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Spontaneous Recognition Memory Measured by Performance in a Memory Stroop Paradigm

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SPONTANEOUS RECOGNTION MEMORY MEASURED

BY PERFORMANCE IN A MEMORY STROOP PARADIGM

by

Benjamin Axel Anderson

A dissertation presented to the
Graduate School of Arts and Sciences
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ABSTRACT OF THE DISSERTATION

Spontaneous Recognition Memory Measured by

Performance in a Memory Stroop Paradigm

by

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Doctor of Philosophy in Psychology

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Professor Larry L. Jacoby, Chair

Studies of recognition memory have generally involved tests in which the
participant's memory is directly questioned. There are occasions, however, in which
memory is more spontaneous in nature (e.g., recognizing an acquaintance out of context).
The current studies investigated spontaneous recognition memory through the use of a
memory Stroop paradigm, which involved study of pictures and words followed by
recognition memory decisions on either the picture or word component of stimuli with an
old or new word superimposed over an old or new picture. Spontaneous recognition was
measured by comparing the influence of old as compared to new distracters on the
probability of responding "old" to target items. The primary aim of the current studies
was to explore the relationship between retrieval constraint and spontaneous recognition
of distracting information. The results revealed that spontaneous recognition was more
likely to occur when retrieval was less constrained to goal relevant information as a result
of having to switch between decisions on pictures and words. In contrast, when
participants were placed under testing conditions that allowed consistent decisions to be

made on the same stimulus type, spontaneous recognition was not revealed. The results also yielded partial evidence to suggest that spontaneous recognition may be more likely to occur when the distracter is made more fluent as a result of having been repeated during study. Finally, a manipulation involving differential constraint of memory search to the list source in which items were originally studied yielded marginally significant effects, such that source constraint to a particular list target was associated with increased processing of distracters belonging to the list being constrained to. Taken together, the results suggest that spontaneous recognition may be more likely to occur when demands are placed on controlled processing and that spontaneous recognition may be qualitatively modulated by the way control is being oriented in one's environment.

Spontaneous Recognition Memory Measured by Performance in a Memory Stroop

Paradigm

Ebbinghaus (1885) distinguished between *voluntary memory,* the intentional

retrieval of information, and *involuntary memory,* which occurs "…without any act of the

will…". He further stated, "As more exact observation teaches us, the occurrence of these

involuntary reproductions is not an entirely random and accidental one. On the contrary

they are brought about through the instrumentality of other, immediately presented

mental images" (1885/1964, p. 2).

Although memory researchers have typically investigated voluntary memory by

directly asking people to recall or recognize studied items, involuntary memory is

common and at least as important as voluntary memory in daily life. As a commonplace

example, one might encounter an acquaintance and spontaneously recognize him/her

without memory for the acquaintance being directly questioned. There may be important

differences between the memory processes underlying spontaneous recognition and

recognition of the same acquaintance if memory had been directly questioned. The most

obvious difference is that voluntary memory involves the attempt to remember whereas

involuntary memory is more heavily driven by the stimulus. The goal of this thesis is to

further explore the relation between spontaneous recognition memory and recognition

memory that is directed by instructions.

Involuntary memory may be thought of as a more automatic as compared to a

controlled memory process in that it occurs without intention. Mandler (1980) described

encountering an acquaintance in a novel context (viz., his butcher on a bus) to illustrate

the distinction between the experience of familiarity in "knowing" the acquaintance from

somewhere and the retrieval attempt directed toward identifying the acquaintance. Although much research has explored how familiarity influences recognition memory performance when the participant has an explicit goal to remember (e.g., Jacoby, 1991; Jacoby, Woloshyn, & Kelley,1989), the "butcher on the bus" example demonstrates a type of spontaneous recognition memory which appears to be involuntary. In that example, the spontaneous recognition of the acquaintance captures attention (c.f., James, 1890; Johnston, Hawley, Plewe, Elliott, & Dewitt, 1990), whereas familiarity in a recognition test occurs when attention is focused on the direct memory task. The two forms of familiarity might differ in that only the familiarity accompanying spontaneous recognition occurs without intention.

Measuring spontaneous recognition memory requires a means of assessing recognition of an item without directly asking participants to engage in a memory search. Previous research on implicit memory (for a review, see Roediger, 1990) employed "indirect" memory tests to reveal the influence of prior experience when a person has not been directed to engage in voluntary memory. For example, reading a word enhances later perceptual identification of the word when it is briefly flashed, even when the word is not recognized as having been earlier studied (Jacoby & Dallas, 1981). Although indirect tests of this sort reveal a use of memory that is unintentional, they do not provide a measure of spontaneous recognition memory. This is because effects of memory on such tests are often not accompanied by awareness of the past. To measure spontaneous recognition, the subjective experience of "oldness" for an item should influence performance on the indirect test of memory.
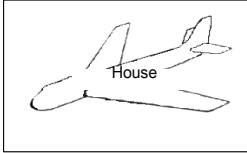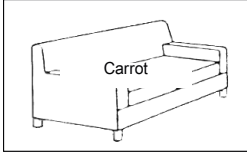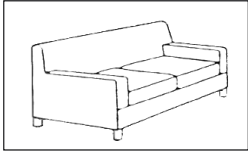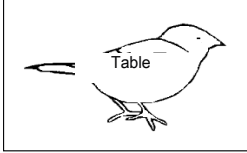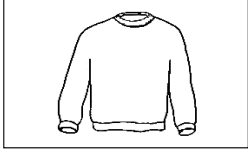
There is little work exploring the dynamics of involuntary recognition memory in the laboratory. However, although not discussed as such, Eriksen, Eriksen, and Hoffman's (1986) use of a "flanker" procedure highlighted the distinction between spontaneous and directed recognition memory. In a procedure designed to investigate memory search processes, they presented sets of letters followed by a memory test that required participants to judge whether a probe letter was presented in the most recent set. The probe letter was flanked by either old letters from the memory set or new letters. Importantly, participants were instructed to ignore the flanking letters and base their judgment solely on the oldness of the probe letter. However, the oldness of the flanker influenced recognition of the probe. The memory judgment on the probe letter was slowed when it was surrounded by an incongruent flanker (e.g., an old probe letter flanked by new letters) compared to a congruent flanker (e.g., an old probe letter flanked by old letters). Further, there was a dissociation between directed and spontaneous recognition in the effect of memory set sizes on performance. Larger memory sets were associated with reduced recognition of the probe letter, but memory set size did not change the effect of flanker oldness on memory. The effect of flanking letters was said to be produced by their familiarity, which was independent of the memory search that was engaged to recognize probe letters.

In a study designed to investigate spontaneous recognition more directly, Ste. Marie and Jacoby (1993) used a similar flanker paradigm that involved words instead of letters. Spontaneous recognition was measured by comparing the influence of *old* compared to *new* flanker words on accuracy and response time of recognition judgments for the target word. That is, if the flanking word was spontaneously recognized as being

old, then it should influence processing of the target word. The experiments included full and divided attention conditions during the recognition test to examine whether attention influenced the likelihood that spontaneous recognition would occur. Results showed that the oldness of the flankers had *no* influence on either response time or accuracy of performance when full attention was given to the recognition memory test. However, when attention was divided, spontaneous recognition was evidenced by results showing that response time was faster when the oldness of the target and flanker was congruent (e.g., old target paired with old compared to new distracter) and slowed when the oldness of the target was incongruent with the distracter (e.g., new target paired with old compared to new distracter). Taken together, prior investigations by Eriksen, Eriksen, & Hoffman (1986) and Ste. Marie and Jacoby (1993) suggest that spontaneous recognition may be assessed via the indirect influence of the distracting information on a target decision.

The current studies further investigated spontaneous recognition by assessing whether the ability to constrain retrieval would influence the contribution of distracting stimuli to recognition memory decisions in a novel picture-word interference paradigm. Participants first studied a series of pictures and words followed by a memory test with each trial displaying an old or new word superimposed over an old or new picture. Participants were instructed to make their recognition decision on either the picture or word and to ignore the distracting stimulus (see Figure 1). As in Ste. Marie and Jacoby (1993), the primary measure for spontaneous recognition was the influence of an old compared to a new distracter on target processing. Recognition memory of the distracter is thought to be spontaneous with its effect being automatic in the same way that word-

Figure 1. Memory Stroop Task

Study Phase	Recognition Test Phase			
			Correct Response	
Study Stimuli	Test Stimuli	Item Type	Word Test	Picture Test
Table	House	New Word New Picture	"New"	"New"
Tiger	Carrot	New Word Old Picture	"New"	"Old"
[couch picture]	Table	Old Word New Picture	"Old"	"New"
[sweatshirt picture]	Tiger	Old Word Old Picture	"Old"	"Old"

reading influences color naming in the color-word Stroop (1935) task. Results from the Stroop task show that naming the ink color is slowed when the color word is incongruent (e.g., the word "red" in green ink) as compared to congruent (e.g., the word "red" in red ink) with the correct response (for a review, see McLeod, 1991). As in the color-word Stroop task, the irrelevant feature of the stimulus is expected to influence judgment of the target in the current paradigm. That is, spontaneous recognition of an old distracter was expected to lead to interference when paired with a new target (i.e., incongruent condition) and facilitation when paired with an old target (i.e., congruent condition). Consequently, I refer to our test of spontaneous recognition as a "Memory Stroop" task.

