THE EFFECTS OF VISUAL AND AUDITORY NOISE ON AUTOBIOGRAPHICAL MEMORIES

By

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To my parents

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LIST OF ABBREVIATIONS

AIM	Affect infusion model
AM	Autobiographical memories
ANOVA	Analysis of variance

Abstract of Dissertation Presented to the Graduate School
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The present study examined the relationship between working memory and autobiographical memory. Participants were presented with either auditory or visual noise concurrently with an autobiographical memory retrieval task. The auditory and visual noise were intended to specifically interfere with the ability to utilize the phonological loop and visuospatial sketchpad components of working memory, respectively. In Experiment 1, the visual or auditory noise began 3 sec before the presentation of an autobiographical memory cue word. Participants were asked to recall memories in response to the cue words, and then talk about the memory while being recorded. They then rated various phenomenological characteristics of the recalled event (e.g., imagery, auditory experience, linguistic relatedness, uniqueness, typicality, etc.). Results showed that visual and auditory noise led to faster, rather than slower, retrieval of autobiographical memories. Auditory noise also decreased the auditory and verbal qualities of the recalled memories compared to control group. There were no other effects of noise conditions on the phenomenological characteristics of autobiographical memories. In a second experiment, presentation of visual or auditory noise following retrieval of memories during a five-second period of memory maintenance similarly had little effect on subsequent ratings of those memories. Results were discussed in the context of the robustness of autobiographical

memory retrieval, and of autobiographical memory characteristics and their relationship to working memory components. It is suggested that the additional auditory or visual stimulation may serve to prime, rather than interfere with, retrieval of autobiographical memory.

CHAPTER 1
INTRODUCTION

Aim of the Study

Research has shown that the structure and organization of autobiographical memories can be affected by many factors, including but not limited to emotion (Schaefer & Philippot, 2005), depression (Kuyken & Brewin, 1995), post-traumatic stress disorder (Harvey, Bryant, & Dang, 1998), and cognitive load (Williams et al., 2006). The aim of this research was to examine the effect of certain kinds of cognitive load, namely the presence of concurrent "loads" on visual and auditory components of working memory, on the retrieval and evaluation of autobiographical episodes from long-term memory.

Autobiographical Memories

Autobiographical memory can be defined simply as an individual's memory for his/her own personal history (Conway, 1996; Conway & Pleydell-Pearce, 2000). There are different classifications of memory, such as episodic, semantic, declarative, procedural, implicit, and explicit memories. However, it is not easy to classify autobiographical memory as one type of memory in these terms. It seems awkward and somewhat misleading to try to divide autobiographical memories into such subcategories, as they appear to include both "spatiotemporal" (episodic) and "factual" (semantic) knowledge (Conway, 1996). Hence, autobiographical memories can be understood to include both episodic and semantic memories.

Autobiographical memories are not complete records of events; encoded memories are reconstructed each time at recall. These reconstructed memories include both "sensory-perceptual" and "decontextualized" information. Sensory perceptual knowledge makes the subjective reliving of the event possible, whereas decontextualized knowledge gives some basic information about the event (Conway, 1996; Haque & Conway, 2001).

Organization of Autobiographical Memories

Autobiographical memories are proposed to have a unique organization. Conway (1996; Conway & Pleydell-Pearce, 2000) suggested that the autobiographical “knowledge base” has three hierarchically organized levels: lifetime periods, general events, and event-specific knowledge.

Lifetime periods are long-lasting periods, usually in years, which have specific beginnings and endings. Aims, plans, and themes of the self in those time periods are encoded in this layer. Lifetime periods also include knowledge about significant others, locations, actions, and activities specific to those time periods. Therefore, information encoded in lifetime periods includes both thematic and temporal knowledge about that specific period (Conway, 1996; Conway & Pleydell-Pearce, 2000).

General events are more precise than lifetime periods, and include information for extended and repeated events that have occurred over weeks and months. General events are more heterogeneous than lifetime periods, and there are typically numerous thematically-related events at this level. General events also include information by which knowledge and details of specific events and episodes can be accessed (Conway, 1996; Conway & Pleydell-Pearce, 2000).

Event-specific knowledge includes sensory-perceptual information (e.g., images, sensations, smells, thoughts) about the specific memory. Therefore, it is related to the vividness and specificity of autobiographical memory (Conway, 1996; Conway & Pleydell-Pearce, 2000).

Bluck and Habermas (2000) proposed an additional level for autobiographical knowledge base, that of a *life story* schema. According to this view, a life story schema is the highest level of autobiographical knowledge base, which integrates and includes contextual information for the personal history of the self in relation to past events and developments. The life story schema can be assumed to have connections to different lifetime period events, and it can give access to specific lifetime period events. With the help of this schema a person becomes able to form a life story that "…is structured, coherent, evaluative, and based on actual events and transitions" (p.128). According to Bluck and Habermas, life stories are important themes in life which might include the successes, turning points, events towards achieving a goal, and etc.

Conway (1996; Conway & Pleydell-Pearce, 2000) modified and elaborated his model of autobiographical memory in response to an extensive program of empirical research by him and his colleagues. In one such study, Anderson and Conway (1993) examined the structure of autobiographical memories in a series of experiments. The participants were told to retrieve memories as quickly as possible either from a period of the past ten years, or from a period more than ten years before. As soon as the participant retrieved a memory he/she was told to list the details of the memory either in 10 seconds or in 30 seconds. Then he/she was instructed to list the details of the memory in one of five conditions: in free recall, in forward temporal order, in reverse temporal order, in terms of centrality (i.e., the detail that is most central to the memory), and in terms of personal significance. Results of their first three experiments showed that subjects listed more details in free recall and forward temporal conditions than in the other conditions. Details in the free recall conditions were more personal than the other conditions. In experiments 4 and 5, it was found that the distinctive cues gave faster access to autobiographical memories than did less distinctive or thematically relevant cues. These findings suggested that both temporal organization and personal significance are important elements in the organization of autobiographical memories.

In a similar study, Haque and Conway (2001) asked participants to retrieve autobiographical memories in response to cues. At some point after cue presentation, they were told to report "what was in their minds" at that time. The results showed that in the early stages of retrieval (2 sec after cue presentation) participants reported more abstract knowledge, whereas in later stages they reported general (5 sec) and specific knowledge (30 sec) about the memory in response to the cue word. Of all the lifetime period memories, 70% of them came from the 2 sec group, whereas 41% of the all general memories came from the 5 sec group. Specific memories, on the other hand were prominent in the 30 sec group. The results were in line with the model proposed by Conway (1996; Conway & Pleydell-Pearce, 2000). That is, the organization of memories is hierarchical, and more important for the present study, memories were activated in temporal order from general to more specific knowledge about the remembered event.

Access as well as structure, then, in Conway's model of autobiographical memory is hierarchical in nature; it is assumed that information in upper levels is used to access information in lower levels. In this sense, the flow of information is commonly from upper, less specific levels to lower, more specific levels.

Even though this unique organization is observed in many studies of autobiographical memory retrieval (e.g. Haque and Conway, 2001), it can be modulated by factors such as the emotionality of the memory, and the emotional mood and cognitive capacity of the rememberer (Harvey, Bryant, & Dang, 1998; Kuyken & Brewin, 1995; Schaefer & Philippot, 2005; Williams et al., 2006). The role of affect on autobiographical memory was the focus of the Affect Infusion Model, which will be discussed below.

Affect Infusion Model

The Affect Infusion Model (or AIM) was the first proposed to explain in detail the relationship between mood and memory (Forgas, 1995). However, it may also serve as a useful framework for thinking about the organization of autobiographical memories more generally. It suggested that the relationship between mood and memory is moderated by the characteristics of the individual (e.g., affective state, cognitive capacity, motivation level, personality characteristics, personal relevance of the task), of the situation (e.g., demand effects, cognitive load, expectations), and of the available information e.g., (complexity, familiarity, typicality).

Depending on the "settings" of these three characteristics, people may employ different processing strategies. AIM describes four processing strategies that are increasingly more likely to engender mood and emotion effects in memory. These are termed direct access, motivated processing, heuristic processing, and substantive processing (Forgas, 1995). According to the model, deeper or more elaborative processing as such does not always lead to manipulation effects. It is the combination of personal, contextual, and task characteristics that will make the effects of manipulation on memory more or less likely, and determine the particular direction of these effects.

Direct access is the simplest strategy; it is based on the strongly cued recall of the stored cognitive contents that are "crystallized" in memory. It is closed to affect infusion. It is more likely to be used when the task is familiar, when there is little or no personal involvement, and when no other motivational, cognitive, affective, or situational forces require elaborate processing (Bower & Forgas, 2000).

Motivated processing is guided by a strong, preexisting objective. Hence, little constructive processing takes place, and this in turn limits the probability of affect infusion. Motivated processing is used when a specific outcome is desired and a specific directional goal dominates and guides the information search. Mood maintenance or mood regulation can be examples of motivated processing (Bower & Forgas, 2000). In mood regulation, a current negative mood does not get integrated with the process that is going on at that time. As soon as someone realizes his/her negative mood, he/she tries to eliminate it by some kind of mood regulation strategies, such as intentional recall of pleasant memories. Even though one could argue that in this case the current mood is still responsible for these actions, the result is an absence (or reversal) of the expected congruence or mood-dependence effects.

Heuristic processing occurs when neither direct access nor motivated processing can be used, because the task lacks either personal involvement or sufficient processing resources. This situation is highly susceptible to affect infusion. It is adopted for a relatively simple or typical task with low personal relevance, no specific motivational objectives, limited cognitive capacity, and no demand for accuracy or substantive processing. Environmental context variables and current mood could easily affect information processing in this case (Bower & Forgas, 2000).

Substantive processing is the most constructive strategy, and has the greatest vulnerability to affect infusion. It is used when the other three relatively simple processes cannot be employed. It is more likely to be employed when a task is complex, atypical, and personally relevant, when subjects have adequate processing capacity, but lack a specific motivational goal (Forgas, 1999).

