE	Mean	SE	Mean	SE	Mean	SE
								.82	.02
Naming	Related	.22	.03	.29	.04	.61	.04		
	Not-Related	.21	.03	.24	.03	.62	.04		
Conceptual decision	Related	.22	.03	.18	.03	.76	.03		
	Not-Related	.28	.03	.15	.03	.66	.04		

(M = .26, SE_m = .03) were significantly higher than false alarms for non-relevant lures (M = .18, SE_m = .02, $t(33)$ = 4.19, SE_d = .02). The overall low rate of recognition for non-focal words suggested information incidental to a focal task is not available to the cognitive system when measured by explicit memory test of recognition. The higher rates of recognition for lure words than non-focal words suggested that some categorical information about the stimuli had been acquired. However, this extra information seemed to make some less familiar words (i.e., lures) confusable with old words at test.

Comparison analysis. In this experiment the proportion of correct responses to focal and new words will provide a benchmark against which to compare and contrast performance for non-focal and lure words. Explicit memory performance for focal words did not follow a similar pattern as non-focal words in this experiment. Correct responses for focal words in non-relevant condition (M = .63, SE_m = .03) were not significantly different than focal words in the relevant condition (M = .67, SEm = .03, $t(35)$ = 1.82, SE_d

= .02). Correct responses for new words (M = .82, SE_m = .02) did not resemble any other group of means.

The study session of Experiment 2 was also evaluated for evidence of the flanker compatibility effect with an analysis identical to the one in Experiment 1. The two-way interaction was not significant, $F(1,37) < 1$. The between-subjects effects were significant, $F(1,37) = 32.23$. Again, this was to be expected because naming a word (M = 325, SE_m = 50.38) is typically faster than making a conceptual decision about a word (M = 719, SE_m = 47.66).

CHAPTER 3

General Discussion

The overall hypothesis that an implicit memory trace may be formed for less-attended, non-focal words presented simultaneously with a focal word task was supported. Moreover, it was found that the relevance (i.e., semantic association) influenced the nature of that memory trace. There was little evidence of an explicit memory trace for non-focal words. The finding that identification accuracy at test in Experiment 1 was better when the conceptual level of the test matches that of the study session provides confirming evidence for transfer-appropriate processing account of implicit and explicit memory. Importantly, however, the manipulation of conceptual processing at study had little, if any, influence on subsequent memory for non-focal words on implicit and explicit tests.

The high rate of recognition for focal words suggested that participants were indeed allocating a fair amount of their attentional resources to the focal processing task. Along with the low rate of recognition for non-focal words, recognition errors for lure words, and the high scores on the awareness measures, it can be reasonably concluded that the non-focal word was considered by the participants as extraneous to the current task and that little attention was paid to it.

The shorter naming latencies for non-relevant focal and non-focal words demonstrated that implicit memory can be formed for items that are not the center of a focal task. Furthermore, semantic association plays a role in how less-attended items are processed. Although the predictions were not entirely accurate, the data in the current study suggested that the semantic relatedness between the words influenced which words

were remembered. Items matched for relevance resulted in performance very differently than those not matched for relevance. Non-focal words that were non-relevant were recognized faster on the implicit test than the relevant non-focal words. The fact that non-relevant focal and non-focal words elicited faster naming latencies than all lure and new words suggests a savings (i.e., priming) in having been exposed to those words. What is unclear is why non-relevant focal and non-focal words resulted in priming while relevant focal and non-focal words did not.

The current design, however, does not provide enough information to determine exactly why this is the case because it is not possible to tell if no memory trace was created for relevant focal and non-focal words. It is possible that naming latencies to relevant stimuli were indeed speeded but that both the focal word, non-focal word, and the semantic category were all primed together. Mulligan and colleagues (1997; Mulligan, 2002; Mulligan, Guyer, & Beland, 1999) found that divided attention reduced implicit memory performance when the implicit memory contained more categorical (i.e., conceptual) information. Moreover, they found that explicit memory performance was consistently poor for these same items. The findings in the current study are consistent with the findings that Mulligan reported. That is, implicit memory was differentially affected by attentional and conceptual manipulations with consistent poor recognition performance for non-focal words on explicit tests of memory. If this were the case, response competition may have cancelled out any savings gained from recent exposure to these stimuli. It may be that the creation of a memory trace for semantic category information (i.e., the relation between relevant words) supercedes those memory traces for perceptual information. Future research should seek to determine if to what degree the

current paradigm results in conceptual priming similar to that found in Mulligan's study and if conceptual priming can result in slowing naming latencies on a perceptually degraded test of implicit memory.