In the following, I briefly review literature aimed at specifying how intention to remember has its effect. As will be argued, a better understanding of voluntary memory is a prerequisite for understanding involuntary memory of the sort revealed by spontaneous recognition. Next, I return to techniques of measuring involuntary memory and review prior work that examined spontaneous recognition memory. I then introduce the current experiments done for my thesis, providing further review of the existing literature in the context of those experiments.

Controlled vs. Automatic Processes: Retrieval Orientation.

Controlled processes are generally described as intentional, capacity limited, and "in charge" of the allocation of lower processing resources to goal relevant features of a task (e.g., Hasher & Zacks, 1988, Jacoby, 1991; Schneider & Shiffrin, 1977). In the context of memory, controlled processes involve searching the contents of memory for information relevant to the task at hand and excluding irrelevant information (e.g., Buckner, 2003). The ability to employ control is influenced by dividing attention or

having participants switch between task goals. Manipulations such as these lead to decreased ability to avoid interference from distracters as well as decreased ability to direct memory toward source or contextual information (e.g., Mayr & Kliegl, 2000; Yonelinas, 2002). In sum, the controlled processing characteristics of intention and constraint are at the core of what is considered to be voluntary memory.

The defining characteristics of automatic processes tend to be less agreed upon. In general, disagreements involve whether or not automatic processes are purely stimulus driven, are accompanied by awareness, and whether they are entirely divorced from intention (e.g., Jacoby, 1991; Kinoshita, 2001; Richardson-Klavehn & Gardiner, 1995; Schneider & Shiffrin, 1977). The vast amount of research providing evidence for and against these claims is beyond the scope of the current thesis but will be briefly considered when returning to questions about spontaneous recognition. The approach that I take toward relating automaticity to involuntary and voluntary memory is to consider how automatic processing depends upon how control is being directed, an idea which will be referred to as the "relativity of automaticity" (see Allport, 1989; Folk, Remington, & Johnston, 1992; Neumann, 1984; Ste. Marie & Jacoby, 1993).

The construct of "retrieval orientation" incorporates the processes of preparing to retrieve a particular target from memory and maintaining memory retrieval toward such targets for an extended period of time (Rugg & Wilding, 2000; Tulving, 1983). When retrieval is not effectively focused toward a particular source, irrelevant information from other sources may be processed, leading to increased retrieval demands and decreased performance. Much of the work on retrieval orientation has utilized neuroimaging to isolate networks that are associated with control during memory retrieval. For example, a

recent study conducted by Woodruff, Uncapher, and Rugg (2006) used a mixed design to investigate item and state level neural activation when focusing retrieval decisions toward a particular stimulus type. Their task involved studying words and pictures followed by recognition test blocks which presented a cue instructing participants to orient retrieval toward either pictures or words. The rationale was that orienting and maintaining retrieval to a particular stimulus type during test should bias processing of the retrieval toward the current goal. Results were consistent with the idea of encoding specificity (Tulving & Thompson, 1973) such that orienting retrieval to pictures led to greater recruitment of picture processing areas (e.g., left BA 37) and orienting to words led to greater activation in word processing areas at both sustained and item levels. That is, the controlled process of preparing and maintaining retrieval toward a cued stimulus type led to increased activation of top down areas which allowed for selective recruitment of the task relevant processing areas.

Other research has also considered variation of control processes during retrieval as reflecting qualitatively different ways of using memory. This work has emphasized the extent to which memory is directed toward contextual information compared to using familiarity to decide whether something is old (e.g., Dobbins & Han, 2006). Along these lines, source constrained retrieval has considered differential retrieval constraints as being reliant on a controlled (recollection) rather than an automatic (familiarity) process as a proactive basis for directing recognition memory search. The importance of this work comes in showing that age differences in memory are potentially due to older adults not directing memory toward source information, instead using a fluency or familiarity based decision (e.g., Jacoby, Shimizu, Velanova, & Rhodes, 2005).

Moscovitch and Melo (1997) distinguished between strategic processes taking place pre-retrieval (or "at input") and post-retrieval (or "at output"). Along similar lines, Burgess and Shallice (1996) put forward a schematic model that includes a pre-retrieval descriptor process, which specifies attributes of the solicited trace (cf. Norman & Bobrow, 1979), as well as post-retrieval editing and evaluation processes. Based on their findings, Moscovitch and Melo (1997) and Burgess and Shallice (1996) concluded that both pre- and post-retrieval deficits can contribute to confabulation. Some progress has been made toward specifying the contributions of retrieval processes in preventing wrong information from coming to mind, as opposed to the contribution of post-retrieval monitoring processes in rejecting such information (e.g., Jacoby, Kelley, & McElree, 1999; Jacoby, et al., 2005). In a similar vein, Braver and colleagues (e.g., Braver et al. 2005; Paxton, Barch, Racine, & Braver, 2008) have sought to separate "proactive" (pre-retrieval) processes from "reactive" (post-retrieval) processes that serve to resolve response conflicts. This work emphasizes the importance of goal maintenance in the biasing of retrieval toward task relevant information. Results from these lines suggest that proactive control is more effective than reactive control in allowing one to avoid interference from distracting information.

Returning to the issue of involuntary memory, the nature of cognitive control that is exercised might be an important determinant of involuntary memory. For example, if processing is sufficiently constrained by the demands of an ongoing task, involuntary memory may not occur.

Results from Prior Investigations of Involuntary Memory

The dynamics of involuntary memory have only recently been investigated, primarily in the context of autobiographical recall. The bulk of this work has been done using self report and diary studies in which the participant is asked to report when involuntary memories occur and describe what they were doing at that time (e.g., Berntsen, 2007; Mace, 2006). These studies show that involuntary autobiographical memories tend to be specific, externally driven by people, activities, objects, locations, topics, etc., and typically occur while in a non-focused state (e.g., Berntsen, 2007; Kvavilashvili & Mandler, 2004). Despite the growing area of research on involuntary autobiographical recall that has recently developed, little work has been directly aimed toward experimentally investigating the dynamics of involuntary recognition memory (Anderson, Jacoby, Thomas, & Balota, in press; Ste-Marie & Jacoby, 1993). In line with the involuntary autobiographical studies, this work also highlights the importance of a non-focused state for the occurrence of involuntary memory.

Ste. Marie and Jacoby (1993) used a flanker paradigm to measure spontaneous recognition memory in which old/new target words were presented centrally and flanked by old/new distracter words (c.f., Eriksen, Eriksen, & Hoffman, 1986). The rationale for this design was that involuntary memory can't be measured by asking a direct question regarding its prior occurrence. Spontaneous recognition was therefore measured as the influence of the *old* compared to *new* flanker word on the target word accuracy and reaction time. That is, if the flanking or distracter word was spontaneously recognized as being old, then it should influence processing of the target word. The experiments included full vs. divided attention conditions during test to examine how attention influenced the tendency for spontaneous recognition to occur. Further, the relationship

between the targets and distracters was manipulated by 1) increasing fluency via repeating words during study, and 2) incorporating different source modalities (heard vs. read). Fluency and modality manipulations set up a comparison between match vs. mismatch in prior processing between the target and distracter. Crossing these factors allowed for a test of the relativity of automaticity under which spontaneous recognition might occur.

Results from these experiments yielded the following conditions under which spontaneous recognition occurred. First, the oldness of the flankers had *no* influence on either reaction time or accuracy performance when full attention was given to the test of recognition memory. Second, when attention was divided, the time in deciding the oldness of the target items was facilitated when the oldness of the target and flanker was congruent (e.g., old target paired with old compared to new distracter) and interfered with when the oldness of the target was incongruent with the distracter (e.g., new target paired with old compared to new distracter). Third, a target shown once was *less* influenced by the five-times-presented distracter than it was by the one-time-presented distracter, showing the importance of the match between familiarity of the target and distracter. Spontaneous recognition was not observed when the targets were fluent from having been presented multiple times during study. Finally, when subjects studied words in auditory and visual formats, spontaneous recognition only occurred when there was a match in prior modality during test (e.g., heard word flanked with heard words).

To summarize these results, spontaneous recognition only seemed to occur when attention was divided during test and when there was a match in prior processing between the target and distracter (in modality and repetition). Spontaneous recognition was not

observed under full attention conditions or for the divided attention condition when the targets were made fluent through repeated study.

Given the conditions in which prior processing history match was required to yield spontaneous recognition, these results were interpreted as evidence that spontaneous recognition is not entirely divorced from the orientation of memory retrieval. Other research investigating attention has revealed similar patterns. Neumann (1984) suggested that automatic processes are not independent of one's current attentional state. Folk, Remington, and Johnston (1992) also put forth a theory on the contingent orienting of attention, which states that an attentional set establishes what is relevant to the current task demands and determines what type of information is "filtered" or selected for in our visual environment. In other words, what is distracting is contingent upon the attentional set or the goal one has at the time. Their idea (akin to Neumann's) contrasts with theories that consider involuntary shifts of attention to be solely stimulus driven.

Preliminary Research on Spontaneous Recognition

Prior behavioral experiments were conducted using a novel picture-word interference paradigm to investigate how age, attention, and retrieval constraint relate to the tendency for spontaneous recognition of distracters. The task involved multiple study-test blocks in which participants studied a series of pictures and words and then made recognition memory decisions on either the picture or the word component of stimuli consisting of an old or new word superimposed over an old or new picture (see Figure 1). The oldness of target and distracter stimuli was crossed in a similar fashion to the Ste. Marie and Jacoby (1993) study, allowing for either old or new targets to be paired with old or new distracters. Recall from the Ste. Marie and Jacoby study that the influence of an old

compared to new distracter on target processing is the index for spontaneous recognition. Spontaneous recognition was expected to be shown as interference when a new target was paired with an old rather than new distracter while facilitation was expected when an old target was paired with an old rather than new distracter.