Forgas (1994, 1995) and Bower and Forgas (2000) describe a wide range of studies which provide supportive evidence for AIM in different social domains (e.g., perception and interpretation of interactive behaviors, attributions for success and failure, relationship judgment). For example, Forgas and Moylan (1991) wanted to test one implication of this model, which suggested that the longer and more extensively someone tries to make a judgment, the more he/she will be open to affect infusion. They argued that atypical, unusual, or complex targets would lead to longer and more substantive encoding strategies. In their experiment, Forgas and Moylan studied the effects of happy, neutral, or sad moods on people's perception of other races. Participants were presented Asian (heterostereotype) or Caucasian (autostereotype) characters who were part of a same-race or a mixed-race dyad. The mixed-race dyads were hypothesized to require more detailed and substantive inferential processing than same-race dyad. Mood congruence effects for both positive and negative mood were found, which were significantly larger when participants were presented a mixed dyad, as predicted by AIM.

Autobiographical Memory Retrieval

Reviewing a number of studies of the time needed to access autobiographical memories (see above), Conway (1996) concluded that the retrieval of autobiographical memory in general takes more time than the retrieval of other knowledge from memory. Therefore, Conway (1996) suggested that retrieval of autobiographical memories is more of a constructive and an effortful process, in contrast to a veridical one-to-one reproduction of events stored in memory. Corresponding to the structural model of his autobiographical memory, Conway's dynamic retrieval model is similarly very explicit and detailed. However, this aspect of his model has not received a great deal of empirical attention.

According to Conway (1996), autobiographical memory retrieval takes place in sequential steps. First, a cue is analyzed and a memory description, which can be in the form of fragmented images, is created. Then this information is used to access the autobiographical memory knowledge base. Finally, information in the activated level (general events or lifetime event periods) used to gain access to the sublevels. Retrieval stops when a specific autobiographical memory is retrieved. This kind of model is sometimes called a constraint-satisfaction model, in which a decision made at the end of each step, and this decision process is constrained by some factors. Applied to autobiographical memory, the model proposes that each retrieval process is constrained by task demands and personal characteristics (Conway, 1996; Anderson & Conway, 1993).

According to Conway (1996), during retrieval of an autobiographical memory, activation from one level travels to the other levels. However, this process is not automatic as in the case of spreading activation; it is effortful and takes time. According to the model, information retrieved at the end of each step is temporarily held in working memory, which therefore may concurrently contain knowledge from different levels of autobiographical knowledge base (Anderson & Conway, 1993).

In a recent study, Williams, Chan, and Crane (2006) tested the hierarchical structure of autobiographical memory retrieval by manipulating the search process. They argued that increasing the working memory load by a secondary task when simultaneously searching for an autobiographical memory would lead to general event memories instead of specific memories. Participants were asked to recall autobiographical memories in response to high- and low-imageable cue words while they were doing a random button pressing as the secondary task. Williams et al. expected high imageable cues to lead to specific memories because they are more likely to bring to mind visual images that will be effective cues for specific memories. This in turn would help them to maintain a good performance in a secondary working memory task compared to low imageable cues. There were also two different retrieval modes; specific and generic.

Comparing performance without a secondary task to one with the random number pressing, Williams et al. found that for low imageable cues (which they suggested would lead to generative retrieval), random-number pressing (a task designed to place attentional demands on a person while minimizing sensory-motor demands, see below) caused memories to be less specific. In another experiment, they tested the effect of specific or generic retrieval of autobiographical memories on a secondary task. Participants were first asked to retrieve specific or generic autobiographical memories, then they were given a means-end problem solving task. Williams et al. assumed since more working memory capacity is needed for the specific autobiographical memory retrieval, this will impede the following problem solving task. Results showed that specific memory retrieval did indeed decrease problem solving performance, as measured by the number of means and effectiveness.

The (re)construction of autobiographical memory from the retrieved information is suggested to be moderated by central or executive control processes. Conway and Pleydell-Pearce (2000) proposed the *working self* as a control process that tries to minimize the discrepancies between the current situation and the active goals of the self. The working self compares the present situation with the current goals of the self and produces an output. According to this output different kinds of information processing takes place in mind. Hence, it is clear that active goals of the self can limit or give access to autobiographical knowledge base by setting boundaries in searching, elaborating, and evaluation phases of retrieval process. As a result, the content and structure of autobiographical memories can change according to the current goals of the self. Moreover, in this system the relationship between autobiographical memories and goals of the self is reciprocal; that is, autobiographical memories can determine the goals of the self as well as goals of the self can affect the content and structure of the autobiographical memories. For example, remembering his success in analytical problem solving, someone might acquire the goal of studying marketing in graduate school. Likewise, someone who has the current goal of studying marketing can fail to remember those cases where she was not successful solving analytical problems.

Conway and Pleydell-Pearce (2000) also differentiated two types of specific autobiographical memory retrieval: generative retrieval and direct retrieval. Direct retrieval occurs when a specific memory cue gives rapid and effortless access to event specific knowledge. For example, given “vacation” as a cue word, someone might immediately remember the horrible plane trip with all the details about the trip like the annoying person sitting next to her, bad food, etc. Generative retrieval occurs when a cue is elaborated and used to access an autobiographical memory through working self. These two types of autobiographical memory retrieval exploit different processing strategies. Direct retrieval appears equivalent to the direct access strategy of AIM, and it is suggested to be closed to any manipulation (Forgas, 1995). Generative retrieval, on the other hand, would result in any of the other three strategies (Motivated, heuristic, and substantive), and depending on the personality, contextual, and memory characteristics these strategies would be open to manipulation. Thus, memories retrieved by direct access could be argued to differ from the ones retrieved by generative retrieval in some dimensions, at least, including the organization, structure and/or phenomenological characteristics of these memories.

Cognitive Load

One attribute of individuals whose effect on autobiographical memories has recently been explored experimentally is that of cognitive capacity. Williams et al. (2007) studied the effect of executive control on the relationship between autobiographical memory specificity and depression. Williams et al. (2007) demonstrated, as have others, that depression is characterized by a reduced specificity in autobiographical memories. In a series of experiments using different kinds of executive control tasks (e.g. verbal fluency, design fluency, alternate uses, Porteus maze test, number generation) with non-clinically depressed participants, they showed that autobiographical memory specificity is significantly and negatively correlated with errors on executive control tasks, even after partialling out depression scores (the correlation coefficient changed from -.40 to -.51). These results showed that autobiographical memory specificity is modulated by executive control capacity independent of depression.

Others have taken the approach of manipulating the situation, and varying the cognitive load of the task, to explore the relationship between executive control and specificity of autobiographical memory. Williams et al.'s study, discussed previously, reflects this kind of an approach. They found that increasing working memory load by a secondary task when simultaneously searching for an autobiographical memory lead to general event memories instead of specific memories.

Baddeley (Baddeley & Hitch, 1974; Baddeley, 2000) perceived working memory as "…a limited capacity system allowing the temporary storage and manipulation of information necessary for such complex tasks as comprehension, learning and reasoning" (p.418). Baddeley further claimed working memory is a complex information-processing system composed of four major parts: the central executive, the phonological loop, the visuospatial sketchpad, and (a recent addition) the episodic buffer. The central executive is an attentional control system responsible for coordinating the "slave" systems, which serve to store and maintain sensori-motor representations. The phonological loop maintains verbal and acoustic information by a transitory store and an articulatory rehearsal system. The visuospatial sketchpad stores visual, spatial and kinaesthetic aspects of visuospatial information. The episodic buffer, a recent addition to the multistore model, is a storage space that integrates phonological, visual, spatial, and verbal information into a unitary episodic representation.

Many tasks have been devised to measure the capacity of each of these components of working memory. The procedures used by the previous studies aimed to assess the central executive function of working memory. However, the complex nature of autobiographical memories makes it interesting and useful to explore which specific components of the working memory are more involved in retrieval of autobiographical memories. An overall effect of executive attentional load on memory, as demonstrated by the Williams et al. findings, is hardly surprising. In view of some of Conway's (1996, 2000) suggestions about the strategic, and visual, nature of retrieval dynamics, it should further be possible to selectively interfere with retrieval by interfering not with the central executive, but with one of the "slave" systems. This is the distinctive aspect of the present research .

One of the difficulties of studying the different components of working memory is to find tasks that are supposed to influence and measure different components, but are comparable in nature. For example, the most often-used phonological loop task - concurrent articulation of a string of speech sounds, sometimes as simple as saying "the, the, the" repeatedly - does not on the face of it appear to require as much cognitive capacity as compared to a commonly-used visuospatial loop task of rotating images in one's mind. Irrelevant speech and image effects, however, as described below, appear comparable in nature in terms of the minimal cognitive load involved, and they were therefore used to suppress phonological and visuospatial components of working memory in the present studies, respectively.

Irrelevant Speech Effects

Performance in immediate serial recall of verbal stimuli declines when participants are presented irrelevant speech while studying the items in the list. Their performance decreases even if they are told to not to pay attention to the irrelevant speech. This effect was first observed by Colle and Welsh (1976) in an experiment where the study items were presented visually. According to Salamé and Baddeley (1982), irrelevant speech interferes with the short-term storage of verbal stimuli within a limited capacity phonological input store. The phonological loop consists of this phonological store and articulatory rehearsal process. According to the model, spoken stimuli access the phonological store every time, however visually presented information goes into the phonological store only when it is articulated.

In order to better understand the relationship between articulatory suppression and phonological loop, Hanley and Bakopoulou (2003) studied the additive effects of irrelevant speech and articulatory suppression using auditory stimuli. On half of the trials, they presented the irrelevant speech during stimulus presentation and during the retention interval the other half. For articulatory suppression, the participant was asked to repeat the word '*and*' at a rate of approximately two repetitions per second during presentation, retention interval, and recall of the target stimuli. If Salamé and Baddeley's ideas were correct, then irrelevant speech should have similar effects on recall irrespective of if it takes place during stimuli presentation or the retention interval when there is articulatory suppression. That is, there would be additive effects of irrelevant speech and articulatory suppression. However, if perceptual masking at encoding is responsible for the irrelevant speech effects on auditorily presented items, then presentation of irrelevant speech during the retention interval only would significantly reduce any irrelevant speech effect. The results showed that both irrelevant speech and articulatory suppression decreased performance on a serial recall task, regardless of when the irrelevant speech is presented. However, the performance was worse when irrelevant speech was accompanied with articulatory suppression. Therefore, these results supported ideas of Salamé and Baddeleythat *any* spoken material will automatically enter phonological store.

Similarly, Surprenant, Neath, and LeCompte (1999) examined the relationship between irrelevant speech and phonological similarity. Their results, in line with Hanley and Bakopoulou's, showed that the phonological similarity effect is eliminated by irrelevant speech for items that are visually presented, but not for auditorily presented items.