It appears that these conclusions are at odds with the explanation given by Whittlesea and Jacoby (1990). They found evidence for priming of the repeated word (e.g., GREEN – pLaNt – GREEN) only when the words were related and the middle word was perceptually degraded. It may be that the perceptual activation of the prime word was increased enough when it was recruited to still be present at the word's repetition. In the current study, any perceptual gain in the matched condition during the test phase is lost by the reactivation of the concept. If the semantically related but visually dissimilar percepts activate a similar concept other percepts may be in turn activated. At this point, a decision must be made about which item matches the perceptually degraded stimulus at test. Sohn, Anderson, Reder, & Goode (2004) describe an effect, called *fanning,* that may account for the slower response times as a result of this discussion making process. The typical finding in fanning experiments is that participants are slower to respond to items that have some relation. This relation is created through studying simple factual sentences (e.g., *The lawyer is in the park, The doctor is in the store, The lawyer is in the store*). When participants were later asked to confirm the veracity of a sentence they were slower when the subject and the object occurred more often. That is, the sentence *The lawyer is in the store* would be verified more slowly than the other two sentences because *lawyer* and *store* occur more often than *doctor* and *park.* These findings are consistent with the notion of *spreading activation.* The core idea in spreading activation is that conceptual stimuli (e.g., words) activate semantic meaning in a network.

After a concept, like *lawyer*, for example, is activated its meaning spreads towards other meanings that have also been recently activated, like *store*. The participant verifies the veracity of a statement once the spreading activation of various meanings converge. According to Anderson (1983), the amount of potential spreading activation is capacity limited; it takes longer for activation of concepts to spread along the semantic network when they occurred more often in the study session. Thus when more items are activated together the amount of spreading allocated to each item is reduced and slowed. This results in slower response latencies to highly associated items. In the current experiments it may be possible that the pre-existing semantic relation between focal and non-focal words may have slowed responding because participants were waiting the activation of the related concepts to converge. Because non-related words did not result in concept activation, there is no "waiting" for the activation to spread and converge and non-related words are more rapidly identified. The key difference in the current experiments is that response latencies to non-focal words were different than response latencies to lure words. Future research should seek to clarify how priming multiple exemplars simultaneously may result in response competition in implicit tests while not providing any benefit to performance on an explicit test.

Two other findings in the current study are especially notable. First, an incidental finding in this study supported transfer-appropriate processing accounts of implicit and explicit memory. This theory is based on the notion that memory performance is better when the type of processing that is required at test is similar to that used at study. That is, if one studies information perceptually, for example, memory performance will be better if the test is perceptual than when it is conceptual and vice versa (Morris, Bransford, &

Franks, 1977; Roediger & Blaxton, 1987). Because the current study employs one focal task that is more perceptual and one that is more conceptual, it maybe that memory performance was dependent upon the match between the way the word stimuli were studied and the way in which they were tested. In performing the accuracy check on the naming task in the study phase an anomaly was found. In Experiment 1, the accuracy in identifying the perceptually degraded word was significantly less at test when the study session was the conceptually based concrete/abstract decision than when it was the more perceptual task of naming the word aloud. Interestingly, a trend was noted for naming latencies to be slower when the study task was conceptual. While this study was not designed to explore this, it incidentally provides evidence in favor of transfer-appropriate processing.

Secondly, implicit memory for non-focal words in the non-relevant condition suggests that perceptual identification might not include full articulation of a word. Crabb and Dark (1999) reported that no implicit memory was found for words that had not been articulated. Although Crabb and Dark's paradigm and the current study are not similar enough for direct comparison (e.g., the word pairs in Crabb & Dark were more separated than the current study and did not require a task at study) the findings of the current study suggest that perceptual identification may happen in the absence of articulation. In the current design two words were simultaneously presented for 165 ms. According to Lachter et al. (2004) it takes about 250 ms to read a word and look the next word and read it. In the current paradigm it was virtually impossible to complete the focal task *and* articulate the non-focal word. Thus, it appears that perceptual identification can without articulation. Crabb and Dark encouraged participants to move their eyes twice in each

trial to identify both words. The longest trial duration was 300ms. By Lachter et al.'s calculations, it would take at least 500ms to properly identify both words. Furthermore, perceptual information is not likely to be obtained while the eye is moving (Lachter et al., 2004). In 300ms one would have enough time to see one word and the blurred remains of the other. Thus, the findings of the current study suggest that an implicit memory trace can be created before an item is fully articulated.

Evidence that incidental and simultaneously presented words may create an implicit memory trace is important because it provides insight into how our environment is perceived outside the focus of our attention (i.e., the less-attended region). The distinction between memory traces that are explicit and implicit is important because it appears that the information acquired from the less-attended region is mostly perceptual and not detailed semantic or conceptual in nature. However, the possibility remains that some general conceptual information may be acquired from items that are non-focal. Also, it is important to consider the similarity between the kind of task that is required at study and at test when exploring to what degree non-focal information is remembered.

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APPENDIX A

Awareness Measure

	Not able						Very able
How able were you to ignore the distractor?	1	2	3	4	5	6	7
	Tried a lot						Did not try
Did you try to read the distractors?	1	2	3	4	5	6	7
	Always						Never
How often did you pay attention to the distractor?	1	2	3	4	5	6	7