Anderson et al. (in press) tested the effects of attention and aging on the tendency for spontaneous recognition of distracting information to occur. Full attention younger adults completed the recognition memory test as described above. The divided attention young were asked to monitor a series of auditorily presented digits while simultaneously completing the recognition memory task. An older adult group was tested under full attention conditions in order to examine age differences in spontaneous recognition.

Results from Experiment 2 in Anderson et al. (in press) are shown in Table 1. These findings indicate that when making memory decisions for target pictures or words, older adults and divided attention younger adults were influenced by the oldness of distracters. This was shown by the probability of responding "old" to increase when targets were paired with old as compared to new distracters. Interestingly, the influence of old distracters found for the divided attention young and the older adults was greater for recognition decisions to words than to pictures. This result may have been due to the better memory for the picture information which may have led to greater influence on memory decisions.

Another experiment was conducted to determine whether retrieval orientation influences the tendency for spontaneous recognition to occur in younger adults. The experiment manipulated retrieval orientation by varying the cue to stimulus interval (CSI) in a within subjects fashion such that in some test blocks participants had 250 ms to

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Table 1. *Probability of Judging an Item as "Old" as a Function of Target, Distracter, Test Type, and Group in Experiment 2 from Anderson et al. (in press).*

Group	Old Target		New Target	
	New Distracter	Old Distracter	New Distracter	Old Distracter
Picture Trials				
Full Att. Young	.85 (.13)	.87 (.14)	.07 (.13)	.05 (.08)
Div. Att. Young	.80 (.14)	.79 (.16)	.10 (.06)	.14 (.10)
Older Adults	.91 (.12)	.93 (.08)	.06 (.07)	.10 (.11)
Word Trials				
Full Att. Young	.76 (.17)	.75 (.17)	.09 (.10)	.09 (.09)
Div. Att. Young	.52 (.18)	.64 (.14)	.16 (.13)	.23 (.15)
Older Adults	.65 (.19)	.71 (.21)	.08 (.08)	.16 (.15)

Note. Standard deviations are shown in parentheses.

prepare their response based on the cue ("P" for picture or "W" for word) but had

1500ms to prepare in the other blocks. Another critical change was that participants had

to switch between making decisions on the picture or word during test. Reliable

differences between short and long CSI were not observed. Therefore, results are

collapsed across these conditions.

Results from this second preliminary experiment are displayed in Table 2. Most

important, spontaneous recognition was observed in this experiment for the younger

adults placed under mixed testing conditions. This is most clearly evidenced by the word

trial performance, where the probability of responding "old" was higher for decisions

made to new targets paired with old (.19) as compared to new (.15) distracters and for

decisions made to old targets paired with old (.72) as compared to new (.65) distracters

Post hoc analyses between the two preliminary experiments showed a significant

difference in the influence of old vs. new distracters ($p < .01$), with greater spontaneous

recognition occurring for the younger adults under mixed, as compared to pure testing

conditions. Note that this comparison is being made between experiments and is not

statistically sound given the lack of random assignment and *a priori* hypotheses in

comparing test condition (pure vs. blocked). However, the possibility remains that the

younger adults were showing spontaneous recognition when having to switch between

decisions on the picture vs. word component during test. This difference between

blocked and mixed decision during test is interesting considering the impact that

switching between goals during similar tasks has on the ability to control retrieval (e.g.,

Mayr & Kliegl, 2000).

Table 2. *Probability of Judging an Item as "Old" as a Function of Target, Distracter, and Stimulus Type in the Preliminary Experiment Involving Mixed Test Conditions.*

Group	Old Target		New Target	
	New Distracter	Old Distracter	New Distracter	Old Distracter
Picture Trials	.80 (.16)	.83 (.15)	.10 (.11)	.13 (.12)
Word Trials	.65 (.20)	.72 (.18)	.15 (.17)	.19 (.17)

Note. Standard deviations are shown in parentheses.

Results across both experiments show that age, divided attention, and target switching are associated with an increase in spontaneous recognition. The common theme across these conditions is the decreased ability to control retrieval. Under such situations of limited control, it is likely that individuals rely more heavily on familiarity as the basis for making the recognition decision. If participants were appropriately constrained to the picture or word that the decision should have been made upon, then non-goal related information would not have much of an impact. On the other hand, not constraining control resources to the appropriate source in making the decision would instead lead to use of familiarity for deciding the oldness of the test item. Lack of constraint in the situation where two streams of information are competing for resources would lead to increased processing of the distracting information resulting in spontaneous recognition. Thus far, the very limited amount of work done investigating spontaneous recognition suggests that it tends to occur in conditions in which control processes are limited as found with divided attention and aging comparisons. However, further investigation is needed to understand the dynamics between spontaneous recognition and cognitive control.

Overview of Experiments

The current project aims to establish some of the conditions under which differential ability to constrain retrieval toward a goal leads to spontaneous recognition of other information. Little work has been done exploring the conditions under which spontaneous recognition memory occurs. Additional research exploring these conditions would further establish whether the 'relativity of automaticity' pattern that has been shown in prior work generalizes across conditions where retrieval constraint is

manipulated. Further understanding this relationship has implications for several areas of research that incorporate controlled and automatic processing distinctions as discussed above, including theories of automaticity, retrieval orientation, source constrained retrieval, involuntary memory, and task switching.

Research most relevant to the current project is the work done by Ste. Marie and Jacoby (1993) and the prior work done using the memory Stroop paradigm (Anderson et al., in press). The results from both of these lines will be briefly reviewed in order to highlight the patterns that are beginning to surface, but to also reveal the limitations and necessary research to be conducted to further our understanding of spontaneous recognition.

The Ste. Marie and Jacoby (1993) experiments found that spontaneous recognition only occurs under divided attention when there is a match in prior processing between the target and distracter, given that the target is not easily recognized through repetition. The prior research using the memory Stroop paradigm showed that divided attention (in younger adults) and age led to increased spontaneous recognition of distracters. During the memory Stroop task, participants were instructed to base their memory decision on either the picture or word component of a stimulus during test and to ignore the other information. It is possible that the increased spontaneous recognition of distracters in these groups may have been due to familiarity based responding, such that decisions were based more on the general "oldness" or fluency of the item, rather than the particular stimulus type participants were instructed on which to base their decision. This explanation corresponds with prior results showing increased interference in recognition

for older adults and divided attention younger adults, both of whom are thought to rely more heavily on familiarity (e.g., Yonelinas, 2002).

Taken together, the Ste. Marie and Jacoby (1993) and the memory Stroop experiments reveal the relationship between decreased ability to control retrieval and spontaneous recognition. However, a couple of patterns remain unclear. First of all, the effect that distracter fluency has on spontaneous recognition is ambiguous. The Ste. Marie and Jacoby study found that spontaneous recognition was less likely to occur when a 1x presented target was paired with a 5x presented distracter compared to a 1x presented distracter, showing that increased distracter fluency did not necessarily cause increased spontaneous recognition. In contrast, the memory Stroop study showed that new word targets paired with old picture distracters were significantly more likely to cause spontaneous recognition of the distracter compared to a new picture target paired with an old word distracter. Further, results showed that pictures were reliably judged more accurately and quickly than words, suggesting that pictures are more fluent than words in this task. These results are somewhat contradictory regarding the role that distracter fluency has on the tendency for spontaneous recognition to occur; an issue that the current experiments further explore.

Prior work is also unclear regarding the role of retrieval constraint and intention on spontaneous recognition. Is spontaneous recognition confined to situations in which familiarity is guiding retrieval, or does it also occur when retrieval is constrained to the goal information? The recognition decisions made across the Ste. Marie and Jacoby (1993) experiments did not require participants to intentionally constrain their memory search to a particular source of information (e.g., heard vs. read list). Rather, participants

were not informed of the targets being from the same modality and did not report being aware that target items were from a particular list (read or heard) when questioned after the experiment. Given these conditions of incidental retrieval, it is uncertain what role source constrained retrieval has on whether spontaneous recognition occurs and whether the relativity of automaticity holds under such conditions.

The results from Experiment 2 of the memory Stroop study hint that spontaneous recognition may not be confined to situations where familiarity is the primary basis for recognition. This experiment suggests that younger adults may spontaneously recognize distracters when having to switch between memory decisions on the picture or word during test. Under these conditions, the interference from distracting information is likely due to the decreased ability to maintain retrieval constraint on a particular stimulus type. Retrieval constraint could vary from being tightly constrained to the specific stimulus type to being loosely constrained to the general oldness of the stimuli. The demands of having to switch between the targets can be considered to be on controlled retrieval. The critical difference between this condition and the Ste. Marie and Jacoby task is that intention is used during retrieval with the memory Stroop task. Attention was not divided and the instructions were clear regarding what the retrieval goal was during testing, allowing for controlled retrieval to be used.