The working mechanism of the irrelevant speech effect has also been studied. Gisselgard, Petersson , Baddeley , and Ingvar (2003) asked participants to serially recall the digits that are presented visually while they were hearing irrelevant speech in a PET study. They found out that the effect of irrelevant speech was associated with a decrease of activity in bilateral secondary auditory and inferior/middle frontal areas, as well as in the left inferior parietal cortex. Therefore, they suggested irrelevant speech effect could be explained by the suppression of the components of the verbal working memory (i.e., the phonological loop).

These results suggest that irrelevant speech could be used as a way to suppress the phonological loop of working memory as an alternative to articulatory suppression task.

Irrelevant Pictorial Effects

In principle, irrelevant visual-spatial stimulation should interfere with the visual-spatial sketchpad of working memory in a way analogous to how irrelevant speech interferes with the phonological loop. But there have been far fewer studies of this aspect of working memory. Quinn and McConnell (1996) were the first to investigate a visual equivalent of irrelevant speech effect. They suggested that the *irrelevant picture effect* is a real phenomenon and furthermore it could be manipulated to examine the visuospatial sketchpad. They argued irrelevant pictures enters visuospatial in a similar way that irrelevant speech enters phonological loop using the ideas and results of Logie (1986), who found out that irrelevant pictures did not affect performance in rote rehearsal, but decreased performance under visual mnemonic instructions.

Quinn and McConnell developed a dynamic visual noise, in which dots change randomly and constantly between off and on. They claim this dynamic visual noise is irrelevant and has no time, place and thematic attentional focus but nonetheless cannot be ignored. Participants were presented with this visual noise while they were studying words under verbal and visual mnemonics instructions. The results showed that participants' performances under verbal instructions were not affected by the visual noise; however, participants who were given visual mnemonics instructions performed worse when presented with the visual noise. Furthermore, Quinn and McConnell used a double dissociation approach between irrelevant speech and irrelevant picture (Experiment 3). The results revealed that irrelevant speech did not affect the performance under visual mnemonics, whereas performance got worse under verbal instructions. Similarly, visual noise did not affect the performance under verbal instructions but decreased the performance under visual instructions.

Using the same methodology, McConnell and Quinn (2004) examined the factors that affect the degree of interference. For example, McConnell and Quinn manipulated the complexity of the target stimulus event by increasing the number of dots, the density of the dots, and size of the field in three experiments. Their results showed that the increasing complexity of the stimulus event was associated with the greater interference from a visual noise, again even if participants were told to ignore the visual noise but just look at it. They argued that, these results again showed that visual noise can access the visuospatial sketchpad, and causes interference with ongoing tasks that make use of that working memory structure.

Based on these results, visual noise seems to be a visuospatial sketchpad suppression task that is equivalent to irrelevant speech in terms of the cognitive capacity demand. Therefore, irrelevant speech and dynamic visual noise were used to suppress specifically phonological loop and visuospatial sketchpad components of working memory. It is worth pointing out that, although Quinn and McConnell refer to their interference as pictorial, their “dynamic visual noise” does not involve pictorial stimuli, and would be comparable not to irrelevant speech in the subject’s language, but in a foreign language, where no familiar organized and meaningful patterns could activate semantic memory, attract attention, and otherwise complicate the investigation of the “slave systems” of working memory per se.

General Research Question

If autobiographical memory retrieval depends on language and/or phonological cues and activation of verbal knowledge, then phonological loop suppression will most impair autobiographical memory retrieval. The memories would be expected to be retrieved more slowly, be more general and have lower ratings on certain phenomenological characteristics such as auditory and verbal qualities compared to a control group, who were not exposed to any type of noise. On the other hand, if autobiographical memory retrieval requires active use of visual imagery and image cues, as argued by Conway and others (see above), then the visuospatial sketchpad suppression will most interfere with autobiographical memory recall in these ways. Therefore, similar to the phonological loop suppression, the memories would be retrieved slowly, be more general, and have lower ratings on visual and imagery related phenomenological characteristics of autobiographical memories compared to the control group.

Typicality of autobiographical memories is also predicted to be affected by interference with working memory storage systems. Typical autobiographical memories would be expected to utilize less working memory capacity compared to distinct memories. I therefore expected that the event-specific memories produced under working memory load conditions will be rated as more typical. Furthermore, typical memories would be expected to be more general and have lower ratings on some phenomenological characteristics of memories. Under working memory interference conditions, the autobiographical memories recalled simultaneously would be expected to be more typical ones. The suppression tasks would engage critical components of working memory, therefore leaving fewer resources for recalling a distinct autobiographical memory

Conway and Pleydell-Pearce (2000) distinguished between two stages of autobiographical memory processing: search and retrieval, on one hand; and maintenance and elaboration on the other. The search phase refers to the attempt to retrieve or activate a specific autobiographical memory after being presented with some sort of cue. Once this phase is complete, the memory can be maintained in working memory, elaborated with other memories or thoughts, or inspected in various ways. Experiment 1 examined the effects of visual and phonological noise on the search phase of autobiographical recall, which I hypothesis would be the most disrupted by irrelevant stimuli. Further, if the process of searching for and retrieving an autobiographical memory is founded on visual and spatial information, then the irrelevant picture task should be more disruptive, and change the characteristics of the retrieved memories, more than would the irrelevant speech task. In Experiment 2, the effects of irrelevant speech and visual noise on the maintenance and elaboration of retrieved autobiographical memories was explored.

CHAPTER 2
COMMON METHOD

Phonological Loop Suppression

An irrelevant-speech paradigm was used to attempt to suppress the phonological loop of working memory. Thirteen-seconds-long passages from a Turkish novel were recorded by a female native speaker of Turkish. The passages were selected so that no there were no words that could sound like English words. A randomly selected different passage was played for each trial of the autobiographical memory task.

Visuospatial Sketchpad Suppression

A dynamic visual display of randomly turning on and off black and white dots in a window on the monitor screen was used to suppress the visuospatial sketchpad of working memory. Each of these dots was 100x100 pixels square which is colored either black or white. The display was a 10000x8000 pixels rectangle consisting of these 100x100 black or white colored squares. Two hundred of these small squares turned on and off randomly every 200ms and created the dynamic visual display (Fig-1).

Autobiographical Memory Task

Neutral nouns that are likely to elicit autobiographical memories were used as cue words. There were a total of 30 cue words (Appendix A). Participants were given the following instructions:

"We want you to remember an event from your life that each word reminds you of. Any event will do as long as it is a single event that lasted less than a day, and occurred at a particular time and a place. The events could have occurred at any time in your life, they may be important or trivial, but they should be real events. If you remember something that happened today, please try to remember something else. Also if you remember the same memory again for another word, please try to remember a new memory. We will record your memories without any identifiers for the filename, so please try to include as many details (e.g. why, where, when, who, how) as you could in your memories."

Participants were also given an example memory that demonstrates the difference between general and specific autobiographical memories. Before they started the experiment, they were presented with a practice cue word and asked to recall an event. The difference between general and specific autobiographical memories was demonstrated once again on their personal memories.

Autobiographical Memory Characteristics Questionnaire

In order to investigate the phenomenological characteristics of the recalled memories that are of interest to the current study (visual and phonological/language), participants were asked to answer an autobiographical memory characteristic questionnaire, which included questions about the pleasantness and intensity of emotions, degree to which the memory was experienced as an auditory event, linguistic characteristics, imagery, location, time travel, typicality, personal uniqueness, and age of memory (Appendix B).

Figure 2-1. A static representation of the visual dynamic noise used in Experiments 1 and 2. The display measured 10000x8000 pixels consisting of 100x100 pixels squares on the computer screen and 200 of these squares moved randomly every 200ms.

CHAPTER 3
EXPERIMENT 1

Introduction

Conway and Pleydell-Pearce (2000) distinguished between two stages of autobiographical memory retrieval; search and elaboration phases. Search phase refers to the actual search for a memory, after being presented with some sort of cue. Elaboration starts just after one recalls a memory in response to the cues. This phase has more to do with the organization of memories into a coherent story. Experiment 1 examined the effects of visual and phonological noises on the search phase of autobiographical recall.

Method

Participants

Participants were recruited from the general psychology participant pool at the University of Florida. They received credits towards their course for participation. A total of 91 participants took part in the experiment (63 females) from ages 18 to 23. Thirty-one of them were randomly assigned to visual noise condition, another 31 to auditory noise condition, and the remaining were assigned to control group (26 of them to auditory first condition).

Procedure

The materials and tasks that were described in the previous chapter were used. In order to ensure the exposure to noise, participants in the visual noise condition were told they would be seeing some dots moving around randomly on the screen and they needed to be looking at the screen at all times when they were trying to recall a memory. They were told not to look around nor close their eyes. Since participants in the auditory condition had to wear earphones, they were not specifically told to listen to the passage.

Each trial in the experiment started with the visual or auditory noise, depending on the experimental group the participant is assigned. After being exposed to the noise for 3 seconds, participants in visual noise condition heard the cue words through earphones. Auditory noise participants were shown the cue word on the computer screen. Participants in both conditions had to indicate the retrieval of a memory by pressing any key. Then, they talked about the recalled event while the experimenter was inside the room with the participant. The trial finished after the participant answered the questions about the event and then the next trial started. All participants were given 10 seconds to recall a memory and if they could not remember one during this time they were presented with the next cue word.

Participants in the control group were not exposed to any of the visual or auditory noise conditions. They were presented the half of the same cue words visually on the computer screen and the other half were presented auditorily through headphones. The order of this presentation was counterbalanced so that half of the control group participants saw the first half of the cue words on the screen and heard the other half through the headphones. The other half of the participants started with the auditory cues and finished with visual cues.

Results

First, responses for each participant were averaged across trials for response time, as well as for each of the various characteristics of autobiographical memories (age at event, intensity of emotions, etc). Mean and standard errors of these variables across participants are shown in Table 3-1.

The probability of recalling a memory within the 10s limit was similar for the three groups. On the other hand, comparison of response times across condition in Table 1 suggests that visual noise led to faster responses than the other two conditions. Regarding the phenomenological ratings, the visual noise condition appeared to lead to higher ratings than auditory noise condition for imagery, auditory experience, time travel, and linguistic characteristics, whereas auditory noise condition had higher ratings on negativity, typicality, and uniqueness compared to visual noise condition. They have similar ratings on positivity, intensity, location, and specificity. Age of memory did not appear to differ across conditions.

Effects of Visual versus Auditory Presentation of Cue Words: Control Group

Prior to the main analyses, the data from the control group was examined in order to test if presentation mode of cue words affected the response variables, since this differed for the auditory and visual noise conditions. The response variables for the model tested included mean response time, mean age of memories, and mean ratings for (a) imagery, (b) auditory experience, (c) linguistic relatedness, (d) personal uniqueness, (e) typicality, and (f) specificity for autobiographical memories. The specificity rating was obtained by summing the ratings for location remembrance and ratings for ability to travel in time when recalling the memory. Means and standard errors of response variables across presentation mode are shown in Table 3-2. A repeated measures mixed model analysis was performed using order of cue word presentation (visual first vs. auditory first), mode of presentation (visual or auditory), and interaction between them. The analysis is weighted by the number of memories each participant recalled (Table 3-3). Results showed that main effect of presentation mode was not significant ($F(1,27)= .03$, $p>.1$). That is, the mode of presentation did not have any effect on the reaction times. However, the main effect of order of presentation and interaction effect was significant ($F(1,27)= .03$, $p=.012$, and $F(1,27)= 6.90$, $p=.015$, respectively). Auditory first conditions were faster than the visual first conditions on average. Visually presented cues led to faster reactions times in auditory first condition compared to visual first condition. Therefore, these results suggest that mode of presentation did not affect the reaction times of the memories recalled.

For the response variables imagery, auditory experience, linguistic characteristics, specificity, number of memories recalled, and age of memories, none of the predictors were significant. However, typicality and personal uniqueness were affected by the presentation mode. Memories for visually presented cue words got higher ratings for both typicality and personal uniqueness. The main effect of order and the interaction were not statistically significant.

Analysis of residual plots and the distributions (Fig 3-1, Fig 3-2, and Fig 3-3) for all the response variables did not reveal any anomalies or systematic patterns that would indicate problems with normality, homogeneity of variances, and fit of the models.

Effects of Auditory versus Visual Noise on Memories

The lack of an overall effect of modality of cue word presentation in the control group indicates that the two experimental groups, which used different cue presentation modalities, may be directly compared. In order to test the effect of auditory and visual noise on autobiographical memories, a multivariate ANOVA was followed by a series of independent ANOVA analyses. For this set of analyses, if the participant was unable to recall a memory in given interval, response time is set to missing; that is, only those trials in which participant recalled an event were averaged to obtain the average response variables. The analyses were again weighted by the number of memories recalled by each participant.

The same response variables as the previous repeated measures ANOVA model were used in MANOVA. Independent variables included in the model were type of noise (auditory vs. visual), gender of the participants, and the two-way interaction between type of noise and gender.

Results of MANOVA showed that there was a main effect of type of noise on the composite response variable, Wilks' λ= .55 ($F(9,30)$= 2.74, p=.02).Since this result revealed that type of noise affected the composite multivariate response variable, independent ANOVA analysis were conducted for each of the individual response variables. The same independent variables and the model that was used in MANOVA were adopted for all further analysis (Table 3-4).

For response time, ANOVA results showed that there was a significant main effect of type of noise ($F(1,60)= 33.73$, $p<.0001$). Memories in visual noise condition were retrieved more quickly than were memories in the auditory noise condition. However, there were no differences between visual and auditory noises in terms of number of memories recalled.

The following analyses compared the phenomenological aspects of memories of different experimental conditions. For ratings of imagery, auditory experience, linguistic characteristics, specificity, and age of memory, none of the variables in the model were statistically significant. For the mean ratings of typicality, participants in the visual noise condition rated their memories to be marginally less unique than the memories of participants in the auditory noise condition ($F(,60)= 3.61$, $p=.06$). Moreover, memories of participants in auditory condition were rated to be more personally unique than that of control group ($F(1,60)= 3.65$, $p=.06$).

Data from the control (no noise) conditions were divided according to the mode of cue word presentation (visual vs. auditory). The auditory portion of the data was used as the control for visual noise condition whereas visual portion of the data was used as the control for auditory noise condition. For this analysis, the same response variables were used as previously. The model included the independent variable noise (noise vs. control) (Table 3-5 and Table 3-6).

Response times in the visual noise condition were faster than the control group ($F(1,58)= 34.57$, $p<.0001$). The comparison between auditory noise condition and corresponding control group showed that participants in the auditory noise condition were marginally faster than control group ($F(1,58)= 3.82$, $p=.055$). With respect to the number of memories recalled, there were no differences between visual noise group and control group and auditory noise group and control group.

In terms of the linguistic characteristics of memories, participants in auditory noise condition rated their memories to be less linguistic in nature compared to the corresponding control group ($F(1,58)= 5$, $p= .03$). Furthermore, auditory noise condition led to memories with marginally less auditory experience compared to memories of the control group. However, there were no differences between visual noise condition and corresponding control group with respect to the linguistic characteristics of the memories recalled and the auditory experience.

Additionally, for mean ratings of imagery, typicality, uniqueness, specificity, and age of memory, none of the variables in the model were statistically significant for both visual noise to control group and auditory noise to control group comparisons.

Finally, in order to find out if the response time for retrieving a memory affected the qualities of the recalled memories a series of correlations analyses were performed. First, data for individual trials were used to calculate the correlations by noise conditions (Table 3-7). Results for the visual noise condition showed that there were significant negative correlations between imagery, auditory qualities, time travel, typicality, uniqueness, and linguistic characteristics. The auditory noise condition, on the other hand, showed that the only significant correlation was the negative correlation between imagery and response times. Control group results showed that the negative correlation between imagery and response times was significant as well as the positive correlation between linguistic characteristics and age at memory. However, all of these correlation coefficients were less than .15, which corresponds to less than 2.5% of the total variance.

After these individual trial analyses, data for the mean response variables across trials were used to compute the correlations (Table 3-8). Results showed that for the control group, there was a significant positive correlation between linguistic characteristics and response times with a coefficient of .240. However, for both visual and auditory noise conditions none of the correlations were statistically significant.

Table 3-1. Mean and standard error of response variables by type of noise

Measure	Visual	Auditory	Control
Response Time (s)	4.36 (0.09)	5.99 (0.1)	6.62 (0.11)
Percent Recall	0.73 (0.01)	0.75 (0.01)	0.73 (0.02)
Attribute Ratings			
Positivity	4.73 (0.09)	4.71 (0.08)	4.95 (0.08)
Negativity	2.72 (0.08)	2.86 (0.08)	2.89 (0.08)
Intensity	3.91 (0.07)	3.98 (0.07)	4.06 (0.07)
Imagery	5.97 (0.05)	5.78 (0.05)	5.82 (0.05)
Auditory Experience	4.25 (0.08)	3.96 (0.08)	4.71 (0.08)
Location	6.36 (0.05)	6.34 (0.04)	6.17 (0.05)
Time Travel	5.31 (0.06)	4.90 (0.07)	5.05 (0.07)
Typicality	3.59 (0.07)	4.10 (0.07)	4.02 (0.08)
Uniqueness	4.23 (0.08)	4.74 (0.07)	4.51 (0.08)
Linguistic Characteristics	3.36 (0.07)	3.01 (0.07)	4.07 (0.08)
Age at event	15.15 (0.32)	15.67 (0.17)	15.29 (0.26)
Specificity	11.66 (0.09)	11.24 (0.09)	11.22 (0.09)
Age of Memory	3.69 (0.33)	3.29 (0.16)	4.26 (0.25)

Table 3-2. Mean and standard error of response variables by mode of presentation for control group

Measure	Auditory	Visual
Response Time (s)	6.52 (0.16)	6.72 (0.15)
Percent Recall	0.75 (0.02)	0.71 (0.02)
Attribute Ratings		
Positivity	4.95 (0.11)	4.94 (0.12)
Negativity	2.84 (0.11)	2.95 (0.12)
Intensity	3.98 (0.1)	4.15 (0.11)
Imagery	5.8 (0.07)	5.84 (0.07)
Auditory Experience	4.68 (0.11)	4.75 (0.12)
Location	6.14 (0.07)	6.19 (0.07)
Time Travel	5.07 (0.09)	5.03 (0.1)
Typicality	3.88 (0.11)	4.17 (0.12)
Uniqueness	4.28 (0.11)	4.75 (0.12)
Linguistic Characteristics	4.01 (0.11)	4.13 (0.13)
Age at event	15.18 (0.36)	15.41 (0.39)
Specificity	11.22 (0.13)	11.22 (0.14)
Age of Memory	4.35 (0.35)	4.15 (0.36)

Table 3-3. Repeated measures ANOVA F-test results for mode of presentation effects

Response Variable	Order	Presentation Mode	Order*Presentation Mode
Response Time (s)	7.31**	0.03	6.9**
Imagery	0.39	0.01	0.16
Auditory Experience	0.13	0.32	1.53
Typicality	0.05	4.71**	2.13
Uniqueness	0.45	6.36**	0.32
Linguistic Characteristics	1.53	0.38	0.08
Specificity	0.33	0.18	1.66
Age of Memory	1.68	0.19	0.02
Percent Recall	0.07	0.32	0.35

***** p<.0001;**** p<.001;*** p<.01;** p<.05; * p<.1

Table 3-4. Mixed model F-test results for comparison of visual to auditory noise

Measure	Noise
Response Time (s)	33.73*****
Percent Recall	0.17
Attribute Ratings	
Imagery	1.17
Auditory Experience	0.74
Typicality	3.61*
Uniqueness	3.65*
Linguistic Characteristics	0.80
Specificity	1.16
Age of Memory	0.06

***** p<.0001;**** p<.001;*** p<.01;** p<.05; * p<.1

Table 3-5. Mixed model F-test results for comparison of visual noise to control group

Measure	Noise
Response Time (s)	34.57*****
Percent Recall	0.52
Attribute Ratings	
Imagery	0.79
Auditory Experience	1.46
Typicality	0.77
Uniqueness	0.02
Linguistic Characteristics	2.24
Specificity	1.37
Age of Memory	0.11

***** p<.0001;**** p<.001;*** p<.01;** p<.05; * p<.1

Table 3-6. Mixed model F-test results for comparison of auditory noise to control group