It thus remains unclear whether spontaneous recognition only occurs under conditions in which attention is divided and familiarity drives the memory decision. Further investigation of this possibility is needed with more thorough methods that allow constraint or a recollective decision to be in play during memory. This would help determine whether spontaneous recognition extends to such situations, or if it only occurs

when one is more reliant on familiarity (as would be the case if attention is divided across tasks). Testing the generality of spontaneous recognition is important for understanding the dynamics under which it occurs. This would be informative to theories of recognition memory and cognitive control. In line with this, testing spontaneous recognition under conditions in which retrieval constraint is in play explores the extent to which the "relativity of automaticity" explanation that yielded the occurrence of spontaneous recognition in prior studies generalizes to conditions in which retrieval constraint and control is required.

The current thesis aims to shed light on the issues just brought to bear through three experiments designed to test 1) the extent to which spontaneous recognition occurs when demands on retrieval constraint are manipulated (as when having to switch between retrieval goals), 2) how the fluency of target and distracter information affects spontaneous recognition, and 3) the extent to which spontaneous recognition occurs when memory is being intentionally directed toward the context that targets (pictures vs. words) were presented within. Inherent to all of these aims is an attempt to determine how tractable the relativity of automaticity pattern is across manipulations of fluency and intentional retrieval of source information.

The experiments implemented an interference paradigm similar to that used in the preliminary results discussed above that includes target and distracter information presented simultaneously during testing. The task for the participant was to utilize instructions and/or cues in making their recognition decision. In all cases, these instructions and cues are a means to test how different levels of constraint can potentially influence spontaneous recognition memory. As discussed, spontaneous recognition has

been demonstrated as a significant influence of an "old" vs. "new" distracter on an "old" or "new" target decision. This influence can be shown in both accuracy and reaction time in the forms of both facilitation and interference. More specific rationale, methods, and expected results will now be described for each individual experiment.

Experiment 1: Pure vs. Mixed Retrieval Constraint

Controlled processing is generally considered to be involved when directing memory toward source or contextual information and/or avoiding interference from distracting information (e.g., Mayr & Kliegl, 2000; Yonelinas, 2002). These controlled processing characteristics are central to voluntary memory, while their relationship with spontaneous recognition is uncertain. In general, experiments have utilized interference paradigms in order to influence the ability to use control during memory or attention. Braver & West (2008) discuss "task switching" studies in the context of other manipulations used in the domain of executive control and goal maintenance that put constraints on control such as when dividing attention or placing individuals in a dual task situation (e.g., Craik, 1982; 1983; Craik & McDowd, 1987; Skinner & Fernandes, 2008).

Research in the area of task switching is generally focused toward better understanding the mechanisms involved when having to switch between tasks in one's environment. The basic idea is that a "task set" is configured toward goal relevant information to constrain the information required to fulfill the task demands (De Jong, Berendsen, & Cools, 1999). Such processes within the memory domain are very similar to those discussed above regarding retrieval orientation and the controlled process of constraining memory to a particular source. The task switching approach is particularly

interesting for current purposes since it involves manipulations that influence level of constraint while introducing additional factors such as local and global switch costs, task set coordination, representation, and updating.

Mayr & Kliegl (2000) suggest that the costs of switching from one task set to another are due to the demands on retrieving the appropriate task rules from LTM. They found that the demands of switching to tasks requiring the use of episodic information were significantly greater than the demands of switching to tasks requiring semantic information. The reason for greater costs from switching to episodic task processing was the additional retrieval of contextual information used to support such a decision. Switching between different tasks tends to cause an increase in interference as typically shown in slowed response time and decreased accuracy. Control is required to reconfigure to another task set and doing so places higher demands on the system. These demands may be due to the need to maintain partial activation of both tasks when switching, as compared to situations wherein a single task goal is maintained.

Across prior experiments done with the memory Stroop task (Anderson et al., in press), little evidence was found for spontaneous recognition in younger adults with a blocked test design. In contrast, spontaneous recognition of distracters was found with a mixed (switching) test design. These results suggest that younger adults might be susceptible to the influence of distracting information when they have less ability to constrain to the source of the information as a result of having to switch between making memory decisions on picture and words.

Experiment 1 tested whether switching between memory sources leads to an increased tendency to spontaneously recognize non-target information. The rationale is

that in a switching condition, residual effects of prior target constraint should increase the demands on control when having to update to a new a target decision. For Experiment 1, constraint was manipulated via test format (pure vs. mixed). The pure test condition included separate test blocks in which the recognition decision was made purely on the picture or the word component. In contrast, the mixed test condition included test blocks with intermixed recognition decisions. Comparisons between these test conditions yield evidence for how spontaneous recognition is influenced when switching between test decisions versus maintaining a task set throughout the test sequence.

Experiment 1 utilized a within subjects design (rather than a between subjects design), because it allows greater consistency between the pure and mixed condition test formats, such that cues could be displayed prior to each test item for both conditions. Further, a within subjects design was thought to increase the cue utilization for the pure condition given the contrasting mixed condition in which it is necessary to attend to each cue in order to make the appropriate response. Finally, note that the design for Experiment 1 differs from preliminary experiments described above, which either involved pure retrieval blocks (see Table 1) or mixed retrieval blocks (see Table 2).

Participants were expected to show more spontaneous recognition of old distracters in the mixed compared to the pure condition. Two primary comparisons (facilitation and interference) were made to determine the amount of spontaneous recognition of distracters between the conditions. Interference is marked by decreased accuracy and increased RT when a new target is paired with an old rather than new distracter. Facilitation is marked by increased accuracy and decreased RT when an old target is paired with an old rather than new distracter. Both interference and facilitation

from old distracters are expected to be greater for the mixed test condition. This overall comparison between conditions will be labeled as global switch costs.

Local switch costs refer to the difference between switch and non-switch trials within the test phase for the mixed condition. Local switch costs were assessed by comparing trials that were preceded by a decision on the same stimulus type (non-switch) to trials that were preceded by a decision on the other stimulus type (switch). It was expected that switch costs (switch-non-switch trials) would be associated with decreased accuracy and increased response time.

The overall design was a 2 (test condition: pure, mixed) x 2 (stimulus type: picture, word) x 2 (target type: old, new) x 2 (distracter type: old, new) within subjects design. A schematic of the task and representative stimuli used in the experiment is shown in Figure 1.

Methods

Participants

Thirty-two Washington University students between the ages of 18 and 21, ($M =$ 19.41, $SD = .98$) participated in this study. Participants were recruited via the Psychology department subject pool and received either credit or payment for their participation.

Materials and Design

The experiment included 496 pictures and 496 words. Sixteen of these pictures and words were assigned to the practice round while the remaining 480 were used in the experiment proper. The picture material set consisted of pictures courtesy of Michael J. Tarr, Brown University, http://www.tarrlab.org/ (see Rossion & Pourtois, 2004) as well

as Wilma Koutstaal, University of Minnesota. These pictures were all single line drawings of objects without background, shading, or color. The words were selected from the Elexicon database (Balota et al., 2007; http://elexicon.wustl.edu/). All words were nouns ranging from 3-8 letters in length and presented in black 20 point Arial font.

Pictures and words were pseudo-randomly paired for the memory test with the only restriction being that the picture and word were not semantically related. The test lists were randomly ordered and identical across all participants. The test items were fully counterbalanced such that each item occurred equally often across participants in each condition.

The experiment consisted of ten epochs, each of which included a study and test phase. Each study phase included an intermixed presentation of 24 pictures and 24 words, with the restriction that no more than three consecutive presentations of the same stimulus type occurred.

For the test phase, the pure condition included two blocks of 24 items, with one block testing memory for pictures and the other testing memory for words. The mixed condition included a single block of 48 items which tested memory for both pictures and words, with the restriction that no more than three consecutive decisions on the same stimulus type occurred. For both the pure and mixed conditions, each test block included an equal number of the test item types (e.g., new target/old distracter) with the condition that no more than two of the same item type occurred consecutively. The pure and mixed test conditions were alternated between runs for each subject, and the order of test conditions was further counterbalanced across participants.

Procedure

The experiment began with task instructions followed by a brief practice round. Task instructions informed participants that they would complete a series of study/test blocks involving pictures and words; that a cue would be shown prior to each test item; and that during some test blocks these cues would alternate more often than others. Each of the ten study/test runs began with an instruction screen telling participants to study the following pictures and words. Study items were then presented one at a time on the center of the screen for 1.5 seconds with a 500 ms inter-stimulus interval (ISI).

Each recognition test phase included an instruction screen informing participants to pay attention to the cue shown prior to each test item and to base their recognition decision on that cue for the picture or word. During the pure condition test blocks, participants were further instructed that all of the following cues would be for the same stimulus type (pictures or words). The test cues were a "P" or "W" displayed at the center of the screen for 1 second. The test display was presented immediately following the cue, and consisted of an old or new picture with an old or new word superimposed in its center. The test stimulus was randomly presented in one of four slightly off center quadrants on a white screen. Participants were given up to three seconds to make their response. After the participant's response or the exhaustion of the three seconds, the screen cleared for an ISI of 500ms and the next test cue was presented. This same procedure consisting of instructions, study blocks, and test blocks was repeated 10 times across the experiment with a break occurring half way through. The total time of testing was approximately 45 to 60 minutes.