Measure	Noise
Response Time (s)	3.82*
Percent Recall	0.98
Attribute Ratings	
Imagery	0.09
Auditory Experience	3.49*
Typicality	0.06
Uniqueness	0
Linguistic Characteristics	5.00**
Specificity	0.02
Age of Memory	0

***** p<.0001;**** p<.001;*** p<.01;** p<.05; * p<.1

Table 3-7. Correlations of measures for each trial with response time by experimental condition

Measure	Visual Noise	Auditory Noise	Control Group
Imagery	-0.07*	-0.08**	-0.08*
Auditory Experience	-0.89**	0.01	-0.06
Location	-0.03	-0.01	-0.04
Time Travel	-0.08**	-0.06	0.04
Typicality	-0.14****	0.06	-0.04
Uniqueness	-0.13***	0.01	-0.06
Linguistic Characteristics	-0.14****	0.02	0.14****
Age of Memory	-0.07	0.05	-0.09***

***** p<.0001;**** p<.001;*** p<.01;** p<.05; * p<.1

Table 3-8. Correlations of measures averaged over trials for each participant with reaction time by experimental condition

Measure	Visual	Auditory	Control
Imagery	0.06	0.12	-0.11
Auditory Experience	-0.12	0.15	-0.08
Typicality	-0.30	0.06	-0.12
Uniqueness	-0.11	0.18	-0.15
Linguistic Characteristics	-0.27	0.05	0.24*
Specificity	0.05	-0.01	0.10
Age of Memory	-0.08	-0.01	-0.12

***** p<.0001;**** p<.001;*** p<.01;** p<.05; * p<.1

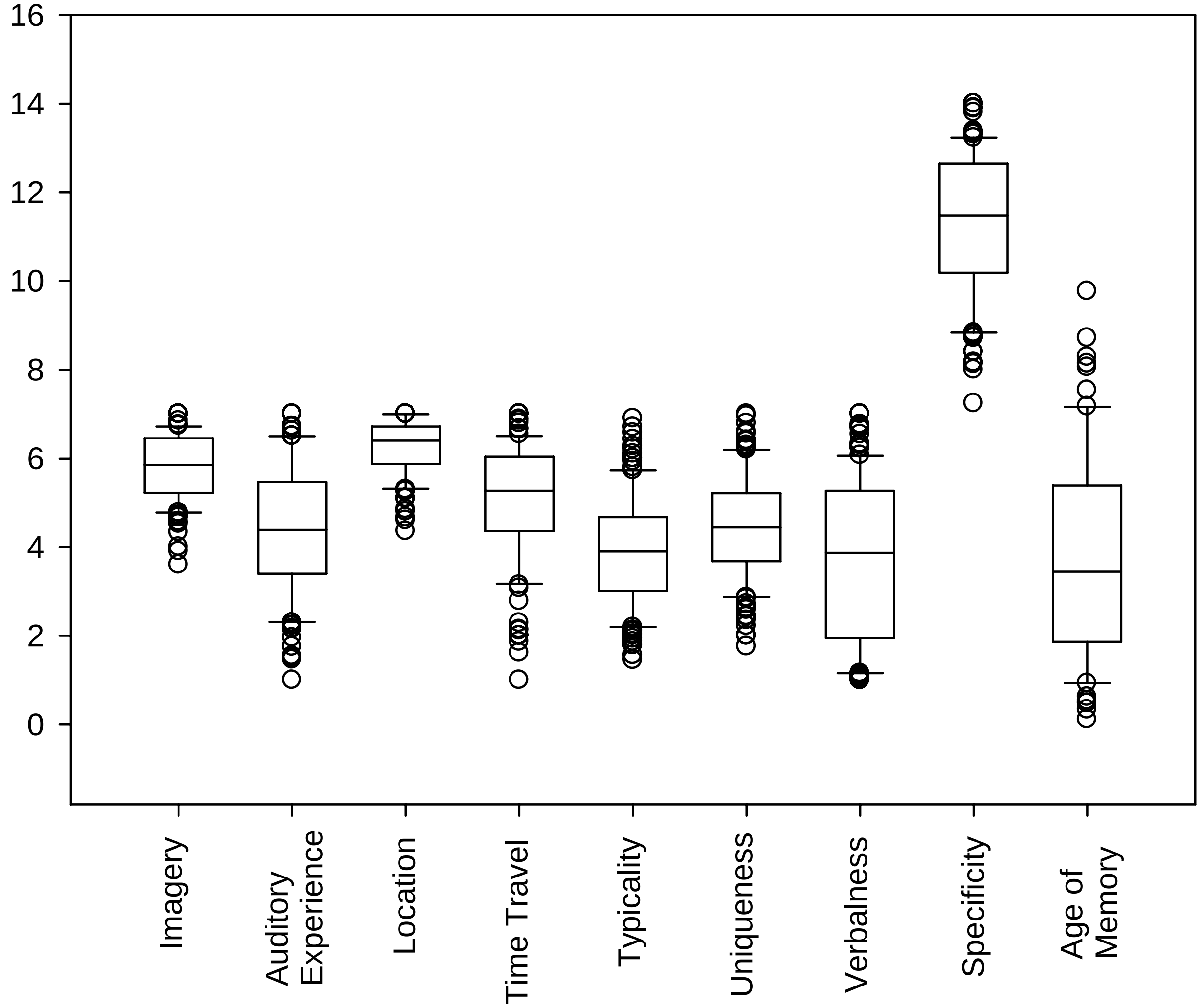

Figure 3-1. Box plots for the attribute ratings for the autobiographical memories

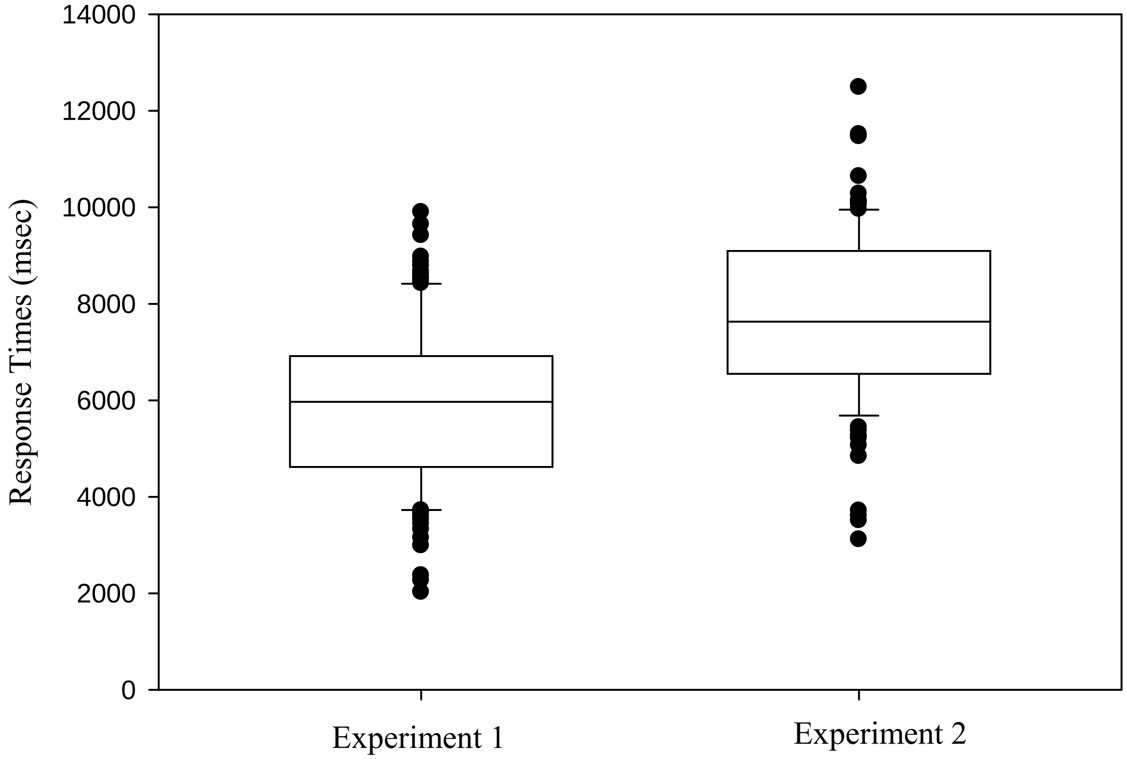

Figure 3-2. Box plots for the response times for retrieving autobiographical memories for experiment 1 and 2

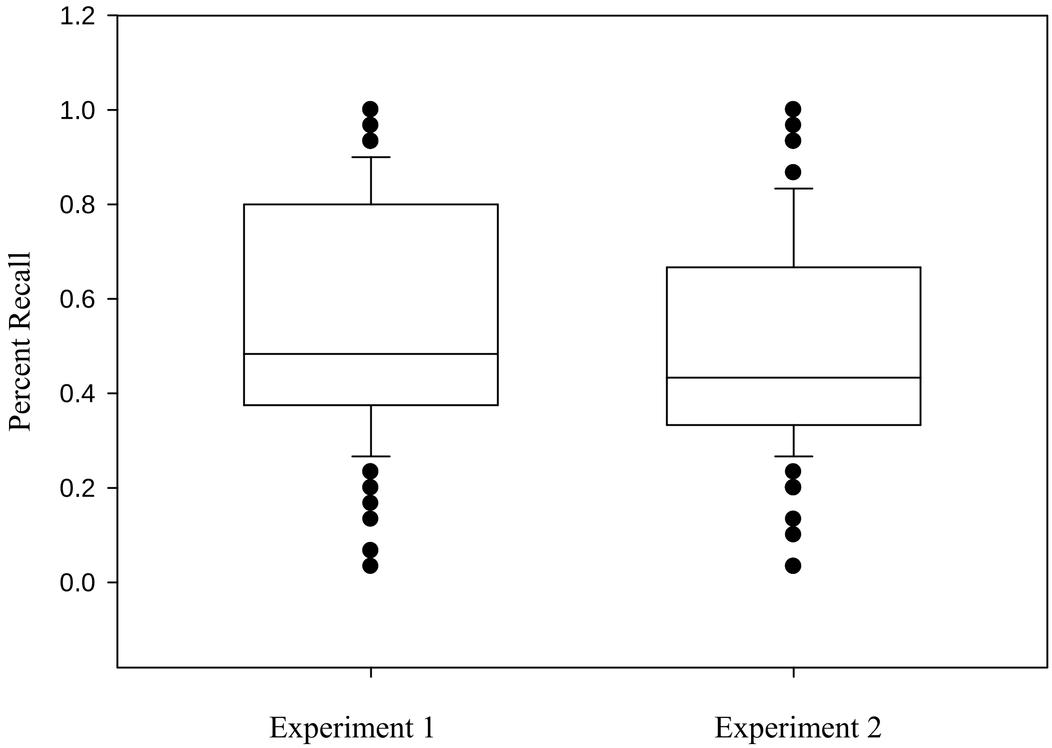

Figure 3-3. Box plots for the percent recall of autobiographical memories for experiment 1 and 2

CHAPTER 4
EXPERIMENT 2

Introduction

According to Conway and Pleydell-Pearce (2000), elaboration refers to the phase of autobiographical memory recall which starts just after one indicates recalling a memory in response to the cues, and continues until the memory is recounted. This phase has more to do with the organization of memories into a coherent story. The purpose of Experiment 2 was to examine the effects of visual and phonological noises on the elaboration phase of autobiographical recall.