Results and Discussion

   Overview

Spontaneous recognition is evidenced by a significant influence of old compared to new distracters on memory judgments of the target picture or word. The current experiment sought to determine whether spontaneous recognition would be greater when making judgments in the mixed test condition than the pure test condition. This interaction between test condition and distracter type was of particular interest since it would provide the primary measure of global switch costs on spontaneous recognition. Local switch costs were also assessed by comparing trials in the mixed condition that involved a switch vs. non-switch from the former stimulus type decision (picture or word). The influence of spontaneous recognition on memory performance was assessed across these factors by separate analyses on hits and false alarms, and on response times to correct trials. Unless otherwise noted, significance for all reported statistics was $p < .05$.

Hits and False Alarms

Spontaneous recognition of old distracters can be seen by either an increase in hits when responding to old targets or an increase in false alarms when responding to new targets. Table 3a shows recognition accuracy in the probability of responding "old" to items as a function of condition (mixed vs. pure), stimulus type (picture vs. word), target status (old vs. new), and distracter status (old vs. new). Hits are shown on the left and false alarms on the right side of the table. The analysis of hits (left side of Table 3a) indicated a non-significant difference between the pure and mixed conditions in overall hit rate, $F < 1$. Hit rate was higher for pictures (.80) than for words (.69), $F(1, 31) = 26.38$, $p < .001$, $\eta_p^2 = .460$, and was higher for targets paired with old (.76) compared to new (.72) distracters, $F(1, 31) = 16.98$, $p < .001$, $\eta_p^2 = .354$.

Table 3a. *Probability of Judging an Item as "Old" as a Function of Target, Distracter, Stimulus Type, and Test Condition in Experiment 1.*

| Condition | Old Target | | New Target | |
	New Distracter	Old Distracter	New Distracter	Old Distracter
		Picture Trials		
Mixed	.75 (.15)	.82 (.15)	.08 (.10)	.12 (.10)
Pure	.80 (.18)	.81 (.19)	.08 (.09)	.10 (.10)
		Word Trials		
Mixed	.67 (.19)	.72 (.17)	.16 (.13)	.22 (.14)
Pure	.67 (.17)	.69 (.20)	.12 (.11)	.14 (.11)

Note. Standard deviations are shown in parentheses.

The Stimulus Type x Distracter and the Condition x Stimulus Type x Distracter interactions were non-significant, both F's < 1. The Condition x Stimulus-Type interaction was marginally significant, $F(1, 31) = 4.09$, $p = .052$, $\eta_p^2 = .117$, indicating that hit rate for words was more closely matched between the pure (.68) and mixed (.69) conditions, whereas hit rate for pictures was greater for the pure (.81) than mixed (.78) condition. More importantly, the Condition x Distracter interaction demonstrated that the increase in hit rate for targets paired with old rather than new distracters was greater in the mixed condition (.77 vs. .71), as compared to the pure condition (.75 vs. .73), $F(1, 31) = 4.62$, $p = .039$, $\eta_p^2 = .130$.

The analysis of false alarms (right side of Table 3a) indicated that false alarms were higher in the mixed (.15) than the pure (.11) condition, $F(1, 31) = 15.12$, $p < .001$, $\eta_p^2 = .328$; for new words (.16) than for new pictures (.09), $F(1, 31) = 20.44$, $p < .001$, $\eta_p^2 = .397$, and for new targets paired with old (.15) vs. new (.11) distracters, $F(1, 31) = 22.06$, $p < .001$, $\eta_p^2 = .416$. The Condition x Stimulus-Type interaction was also significant, indicating that false alarms to picture targets was closely matched between the mixed and pure conditions (.10 vs. .09, respectively), but false alarms to target words was greater in the mixed than the pure condition (.19 vs. .13, respectively), $F(1, 31) = 9.94$, $p = .004$, $\eta_p^2 = .243$. The Stimulus Type x Distracter and the Condition x Stimulus Type x Distracter interactions were non-significant, both F's < 1.13. Most importantly, the comparison of spontaneous recognition between the pure and mixed conditions (Condition x Distracter interaction) demonstrated that the increase in false alarm rate for targets paired with old rather than new distracters was higher in the mixed condition (.17

vs. .12), as compared to the pure condition (.12 vs. .10), $F(1, 31) = 4.97$, $p = .033$, $\eta_p^2 = .138$.

In sum, analyses on both hits and false alarms showed an increased tendency for spontaneous recognition of old distracters in the mixed as compared to the pure condition.

Response time

Response time (RT) analyses were restricted to correct responses that were no more than 3 standard deviations above or below each participant's mean RT, resulting in approximately 1% of correct trials being removed. Analyses on RT were conducted in the same fashion as accuracy, with separate repeated measures ANOVAs on facilitation (old targets paired with old vs. new distracters) and interference (new targets paired with old vs. new distracters) effects across test type and between condition.

As can be seen on the left side of Table 3b, there were large RT differences between conditions and stimulus type when responding to old targets. Participants were faster to respond in the pure condition (904 ms) than in the mixed condition (1169 ms), $F(1, 31) = 177.84$, $p < .001$, $\eta_p^2 = .852$. Participants were also faster to respond to pictures (954 ms) than to words (1119 ms), $F(1, 31) = 106.66$, $p < .001$, $\eta_p^2 = .775$. The central comparison of interest between condition and distracter showed a significant difference, such that participants were more influenced by old compared to new distracters in the mixed condition (1182 vs. 1156 ms) than in the pure condition (898 vs. 910 ms), $F(1, 31) = 7.27$, $p = .011$, $\eta_p^2 = .190$. All other effects were non-significant, all F's < 1.

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Table 3b. *Response Time (in ms) as a Function of Target, Distracter, Stimulus Type, and Test Condition in Experiment 1.*

Condition	Old Target		New Target	
	New Distracter	Old Distracter	New Distracter	Old Distracter
Picture Trials				
Mixed	1072 (187)	1095 (214)	1102 (210)	1121 (241)
Pure	834 (139)	816 (113)	885 (128)	890 (146)
Word Trials				
Mixed	1239 (220)	1269 (234)	1195 (231)	1275 (269)
Pure	986 (137)	981 (142)	979 (152)	1003 (160)

Note. Standard deviations are shown in parentheses.

The analyses on response time for new targets showed a similar pattern to that on old targets. As can be seen on the right side of Table 3b, participants were faster to respond in the pure condition (939 ms) than in the mixed condition (1173 ms), $F(1, 31) = 102.77$, $p < .001$, $\eta_p^2 = .768$. Participants were faster to respond to pictures (999 ms) than to words (1113 ms), $F(1, 31) = 74.13$, $p < .001$, $\eta_p^2 = .705$, and were slower to respond to new targets paired with old (1072 ms) as compared to new (1040 ms) distracters, $F(1, 31) = 13.21$, $p = .001$, $\eta_p^2 = .299$. The Stimulus Type x Distracter interaction was also significant, such that greater interference from old vs. new distracters occurred for words (1139 ms vs. 1087 ms) than for pictures (1005 ms vs. 993 ms), $F(1, 31) = 6.02$, $p = .020$, $\eta_p^2 = .163$. Non-significant effects were observed for the Condition x Stimulus Type interaction, $F(1, 31) = 2.59$, $p = .177$, $\eta_p^2 = .077$, and for the Condition x Stimulus Type x Distracter interaction, $F(1, 31) = 2.49$, $p = .125$, $\eta_p^2 = .074$. The primary comparison of interest between condition and distracter showed a significant interaction. Greater interference occurred from new targets paired with old compared to new distracters in the mixed condition (1198 vs. 1148 ms) than in the pure condition (946 vs. 932 ms), $F(1, 31) = 6.08$, $p = .019$, $\eta_p^2 = .164$.

Spontaneous recognition of old as compared to new distracters was associated with slowing of response time across both new and old target decisions. Slower response times would be expected for decisions made on new targets paired with old distracters; in a similar way that Stroop interference occurs when naming a color paired with an incongruent word (e.g., naming the color "blue" on the word "red"). Further extending this parallel, one might have expected that an old distracter would have led to speeding, or facilitation, when judging an old target. However, the response times to old target

items did not show facilitation when paired with old distracters. Rather, old distracters were associated with slower response time when participants judged either old or new target items. The respective pattern of interference and facilitation from spontaneously recognizing old distracters was observed in accuracy but not in response time. Note that prior results (Anderson et al., in press) and those to be presented in Experiments 2 and 3 tend to show effects of spontaneous recognition in measures of accuracy rather than response time. It is possible that greater emphasis on accuracy (e.g., by providing feedback at test) may have led to greater influence on response time, as is typically observed in color-word Stroop (MacLeod, 1991). It should also be mentioned that decisions on picture targets were associated with higher response accuracy and faster response time. It is possible that this pattern may have been due to the picture superiority effect (Ally, et al., 2008; Madigan, 1983; Paivio, 1969), such that pictures are more distinctive than words (also see Dodson & Schacter, 2002).

To summarize briefly, global accuracy and response time analyses showed greater spontaneous recognition of old distracters in the mixed than in the pure test condition when judgments were made on old as well as new targets.

Local Switch Costs

Overview

Additional analyses were conducted on switch costs at the local level for the mixed testing condition. As mentioned above, switch trials were those in which the preceding trial involved a decision on the other, rather than the same stimulus type (e.g., a trial in which the decision was made on the picture target, when the previous trial involved a decision on the word target). Since switch trials only occurred in the mixed

condition, analyses were restricted to that condition. This resulted in 2 (Switch Trial: switch vs. non-switch) x 2 (Stimulus Type: picture vs. word decision) x 2 (Distracter Type: old vs. new) repeated measures ANOVAs conducted for hits, false alarms, and response time to old and new targets in the same fashion as for the global differences presented above. The primary comparisons of interest for all of these analyses was whether there was a main effect of switch trial, and whether switch trial further interacted with distracter type and/or stimulus type.