Method

Participants

Participants were recruited from the general psychology participant pool at the University of Florida. They received credits towards their course for participation. A total of 82 participants took part in the experiment (49 females) from ages 18 to 23. Twenty-six of them were assigned to visual noise condition, 29 to auditory, and the remaining 27 were assigned to control group (13 of them to auditory first condition).

Procedure

The same materials and tasks that were described in the previous chapter were used in Experiment 2. In order to ensure the exposure to noise, participants in the visual noise condition were told they would be seeing some dots moving around randomly on the screen and they needed to be looking at the screen at all times when they were trying to think about a retrieved memory. They were told not to look around or close their eyes. Since participants in the auditory condition had to wear earphones, they were not specifically told to listen to the passage.

Each trial in the experiment started with the autobiographical memory task, regardless of which group the participants were assigned. Once again, participants in visual noise condition heard the cue words through earphones. Auditory noise participants were presented the cue word on the computer screen. After participants indicated they have a memory by pressing a key, depending on their assignment they were either exposed to one of the two noise condition (visual or auditory) or no noise. Participants were exposed to these noises for 5 sec; control group had to wait 5 sec without doing anything. Participants in the control group were told that they would be able to talk about their memory after they were prompted by the program. Then, they talked about the recalled event while the experimenter was inside the room with the participant. The trial finished after the participant answered the questions about the event and then the next trial started. All participants were given 10 seconds to recall a memory and if they could not remember one during this time they were presented with the next cue word.

Participants in the control group were not exposed to any of the visual or auditory noise conditions. They were presented the half of the same cue words visually on the computer screen and the other half were presented auditorily through headphones. The order of this presentation if counter balanced so that half of the control group participants saw the first half of the cue words on the screen and heard the other half through the headphones. The other half of the participants started with the auditory cues and finished with visual cues.

Results

As in Experiment 1, data for each participant was averaged across trials for response time, as well as for each of the various characteristics of autobiographical memories (age at event, intensity of emotions, etc). Mean and standard errors of these variables across participants are shown Table 4-1.

Similar to the experiment 1, the probability of recalling a memory within the 10s limit was similar for the three groups. However, once again, comparison of response times across condition in Table 1 suggests that participants in visual and auditory noise conditions were faster than participants in the control condition in recalling autobiographical memories. However, like the experiment 1, in terms of autobiographical memory characteristics, there are not consistent differences among different conditions. Visual noise condition seemed to have higher ratings than auditory noise condition in auditory experience and typicality, on the other hand auditory noise condition had higher negativity ratings than visual noise condition. Moreover, memories of visual noise condition were older than the memories of auditory noise condition. There were no differences between visual and auditory noise conditions in terms of positivity, intensity of emotions, imagery, location, time travel, uniqueness, linguistic characteristics, specificity, and percent recall.

Effects ff Visual versus Auditory Presentation of Cue Words: Control Group

As was the case in the experiment 1, before the main analyses, the control group data was examined in order to examine if the mode of presentation affected any of the autobiographical memory characteristics. The response variables for the model tested included mean response time, mean age of memories, and mean ratings for (a) imagery, (b) auditory experience, (c) linguistic relatedness, (d) personal uniqueness, (e) typicality, and (f) specificity for autobiographical memories. The specificity rating was obtained by summing the ratings for location remembrance and ratings for ability to travel in time when recalling the memory. Means and standard errors of response variables across presentation mode are shown in Table 4-2. A repeated-measures mixed model analysis was performed using order of cue word presentation (visual first vs. auditory first), mode of presentation, and interaction between them as the predictor variables. The analysis is weighted by the number of memories each participant recalled (Table 4-3.). As in the experiment 1, the mode of presentation did not have any effect on the reaction times ($F(1,24) = .04$, $p > .1$). Moreover, the main effect of order of presentation was not significant ($F(1,24) = .14$, $p > .1$). However, the two-way interaction was statistically significant ($F(1,24) = 6.81$, $p = .015$). Visually presented cues led to slower reactions times in visual first condition compared to auditorily presented cues, whereas auditorily presented cues led to slower response times in auditory first condition compared to visually presented cues. These results suggest that overall, the mode of presentation did not affect the reaction times of the memories recalled.

Results showed that main effect of presentation mode was not significant ($F(1,24) = .04$, $p > .1$). Like the first experiment the mode of presentation did not have any effect on the reaction times. Moreover, the main effect of order of presentation was not significant ($F(1,24) = .14$, $p > .1$). However, the two-way interaction was statistically significant ($F(1,24) = 6.81$, $p = .015$). Visually presented cues led to slower reactions times in visual first condition compared to auditorily presented cues, whereas auditorily presented cues led to slower response times in auditory first condition compared to visually presented cues.

Similar to experiment 1, for the response variables imagery, auditory experience, linguistic characteristics, typicality, personal uniqueness, specificity, and age of memories, none of the predictors were significant.

Analysis of residual plots and distributions (Fig 3-2, Fig 3-3, and Fig 4-1) for all the response variables did not reveal any anomalies or systematic patterns that would indicate problems with normality, homogeneity of variances, and fit of the models.

Effects of Auditory versus Visual Noise on Memories

The lack of an overall effect of modality of cue word presentation in the control group indicated that the two experimental groups, which used different cue presentation modalities, may be directly compared, similar to the evaluation of cue mode in experiment 1, A multivariate ANOVA which was followed by a series of independent ANOVA analyses were performed in order to test the effect of auditory and visual noise on autobiographical memories. Once again, the analyses were weighted by the number of memories recalled by each participant.

The same response variables as the previous repeated measures ANOVA model were used in MANOVA. The only independent variable that was included in the model was the type of noise (auditory vs. visual).

Results of MANOVA showed that there was a main effect of type of noise on the composite response variable, Wilks' $\lambda = .84$ ($F(9,45) = 8.93$, $p > .10$). One of the shortcomings of the multivariate ANOVA is that even if there are significant differences in only some of the dependent variables but not all of them, the effect of the manipulation could still come out insignificant. Even though, the MANOVA results revealed that type of noise did not affect the composite multivariate response variable, independent ANOVA analysis were still conducted for each of the individual response variables. The same independent variables and the model that was used in MANOVA were adopted for all further analysis (Table 4-4).

For response time, unlike the experiment 1, mixed models analysis results showed that the main effect of noise was not significant ($F(1,53) = .49$, $p > .10$). There were also no differences between the two noise conditions with regards to the probability of recalling autobiographical memories

Similar to the analyses of the experiment 1, in order to fully examine the effects of visual and auditory noise on autobiographical memories other than response times, the following analyses compared memories of different experimental conditions on phenomenological characteristics of autobiographical memory.

Similar to the results of the experiment 1, the mean ratings of imagery, auditory experience, typicality, personal uniqueness, linguistic characteristics, specificity, and age of memory did not differ between the visual and auditory noises.

Data from the control (no-noise) conditions were again divided into two according to the mode of cue word presentation (visual vs. auditory). The auditory portion of the data was used as the control for visual noise condition whereas visual portion of the data was used as the control for auditory noise condition. For this analysis, the same response variables were used as previously. The only independent variable in the model was noise (noise vs. control) (Table 4-5 and Table 4-6).

Similar to experiment 1, response times in noise condition were faster than the control group ($F(1,51)= 9.89$, $p= .003$).. Similarly, auditory noise condition led to faster response times compared to the corresponding control group ($F(1,54)= 10.28$, $p=.002$). There were also no differences between visual noise and control group and auditory noise and control group in terms of probability of recalling autobiographical memories ($F(1,51)= .78$, $p>.10$ and $F(1,54)= .32$, $p>.10$, respectively).

For the comparison between visual noise and the control group counterpart, results showed that visual noise did not affect imagery, auditory experience, typicality, personal uniqueness, linguistic characteristics, specificity, and age of memory.

Comparing auditory noise condition to corresponding control group, the results showed that memories in auditory noise condition were marginally more specific than the memories in the control group ($F(1,54)= 3.13$, $p= 0.08$). However, there were no differences between the memories in the auditory noise condition and memories of the control group in imagery, auditory experience, typicality, personal uniqueness, linguistic characteristics, and age of memory.

Finally, in order to examine the relationship between the response times for retrieving a memory and the qualities of the recalled memories, a series of correlations analyses were performed. First, data for individual trials were used to calculate the correlations for each experimental condition (Table 4-7). Results for the visual noise condition showed that the correlations between auditory qualities and time travel were significantly positive whereas the correlations between uniqueness and response time and age of memory and response time were significantly negative. Results of the auditory noise condition showed that there were significant negative correlations between imagery and response times and uniqueness and response times. Control group results showed that the negative correlations between time travel and response time and age of memory and response time were significant. However, all of these correlation coefficients were less than .105, which corresponded to the explained variance of 1.1% or less.

After these individual trial analyses, data for the mean response variables across trials were used to compute the correlations (Table 4-8). Results showed that for the visual noise condition there was a significant positive correlation between linguistic characteristics and response times and a negative significant correlations between age of memories and response times, the correlation coefficients were .428 and -.782, respectively. For the auditory noise condition and control groups age of memories were significantly and negatively correlated, with coefficients of -.915 and -.824, respectively.