Hits and False Alarms.

The analysis of hits (left side of Table 4a) revealed that hit rate was higher for non-switch (.76) than for switch (.73) trials, $F(1, 31) = 4.56$, $p = .041$, $\eta_p^2 = .128$. Overall hit rate was higher for pictures (.79) than for words (.71), $F(1, 31) = 11.30$, $p = .002$, $\eta_p^2 = .267$, and was higher for old targets paired with old (.77) compared to new (.72) distracters, $F(1, 31) = 14.98$, $p = .001$, $\eta_p^2 = .326$. The Stimulus Type x Distracter and the Switch Type x Distracter interactions were non-significant, both F's < 1.16. The Switch Type x Stimulus-Type interaction was also non-significant, $F(1, 31) = 2.07$, $p = .160$, $\eta_p^2 = .063$, as was the Switch Type x Stimulus Type x Distracter interaction, $F(1, 31) = 2.47$, $p = .126$, $\eta_p^2 = .074$.

The analysis of false alarms (right side of Table 4a) yielded a similar pattern of results to the analysis on hit rate. False alarms were somewhat higher for switch (.16) than non-switch (.13) trials, but the effect was only marginally significant, $F(1, 31) = 4.01$, $p = .054$, $\eta_p^2 = .114$. False alarms were higher when judging new words (.19) than new pictures (.09), $F(1, 31) = 30.72$, $p < .001$, $\eta_p^2 = .498$, and for new targets paired with

Table 4a. *Probability of Judging an Item as "Old" as a Function of Target, Distracter, Stimulus Type, and Switch Type in Experiment 1.*

Trial Type	Old Target		New Target	
	New Distracter	Old Distracter	New Distracter	Old Distracter
Picture Trials				
Non-Switch	.74 (.24)	.84 (.17)	.06 (.09)	.10 (.13)
Switch	.75 (.16)	.81 (.17)	.09 (.12)	.13 (.11)
Word Trials				
Non-Switch	.74 (.19)	.80 (.13)	.17 (.17)	.19 (.19)
Switch	.64 (.22)	.72 (.19)	.16 (.14)	.23 (.14)

Note. Standard deviations are shown in parentheses.

old (.16) vs. new (.12) distracters, $F(1, 31) = 10.71$, $p = .003$, $\eta_p^2 = .257$. No significant interactions were found, all F's < 1.9.

Response Time

Analyses on response time were restricted to correct trials that were within 3 standard deviations of each individual participant's mean response rate. As can be seen in the left side of Table 4b, response time to old targets did not vary much overall. Response time was slower on switch trials (1184 ms) compared to non-switch trials (1136 ms), $F(1, 31) = 7.39$, $p = .011$, $\eta_p^2 = .193$. There was also slower overall responding to words (1248 ms) compared to pictures (1072 ms), $F(1, 31) = 55.60$, $p < .001$, $\eta_p^2 = .642$. Finally, there was a non-significant difference in RT for old targets paired with old distracters (1172 ms) compared to new distracters (1148 ms), $F(1, 31) = 2.60$, $p = .117$, $\eta_p^2 = .077$; and no other significant interactions were found, all F's < 1.6.

Response times to new trials are displayed in the right side of Table 4b. Response time was slower on switch trials (1188 ms) compared to non-switch trials (1125 ms), $F(1, 31) = 18.75$, $p < .001$, $\eta_p^2 = .377$. There was also slower overall responding to words (1213 ms) compared to pictures (1099 ms), $F(1, 31) = 59.02$, $p < .001$, $\eta_p^2 = .656$, and significantly slower RT for new targets paired with old distracters (1184 ms) compared to new distracters (1128 ms), $F(1, 31) = 15.42$, $p < .001$, $\eta_p^2 = .332$. This distracter effect further interacted with stimulus type, such that old vs. new distracters had a greater influence when judging new words (1258 ms vs. 1169 ms) than new pictures (1112 ms vs. 1086 ms), $F(1, 31) = 5.55$, $p = .025$, $\eta_p^2 = .152$. No other significant interactions were found, all F's < 1.

Table 4b. *Response Time (in ms) as a Function of Target, Distracter, Stimulus Type, and Switch Type in Experiment 1.*

Trial Type	Old Target		New Target	
	New Distracter	Old Distracter	New Distracter	Old Distracter
Picture Trials				
Non-Switch	1023 (235)	1067 (247)	1057 (217)	1089 (281)
Switch	1095 (218)	1104 (220)	1116 (213)	1134 (241)
Word Trials				
Non-Switch	1232 (301)	1222 (272)	1138 (266)	1216 (265)
Switch	1242 (206)	1294 (236)	1201 (245)	1299 (295)

Note. Standard deviations are shown in parentheses.

To highlight briefly the results on local switch costs, effects were mostly found in main effects, with switch trials being associated with decreased accuracy in both hits and false alarms and slower response time to both old and new targets. Further interactions between switch trials and the variables were not significant. However, a marginally significant interaction was found between switch type and distracter type such that false alarms to new targets paired with old distracters were higher on switch than for non-switch trials. The mixing of task goals likely increased the need to maintain an active goal set; a process that involves control to constrain retrieval (e.g., Mayr & Kliegl, 2000; De Jong, Berendsen, & Cools, 1999). The increased demands of having to use controlled processing to maintain retrieval in a switching environment may have led to greater spontaneous recognition in the mixed compared to the pure retrieval condition. Results were consistent in showing that the locus of the distracter influence occurred when in a task set that involved switching between picture and word decisions. Note that the spontaneous recognition of distracting information was found when assessing the global or mixing costs of having to alternate between retrieval decisions, but not when assessing the local or switching costs. These results are consistent with recent studies using task switching paradigms (Braver, Reynolds, & Donaldson, 2003; Rubin & Merian, 2005), which have shown that mixing cost, but not switching cost, may implicate the involvement of global or sustained control processes. Thus, the current results suggest that spontaneous recognition of distracters may be more driven by the global demands to maintain a task set rather than the within block effects of switch vs. non-switch interference.

Taken together, the results from Experiment 1 are consistent with prior results showing spontaneous recognition for younger adults when attention was divided at test but not when attention was fully devoted to the task (Anderson, et al., in press; Ste. Marie & Jacoby, 1993). Thus, the results indicate that spontaneous recognition is more likely to occur when memory search is less constrained. More generally, the results are also consistent with those from studies on involuntary autobiographical memory showing that individuals report memories "popping into mind" when in a non-focused state (Bernsten, 2010; Kvavilashvili & Mandler, 2004).

Experiment 2: Effects of Fluency on Spontaneous Recognition

Experiment 2 examined how the fluency of target and distracter information effects spontaneous recognition. As discussed above, prior results are mixed regarding how distracter fluency plays a role in spontaneous recognition. The Ste. Marie and Jacoby (1993) study found that spontaneous recognition depends on the processing match between the target and distracter. More specifically, two experiments using a repetition manipulation during study found that divided attention participants had a greater tendency to spontaneously recognize a one time (1x) presented distracter than a distracter presented four times (4x) or five times (5x), when judging a 1x presented target. Interestingly, those experiments also showed that this relativity pattern was only observed when participants judged 1x presented targets. Spontaneous recognition did not occur when judging targets that had previously been studied 4 or 5 times, regardless of the number of presentations of the distracter.

Prior results from the memory Stroop experiments have shown that picture targets were recognized more accurately and quickly than word targets. Further, picture

distracters were somewhat more likely to be spontaneously recognized than words (Anderson et al., in press). This pattern suggests that pictures may be more fluently processed than words in this task. Thus, in the memory Stroop experiments, fluency of the distracter may increase the tendency for spontaneous recognition. It remains unclear whether spontaneous recognition is more likely to occur for information that is more fluently processed or if it further depends upon the match in fluency between the target and the distracter.

Fluency was manipulated by repeating a subset of both words and pictures during study such that 1x and 3x presented words and pictures were crossed as targets and distracters during test (see Table 5 for Experiment 2 Item Types below). This design allowed a test for the effects of fluency on the tendency for distracters to be spontaneously recognized. Crossing the number of presentations of targets and distracters also provides a test for the relativity of automaticity, such that matching number of repetitions (e.g., a 3x target paired with a 3x distracter) can be compared to a mismatched number (e.g., 3x target paired with a 1x distracter). This would help to determine whether spontaneous recognition of the distracter is more likely to occur when there is a match in prior processing.

Table 5. *Experiment 2 Test Item Types*

		Target Type		
		3x	1x	New
Distracter Type	3x	3x Target 3x Distracter	1x Target 3x Distracter	New Target 3x Distracter
	1x	3x Target 1x Distracter	1x Target 1x Distracter	New Target 1x Distracter
	New	3x target New Distracter	1x target New Distracter	New target New Distracter

Methods

Participants

Thirty-six Washington University students between the ages of 18 and 24 ($M =$ 19.36, $SD = 1.36$) were included in the current study. Participants were recruited via the Psychology department subject pool and received either credit or payment for their participation. Three participants were excluded from the analyses but replaced with additional participants. Two of these participants had low performance accuracy and/or response times that were 2.5 standard deviations below the overall mean. The other excluded participant was noted by the experimenter as not maintaining attention to the screen during the experiment and rushing through the test blocks.

Materials and Design

The materials, design, and procedure for Experiment 2 were similar to those from Experiment 1 with the following exceptions. First, all of the recognition tests included mixed decisions on picture and word targets. Second, the study blocks included a repetition manipulation such that half of the words and half of the pictures were repeated three times, while the other half were presented once. The space between repetitions was random with the constraint that no fewer than 3 words or pictures were presented prior to a repetition. Third, the number of items per study phase was 36 per stimulus type, half of which were repeated and the other half non-repeated. Fourth, the number of test Item Types increased to 18 upon crossing number of prior presentations of targets (3x vs. 1x vs. New) and distracters (3x vs. 1x vs. New) with Stimulus Type (Picture vs. Word judgment). Each test phase included 54 items, consisting of three of each item type. Test items were fully counterbalanced across repetition and item type assignment.

Participants completed seven study-test phases across the experiment, resulting in 21 observations (as compared to 30 in Experiment 1) per item type for each participant.

Results and Discussion

The primary comparisons of interest were 1) whether the pattern found in Experiment 1 for the mixed condition would replicate under conditions where repetition was further manipulated 2) whether spontaneous recognition of old distracters increased when fluency increased via repetition, and 3) whether a relativity pattern would be shown such that spontaneous recognition would be greater for distracters that matched rather than mismatched the repetition of the target. Analyses were conducted in a similar fashion to Experiment 1, with separate repeated measures ANOVAs on hits, false alarms, and response time to old and new targets. Unless otherwise noted, significance for all reported statistics was p < .05.

Hits and False Alarms

Table 6a shows recognition accuracy in the probability of responding "old" to items as a function of stimulus type (picture vs. word), target status (3x, 1x, new), and distracter status (3x, 1x, new). As can be seen in the first two columns of Table 6a, overall hit rate was higher for pictures (.79) than for words (.68), $F(1, 35) = 39.51$, $p < .001$, $\eta_p^2 = .530$. Hit rate was also substantially higher when the target had been presented 3 times during study (.84) as compared to 1 time (.63), $F(1, 35) = 410.72$, $p < .001$, $\eta_p^2 = .921$. The main effect of distracter approached significance, $F(2, 70) = 2.36$, $p = .102$, $\eta_p^2 = .063$. Planned comparisons on Distracter Type yielded a significant difference between 3x (.75) and new (.72) distracters, $p = .03$, but non-significant

Table 6a. *Probability of Judging an Item as "Old" as a Function of Target, Distracter, and Stimulus Type in Experiment 2.*

Distracter	Target 3x	Target 1x	Target New
	Picture Trials		
3x	.91 (.08)	.69 (.16)	.13 (.09)
1x	.90 (.10)	.70 (.15)	.12 (.11)
New	.89 (.08)	.66 (.18)	.09 (.08)
	Word Trials		
3x	.80 (.15)	.61 (.13)	.23 (.18)
1x	.78 (.14)	.57 (.15)	.20 (.13)
New	.78 (.16)	.56 (.16)	.17 (.11)

Note. Standard deviations are shown in parentheses.

differences between 3x and 1x (.74), p = .16, and between1x and new distracters, p = .11; all one-tailed. None of the interactions were found to be significant, with all F's < 1.12.

The relativity pattern of interest, in which the match in presentations between target and distracter would create greater facilitation than repetition alone, was not observed, as indicated by the non-significant Target x Distracter interaction, $F < 1$. Rather, in the current experiment, repetition of the distracter led to slightly greater facilitation across both 3x and 1x targets. More discussion on potential reasons for not finding this relativity will be provided below.

As shown in the last column of Table 6a, false alarms were higher when judging new words (.20) than new pictures (.11), $F(1, 35) = 23.84$, $p < .001$, $\eta_p^2 = .405$. The interaction between stimulus type and distracter did not reach significance, $F < 1$. More importantly, the repetition of distracters during study led to a significant increase in false alarms to new targets paired with 1x presented (.16) vs. 3x presented (.18) distracters vs. new (.13) distracter, $F(2, 70) = 6.67$, $p = .002$, $\eta_p^2 = .160$. One-tailed pairwise comparisons between distracter types all yielded significant effects. There was a greater amount of interference for new targets paired with 3x vs. 1x distracters ($p = .03$), and for 3x vs. new distracters ($p = .001$). There was also a significant interference effect when comparing new targets paired with 1x and new distracters ($p = .03$).

Response Time

Analyses on response time were restricted to correct trials that were within 3 standard deviations of each individual participant's mean response rate. Analyses on RT were conducted in the same fashion as accuracy, with separate repeated measures ANOVAs on old targets and new targets. As can be seen in the first two columns of

Table 6b, response time was faster for pictures (1014 ms) than words (1188 ms), $F(1, 35)$ = 101.49, $p < .001$, $\eta_p^2 = .744$. Response time was also faster for old targets presented 3x (1069 ms) than 1x presented targets (1133 ms), $F(1, 35) = 46.01$, $p < .001$, $\eta_p^2 = .568$. No other effects approached significance, with all F's < 1.45.

Response times to new trials are displayed in the last column of Table 6b. As was found for old targets, response time was faster for pictures (1063 ms) than words (1161 ms), $F(1, 35) = 67.43$, $p < .001$, $\eta_p^2 = .658$. The main effect of distracter was non-significant, $F(2, 70) = 2.09$, $p = .131$, $\eta_p^2 = .056$, and the Stimulus type x Distracter interaction was also non-significant, $F < 1$.

Note that neither of the response time analyses for Experiment 2 revealed significant effects from distracter oldness, as found in Experiment 1. This may have been due to the decreased power, as a result of lower number of observations per cell in Experiment 2 compared to Experiment 1.

In sum, results from Experiment 2 show that repetition of items led to significant increases in hit rate and RT speed to targets presented 3x vs. 1x during study. Repetition also led to significant distracter effects as shown by an increased false alarm rate to new targets paired with a 3x as compared to 1x presented distracters. However, there was only a marginal effect of distracters on hit rate to old targets. Further, repetition did not show any increase in facilitation as indicated by the non-significant difference between 1x and 3x distracters on hits. Finally, the relativity pattern of interest was not observed as indicated by the non-significant interaction between target and distracter repetition.

Table 6b. *Response Time (in ms) as a Function of Target, Distracter, and Stimulus Type in Experiment 2.*

Distracter	Target 3x	Target 1x	Target New
	3x	1x	New
Picture Trials			
3x	972 (201)	1045 (202)	1064 (169)
1x	993 (178)	1059 (184)	1073 (174)
New	970 (202)	1047 (182)	1052 (149)
Word Trials			
3x	1141 (176)	1228 (211)	1179 (186)
1x	1179 (190)	1210 (202)	1157 (163)
New	1161 (205)	1207 (216)	1146 (194)

Note. Standard deviations are shown in parentheses.

This lack of relativity effects should be further discussed. It is difficult to determine how much weight should be given to this null result, in consideration of the significant effects found in the Ste. Marie and Jacoby (1993) experiments. Several methodological differences exist between the current experiment and those from the Ste. Marie and Jacoby (1993) Experiments (2a and 2b), who found that a 1x presented distracter was more likely to be spontaneously recognized than a 4x or 5x presented distracter when judging a 1x presented target. The authors' explanation for this unexpected pattern was that the matching presentations between the 1x target and 1x distracter provided more correlated attributes than the 1x and 5x distracters. When under conditions of divided attention, as was the case in the Ste. Marie and Jacoby experiments, participants are thought to base recognition on familiarity and thus rely more heavily on such attributes. It is possible that the same pattern of results was not found in the current experiment because of the difference in the stimuli used. The Ste. Marie and Jacoby experiments only involved word stimuli, whereas the current experiments involved both words and pictures.

Thus, the relativity pattern for spontaneous recognition may depend on a certain amount of overlap in the processing components between target and distracter stimuli. Perhaps the core factor is not simply the number of presentations of items, but rather, the match in processing between the items. Experiment 3 was aimed toward investigating this possibility by using a manipulation that involved a contextual separation by presenting items in separate lists and providing different instructions to produce more or less orientation to this overlapping contextual information.

Experiment 3: Effects of Source Constrained Retrieval on Spontaneous Recognition

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The results from Experiments 1 and 2 could be taken to suggest that spontaneous recognition occurs when retrieval attempts are primarily based on familiarity. However, further investigation is necessary to explore whether spontaneous recognition also occurs when attempting to rely upon controlled retrieval. It may be the case that a controlled retrieval attempt directed toward the source of a target leads to an increased tendency to spontaneously recognize distracters also belonging to that source. As discussed in the introduction, prior work has not determined whether the relativity of automaticity generalizes to situations in which retrieval is intentionally directed toward source information. Further testing the dynamics of spontaneous recognition under such conditions is important since it helps to establish whether spontaneous recognition is contingent upon the participant's retrieval goals.

Experiment 3 used a design that involved manipulation of the List source that targets and distracters were presented in and whether participants were asked to direct retrieval toward this list source of target items. This design allowed a test for spontaneous recognition of distracters from the same vs. different source depending upon how the participant is constrained during test. Participants were shown an intermixed series of pictures and words during study, as in prior experiments, but study items were further divided into two separate list contexts (List 1 and List 2). During test, participants made decisions on items consisting of targets and distracters that were from List 1, List 2, or new.