Table 4-1. Mean and standard error of response variables by experimental groups

Gender	Visual	Auditory	Control
Response Time (s)	7.06 (0.09)	6.96 (0.10)	8.42 (0.12)
Percent Recall	0.67 (0.17)	0.63 (0.17)	0.70 (0.02)
Attribute Ratings			
Positivity	5.12 (0.09)	4.90 (0.09)	4.56 (0.09)
Negativity	2.45 (0.08)	2.68 (0.09)	3.03 (0.09)
Intensity	3.91 (0.08)	3.73 (0.07)	3.66 (0.07)
Imagery	5.84 (0.06)	5.87 (0.05)	5.60 (0.05)
Auditory Experience	4.46 (0.09)	4.24 (0.09)	3.97 (0.08)
Location	6.27 (0.05)	6.27 (0.05)	6.06 (0.05)
Time Travel	5.26 (0.07)	5.26 (0.06)	4.92 (0.07)
Typicality	3.71 (0.09)	3.94 (0.09)	3.52 (0.08)
Uniqueness	4.50 (0.09)	4.57 (0.08)	4.20 (0.09)
Linguistic Characteristics	2.88 (0.08)	3.07 (0.08)	3.38 (0.08)
Age at event	15.65 (0.20)	15.20 (0.21)	15.44 (0.20)
Specificity	11.53 (0.11)	11.53 (0.09)	10.98 (0.10)
Age of Memory	3.66 (0.19)	4.27 (0.22)	4.11 (0.20)

Table 4-2. Mean and standard error of response variables by mode of presentation for control group

Measure	Auditory	Visual
Response Time (s)	8.29 (0.18)	8.55 (0.19)
Percent Recall	0.74 (0.02)	0.65 (0.02)
Attribute Ratings		
Positivity	4.65 (0.12)	4.46 (0.13)
Negativity	2.98 (0.12)	3.11 (0.13)
Intensity	3.64 (0.1)	3.69 (0.11)
Imagery	5.63 (0.07)	5.57 (0.09)
Auditory Experience	3.88 (0.11)	4.07 (0.12)
Location	6.13 (0.07)	5.98 (0.08)
Time Travel	4.92 (0.09)	4.93 (0.1)
Typicality	3.45 (0.11)	3.61 (0.12)
Uniqueness	4.08 (0.12)	4.33 (0.13)
Linguistic Characteristics	3.45 (0.1)	3.3 (0.11)
Age at event	15.53 (0.27)	15.35 (0.28)
Specificity	11.04 (0.13)	10.91 (0.15)
Age of Memory	4.02 (0.28)	4.21 (0.29)

Table 4-3. Repeated measures ANOVA F-test results for mode of presentation effects

Response Variable	Order	Presentation Mode	Order*Presentation Mode
Response Time (s)	0.14	0.04	6.81**
Imagery	1.78	0.07	0.41
Auditory Experience	0.01	1.53	0.01
Typicality	0.71	0.48	0.61
Uniqueness	1.46	0.91	0.09
Linguistic Characteristics	0	0.26	0
Specificity	0.01	0.17	0.06
Age of Memory	0.51	4.98**	0.06
Percent Recall	1.5	0.08	0

***** p<.0001;**** p<.001;*** p<.01;** p<.05; * p<.1

Table 4-4. Mixed model F-test results for comparison of visual to auditory noise

Measure	Noise
Response Time (s)	0.49
Percent Recall	0.73
Attribute Ratings	
Imagery	0.02
Auditory Experience	0.35
Typicality	0.63
Uniqueness	0.07
Linguistic Characteristics	0.22
Specificity	0
Age of Memory	0.6

***** p<.0001;**** p<.001;*** p<.01;** p<.05; * p<.1

Table 4-5. Mixed model F-test results for comparison of visual noise to control group

Measure	Noise
Response Time (s)	9.89****
Percent Recall	0.28
Attribute Ratings	
Imagery	0.8
Auditory Experience	2.31
Typicality	0.71
Uniqueness	2.03
Linguistic Characteristics	1.65
Specificity	1.16
Age of Memory	0.78

***** p<.0001;**** p<.001;*** p<.01;** p<.05; * p<.1

Table 4-6. Mixed model F-test results for comparison of auditory noise to control group

Measure	Noise
Response Time (s)	10.28****
Percent Recall	0
Attribute Ratings	
Imagery	1.99
Auditory Experience	0.19
Typicality	0.93
Uniqueness	0.48
Linguistic Characteristics	0.26
Specificity	3.13*
Age of Memory	0.32

***** p<.0001;**** p<.001;*** p<.01;** p<.05; * p<.1

Table 4-7. Correlations of measures for each trial with response time by experimental condition

Measure	Visual Noise	Auditory Noise	Control Group
Imagery	-0.01	-0.09**	-0.02
Auditory Experience	0.07*	0.04	-0.02
Location	-0.01	-0.11**	0.06
Time Travel	0.08*	-0.03	-0.08*
Typicality	-0.02	-0.10**	-0.02
Uniqueness	-0.08*	-0.06	0.01
Linguistic Characteristics	0.07	0.05	-0.03
Age of Memory	-0.07*	-0.01	-0.09**

***** p<.0001;**** p<.001;*** p<.01;** p<.05; * p<.1

Table 4-8. Correlations of measures averaged over trials for each participant with response time by experimental condition

Measure	Visual	Auditory	Control
Imagery	-0.29	-0.24	0.04
Auditory Experience	0.18	0.01	-0.07
Typicality	-0.01	-0.17	0.02
Uniqueness	0.16	-0.12	0.27
Linguistic Characteristics	0.43**	0.13	-0.19
Specificity	-0.03	-0.18	0.04
Age of Memory	-0.78*****	-0.91*****	-0.82****

***** $p<.0001$;**** $p<.001$;*** $p<.01$;** $p<.05$; * $p<.1$

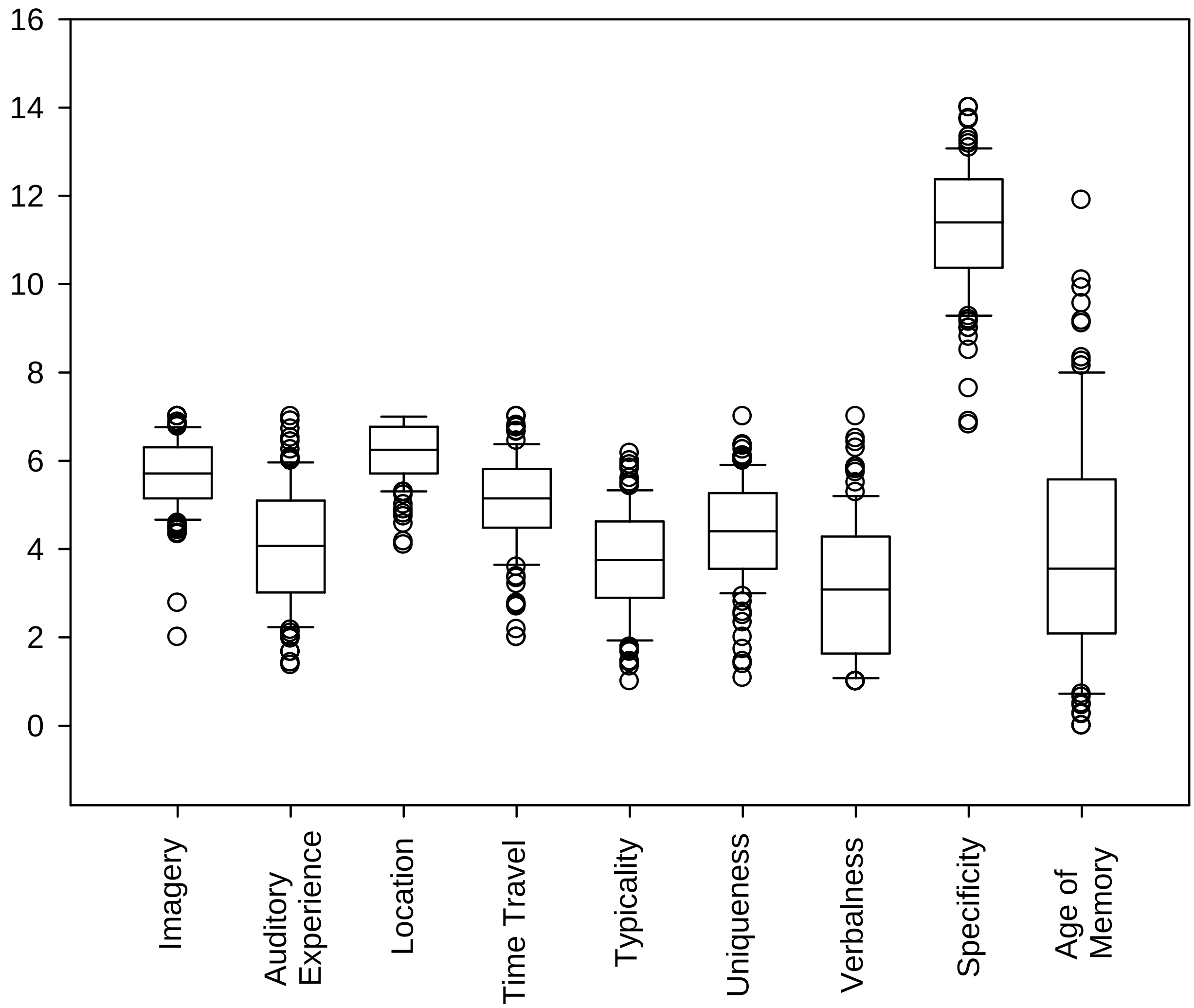

Figure 4-1. Box plots for the attribute ratings for the autobiographical memories

CHAPTER 5
DISCUSSION

Results of the present study showed that some aspects of the processing of autobiographical memories were affected by auditory or visual noise. The experiment 1 was conducted to examine the effects of task-irrelevant noise on the search phase of autobiographical memories, whereas the aim of the second experiment was to investigate the effects of visual and auditory noise on the elaboration phase of the autobiographical memory retrieval. The main findings of these two experiments will be summarized below, followed by a discussion of the results.

Examination of the control group data verified that the presentation mode of cue words (visual or auditory) did not affect the autobiographical memory characteristics except the typicality and personal uniqueness dimensions. Results of the experiment 1 showed that noise condition (visual and auditory) led to shorter response times in retrieving autobiographical memories compared to the control conditions. However, there were few systematic differences in the quality of the retrieved memories in the face of different kinds of noise, despite the differences in retrieval times for these two conditions. The only differences between visual and auditory noise conditions were related to typicality and personal uniqueness of memories: Memories in visual noise condition were found to be more typical, and less personally unique, compared to the memories in auditory noise conditions. However, these two results were difficult to interpret because they were found to be affected by the modality of the cue word presentation.

Additionally, the effects of noise manipulations on autobiographical memory retrieval were tested by comparing each noise condition to its matching control group. Interestingly, participants in both of the noise conditions were *faster* than the control group. However, the only differences related to the phenomenological characteristics appeared in the auditory noise to control group comparison. Auditory noise condition led to memories that were less verbal and included less auditory characteristics.

Results of the experiment 1 also showed that the correlations between response time to recall a memory and the memory characteristics were not of a size to be theoretically significant; even though some of the correlations were statistically significant, they predicted at best less that 2.5% of the variance. When the data averaged across trials for each participant used, the only significant correlation was obtained between linguistic characteristics and response times, in which the memories that took longer to retrieve had higher ratings in linguistic characteristics.

Results of the experiment 2 showed that there were no differences between memories in visual noise condition and memories in auditory noise condition. However, like the experiment 1, response times for memories in both of the noise conditions were faster than the response time for recalling a memory in the control group. Moreover, memories of auditory noise condition were more specific than that of control group. There were no other significant results. As in Experiment 1, when the data for each trial were used to compute the correlations between response time and memory characteristics, results showed that even though some of the correlations were statistically significant, they again were not of a size to be theoretically significant, accounting for only 1.2% or less of the total variance. When the data averaged across trials were used, results showed that for all three groups longer response times were associated with recent memories. It was also found that for visual noise condition, the longer the response time the higher ratings did the memories receive for linguistic characteristics.

Results of the experiment 1 showed that, compared to auditory noise, visual noise led to faster reaction times in retrieving an autobiographical memory. These results might suggest that search phase of the autobiographical memory is more sensitive to auditory manipulations. This, in turn, implies that autobiographical memory search depends more on auditory/phonological mechanism compared to visual cues/mechanism. This account would contradict the description of how autobiographical memories are retrieved given by Conway (1996), which emphasizes the role of early retrieval of visual images that serve as retrieval cues for the autobiographical memories proper. This account was also supported by the results of the comparison between auditory noise condition and control group. It was found that the memories from the auditory noise condition had less auditory qualities and were less verbal than the memories of control group.

However, this picture is complicated by the comparison of the noise conditions to the control group. Contrary to expectations, memories from any of the noise conditions, in both experiment 1 and 2, recalled faster than control conditions. According to the principles of affect infusion model (AIM) (Bower & Forgas, 2000; Forgas, 1995), both visual and auditory noise should have resulted in less cognitive capacity to spend in autobiographical memory search. Also, previous studies such as William et al. (2006) showed that a secondary task leads to more general memories. Yet, participants in any of these noise conditions were faster than control groups.

These results might suggest that the noise conditions could be *activating* the areas of the brain directly involved in autobiographical memory search even before participants were presented the cue words. They may be somehow priming code-specific neural networks, preparing those areas for the autobiographical memory task. Therefore, in both of the noise conditions participants were faster than the control group participants. This explanation could also be used to explain the differences between memories of visual and auditory noises in terms of response times. The memories in visual noise conditions were retrieved faster than the memories in auditory noise condition, so this implies that visual noise makes participant more ready that auditory noise. This in turn suggests, along the lines of Conway's (1996) autobiographical memory retrieval, that autobiographical memory search phase is more sensitive to and depends on visual cues compared to auditory cues. This appears to be a simpler explanation of the pattern of results, than one positing a general arousing effect of the noise, superimposed on a greater interference effect for auditory than for visual noise.

Another explanation for the slower reaction times in control group might be that the visual and, to a greater degree, auditory noise was an aversive stimulus, leading participants to press the key to indicate they have a memory and get rid of the noise. However, this is not very likely. First, participants who were interviewed after the experiment reported that they were not really bothered by the noise and they were able to block the noise out and stay focused on autobiographical memory task. Second, if participants would have been forced to press the keys early to come up with a memory, there should have been some differences in phenomenological characteristics of the "speeded" memories in noise conditions compared to control conditions. As discussed below, this was not observed in the current experiments. Finally, the fact that visual and auditory noise produced faster responses even in the second experiment, where the response led to the presentation rather than the termination of the noise, would seem inconsistent with the "annoyance" explanation of the findings, and more consistent with a general activation account.

Even though both Bower & Forgas (2000; Forgas, 1995) and Williams et al. (2006) mentioned cognitive capacity as a factor that might affect some aspects of autobiographical memory retrieval, neither suggests anything about the response times for autobiographical memory retrieval. It might be the case that these noise conditions lead to memories that are less specific compared to control conditions. These less specific memories would probably have been retrieved form an upper level of autobiographical knowledge base compared to more specific memories, therefore resulting in faster response times.

But there were no such differences between visual and auditory noise conditions despite the (small) response time differences. There were differences between noise conditions with respect to the typicality and personal uniqueness dimensions. However, these two characteristics found to be affected by the modality of cue words, therefore they are difficult to interpret.

Comparing the memories of auditory noise condition to the memories of control group showed that auditory noise affected the memories as expected from a cognitive load perspective at least on two specific attributes: Memories from the auditory noise condition were rated as having less auditory experience and were less verbal than the memories of control group. If the auditory noise manipulation decreased the amount of available cognitive capacity by clouding the phonological loop of the working memory, there would be less capacity to employ for the necessities of an autobiographical task. This could, in turn, lead to memories that are less verbal and have less auditory characteristics. However, this explanation conflicts with the previous account about the relationship between auditory or visual noise and response time.

Moreover, the similar account did not worked out for the visual noise condition. According to the cognitive capacity point of view, visual noise should have resulted in memories that have less visual and imagery characteristics than the control group. But the results of the both experiment failed to reveal any effect of visual noise on autobiographical memories except response times.

Overall, these two experiments showed that a very subtle manipulation like visual or auditory noise affected autobiographical memories in some dimensions. On the one hand, manipulations of working memory load such as the ones used by William et al. decreased the working memory capacity that could be allocated to the autobiographical task, which in turn led to more general memories. One of the aims of the current experiment was to test the effect of cognitive load that is manipulated using more ecological approaches to cognition. Visual and auditory noise are just the sorts of examples of interference one could face in daily life situations while trying to retrieve an autobiographical memory. The results of these experiments suggest that autobiographical memory retrieval is very robust to manipulations of this sort.

However, one can think of situations or manipulations that would increase the demand on the working memory capacity and might hinder autobiographical memory retrieval. For the manipulations of the current study, the demands of the visual task could be increased by increasing the number of dots moving at any moment or increasing the speed of the moving dots. The demands of the auditory task could be increased by adding another person with a mismatching gender, alternating the gender of the voice, or adding random noises every now and then.

There are several limitations of the current study. First, there were no qualitative analyses of the memories other than the participants' own ratings. It might be the case that there are in fact some other effects of the noise conditions that were not picked by the autobiographical memory questionnaire but need a more detailed qualitative analysis such as the number of details included in the memory, narrative structure, etc. A second limitation is related to the control group. In order to utilize time, this study divided the cue words into two conditions, and presented half of them visually and the other half auditorily to the same participant. Ideally there should have been two control groups, one of which the cue words are presented visually and for the other one cue words are presented auditorily. Another limitation of the study is that the sample came from the college freshman students. Studies of autobiographical memory are especially prone to the sample population. Studies with adults give a larger pool of diverse autobiographical memories. Finally, an ecological approach to cognition would suggest incorporation of demographics such as gender, race, etc. in the analyses. However, for the current study it was not feasible to control for those variables.

In summary, present results showed that that the speed and, to a limited degree, the content and structure of autobiographical memories were affected by a subtle manipulation of working memory capacity that was intended to interfere with one of the two major “slave systems” of working memory, namely auditory or visual stores, but appeared rather to activate or prime retrieval of these memories, at least in some ways. On the other hand, the results also suggested that in terms of the phenomenological characteristics, at least, autobiographical memory retrieval was in large part unaffected by what might be thought of as everyday noisy conditions. This makes perfect sense in terms of the functionality of autobiographical memory in everyday life. Facing the complexity, randomness, and interferences from many sources, it is very important to have autobiographical memory available as we go through our daily lives.

APPENDIX A
LIST OF CUE WORDS

1. Beach
2. Birthday
3. Cat
4. Dinner
5. Dress
6. Elevator
7. Hotel
8. Movie
9. Plane
10. Restaurant
11. Watch
12. Bathroom
13. Bus
14. Cake
15. Ca
16. Computer
17. Dog
18. Father
19. Garden
20. Gift
21. Holiday
22. Key

23. Museum
24. Music
25. Perfume
26. Pizza
27. Seat
28. Tree
29. Umbrella
30. Water.

APPENDIX B
AUTOBIOGRAPHICAL MEMORY QUESTIONNAIRE

1. While remembering the event, the emotions are positive.

1	2	3	4	5	6	7
not at all		hardly		somewhat		entirely

2. While remembering the event, the emotions are negative.

1	2	3	4	5	6	7
not at all		hardly		somewhat		entirely

3. The emotions that I feel are intense.

1	2	3	4	5	6	7
not at all		hardly		somewhat		entirely

4. While remembering the event, I can see it in my mind.

1	2	3	4	5	6	7
not at all		vaguely		distinctly		as clearly as if it were happening now

5. While remembering the event, I can hear it in my mind.

1	2	3	4	5	6	7
not at all	vaguely		distinctly		as clearly as if it were happening now	

6. While remembering the event, I know the setting where it occurred.

1	2	3	4	5	6	7
not at all	vaguely		distinctly		as clearly as if it were happening now	

7. While remembering the event, I feel that I travel back to the time when it happened.

1 2 3 4 5 6 7

not at all vaguely distinctly completely

8. My memory is unique to my life, I would not expect most people to have similar memories.

1 2 3 4 5 6 7

not at all in some details in some main points completely

9. My memory is unique among my other memories; I do not have other similar memories.

1 2 3 4 5 6 7

not at all in some details in some main points completely

10. While remembering the event, it comes to me in words.

1 2 3 4 5 6 7

not at all vaguely distinctly completely

11. How old are you in this memory? _______________ years old

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BIOGRAPHICAL SKETCH

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