Retrieval constraint was manipulated between subjects to determine how spontaneous recognition might vary based on the particular source of the distracting information. One condition required participants to constrain retrieval to target items

from the particular list context (source) that it had been studied in. For the other condition, participants constrained retrieval to target items studied in either list. Hence, these conditions are referred to as being either *Source Constrained* or *Source Non-Constrained*. The Source Non-Constrained condition was akin to that previously used, such that participants were instructed to make judgments on the cued items (P or W) and to say "old" if the target was previously studied. For the Source Constrained condition, participants were instructed only to say "old" if the cued items (P or W) were from a particular list (*List 1* or *List 2*). That is, the Source Constrained condition demanded that participants further constrain to the previous list within which targets were presented. The use of such a manipulation involving constraint to the contextual source of the targets was based on similar use of direct vs. indirect tests of recognition (e.g., Jacoby, 1991), in which the requirement to rely on recollection is greater when having to constrain retrieval to the particular list items were studied in rather than being able to rely on familiarity to base one's decision. Note that in the current experiment, the Source Constrained and Source Non-Constrained condition differ from the direct and indirect manipulations, given the assumption that constraint is required to focus on the picture or word target while disregarding the distracter. In the current experiment, the requirement to constrain to the particular list that targets were studied in was thought to increase the need to use recollection beyond making a decision on a picture or word target from either list context.

If source constrained retrieval influences what is spontaneously recognized, then distracters belonging to the list being constrained should be spontaneously recognized more than those from the list not being constrained. For example, a recognition decision on a new target word might be more influenced by an old picture distracter that belonged

to the same list rather than the other list. Further details on the comparisons of interest are discussed after a more extensive description of this novel design.

Methods

Participants

Seventy-two Washington University students between the ages of 18 and 22 ($M =$ 19.71, $SD = 1.35$) were included in this study. Participants were recruited via the Psychology department subject pool and received either credit or payment for their participation. Participants were randomly assigned to the Source Constrained or Source Non-Constrained condition, each of which included 36 participants.

Materials and Design

The methods for Experiment 3 were generally consistent with those from Experiment 2. However, the design included separate item lists during study along with changes to test instructions and item types presented at test. The experiment included two between-subjects conditions that differed in how items should be decided upon at test. All characteristics of the design including the item types, counterbalancing, materials, and presentation of items were identical for both conditions. The only difference between the Source Constrained and Source Non-Constrained conditions was the instruction given during test regarding whether or not the participant should constrain retrieval to the particular list the target item was studied in.

The experiment included 8 runs, each including a study and test phase. Each study phase included two separate lists (List 1 or List 2) with 18 pictures and 18 words per list presented with the constraint that no more than three consecutive presentations of the same stimulus type occur. A buffer task (see Procedure below) was administered between

each study List in order to allow segmentation between study list contexts. Each test

phase included 54 items consisting of target and distracter pictures and words that were

from List 1, List 2, or New (See Table 7 of item types below). Further crossing these

item types with the stimulus type being judged resulted in a total of 18 item types. There

were a total of 24 observations per cell, per participant, across the course of the

experiment.

Table 7. *Experiment 3 Test Item Types.*

		Target Type		
		List 1	List 2	New
Distracter Type	List 1	List 1 Target List 1 Distracter	List 2 Target List 1 Distracter	New Target List 1 Distracter
	List 2	List 1 Target List 2 Distracter	List 2 Target List 2 Distracter	New Target List 2 Distracter
	New	List 1 target New Distracter	List 2 target New Distracter	New target New Distracter

Procedure

      The procedure was the same as that used for the other two experiments, except for the following: 1) Prior to each of the two study blocks, participants were shown a screen instructing them that the following items would be from "List 1" or "List 2" and to press the spacebar to begin studying the intermixed presentation of pictures and words. 2) A brief buffer task consisting of 1 minute of simple math problems was given after each of the two study blocks. This task presented computations (e.g., "18 - _ = 11") on the screen to which the participant entered a numerical response on the keyboard. 3) Different test instructions were used, depending upon condition assignment: for the Source Non-Constrained condition participants were instructed to respond "old" to the picture or the word based on the "P" or "W" cue shown on the screen prior to each test item. Participants in the Source Constrained condition were further instructed only to say "old" to the cued item ("P" or "W") if it belonged to the target list they were instructed to constrain to. The list being judged in the Source Constrained condition alternated from List 1 to List 2 half way through each test block, with instructions regarding the appropriate list to constrain to shown prior to each half. The order of list constraint during test (List 1 or List 2) was alternated between each run within the experiment (e.g., Run 1 test: List 1 for the first half and List 2 for the second half, Run 2: List 2 for the first half and List 1 for the second half) and was further counterbalanced across participants, such that half of the participants would constrain to List 1 and then List 2 for the first run, while the other half of participants would constrain to List 2 and then List 1 for the first run. Finally, participants were given up to 5 seconds to make their response, rather than the 3-second response deadline used in the first two experiments. The additional time

was given to provide participants with ample time to make the more difficult source

constrained decision required in this experiment.

Results and Discussion

As in the prior experiments, spontaneous recognition was evidenced by a

significant influence of old compared to new distracters on memory judgments of the

target picture or word. The primary factor in determining a relationship between source-

constrained retrieval and spontaneous recognition was the congruence between the list

source that participants were instructed to retrieve items from and the List in which

distracter items were previously studied. Thus, if the participant was instructed to

constrain retrieval to List 1 items, the distracting picture or word from List 1 should be

more likely to be spontaneously recognized compared to distracting items from List 2 or

new distracters. The Source Non-Constrained condition was not given instructions about

the list toward which they were to constrain retrieval. However, the labeling of items as

List 1 or List 2 constrained was made consistent for participants by using the same labels

that were used for the corresponding Source Constrained participants based on

counterbalancing. Assigning these pseudo-labels to the Source Non-Constrained

condition allowed a consistent statistical comparison across conditions.

Three separate sets of analyses were conducted to determine whether retrieval

constraint was associated with greater spontaneous recognition of distracters from the

target source list. These analyses included the probability of responding "old" to 1) old

source target items [items that belonged to the list source that the participant was

instructed to constrain retrieval to], 2) old non-source target items [items that belonged to

the list not instructed to constrain to], and 3) new target items [items that had not been

studied in either list]. The first set of analyses on old source target items were calculated

as hits for both conditions. The second set of analyses on non-source target items were

calculated as hits for the Source Non-Constrained condition but as false alarms for the

Source Constrained condition. The third set of analyses on new items was calculated as

false alarms for both conditions.

Each set of analyses included a 2 (List constraint: List 1 vs. List 2) x 2 (Stimulus

Type: pictures vs. words) x 3(Distracter: List 1, List 2, New) repeated measures

ANOVA, conducted separately for the Source Constrained and Source Non-Constrained

conditions. Response time analyses on correct responses were also conducted for each of

these comparisons and will be presented after those conducted on accuracy. Unless

otherwise noted, significance for all reported statistics was p < .05.

Recognition Accuracy

Old Source Target Items:

As can be seen in Table 8a, the Source Non-Constrained condition showed a

significant effect of Stimulus Type, with higher accuracy for pictures (.76) than words

(.69), $F(1, 35) = 11.52$, $p = .002$, $\eta_p^2 = .248$. There was a slight, but non-significant

increase in hit rate when old targets were paired with distracters that were from List 1

(.72), and List 2 (.74), compared to new distracters (.71), $F(2, 70) = 2.76$, $p = .07$, $\eta_p^2 =$

.073. Pairwise comparisons on distracter type revealed a marginal difference between

List 1 and List 2 distracters, $p = .10$, and a significant difference between List 2 and new

distracters, $p = .037$. All other effects in the ANOVA on hits to old source targets for the

Source Non-Constrained condition were non-significant F's < 1.45.

Table 8a. *Probability of Judging Source Target Items as "Old" as a Function of Target List, Distracter, and Stimulus Type for the Source Non-Constrained Condition in Experiment 3.*

	Target	
	List 1	List 2
Distracter		
Picture Trials		
List 1	.73 (.20)	.77 (.17)
List 2	.76 (.21)	.78 (.18)
New	.74 (.19)	.78 (.18)
Word Trials		
List 1	. 67 (.19)	.71 (.15)
List 2	.71 (.17)	.72 (.19)
New	.68 (.20)	.65 (.19)

Note. Standard deviations are shown in parentheses.

Table 8b. *Probability of Judging Source Target Items as "Old" as a Function of Target List, Distracter, and Stimulus Type for the Source Constrained Condition in Experiment 3.*

	Target	
	List 1	List 2
Distracter		
Picture Trials		
List 1	.67 (.18)	.64 (.16)
List 2	.66 (.17)	.63 (.15)
New	.69 (.19)	.63 (.19)
Word Trials		
List 1	.57 (.24)	.52 (.18)
List 2	.56 (.21)	.58 (.20)
New	.51 (.20)	.55 (.18)

Note. Standard deviations are shown in parentheses.

An exploratory analysis was conducted to determine whether the slight increase in facilitation from List 2 distracters may have been driven by a recency effect, such that List 2 distracters had greater impact when presented in the first rather than second test block. Only a significant main effect of block was found, with greater overall accuracy in the first (.76) vs. second (.70) test block, p < .001. More important, the higher facilitation from List 2 distracters did not depend upon their presentation in the first rather than second test block.

The Source Constrained condition (see Table 8b) only showed greater overall recognition of pictures (.65) than words (.55), $F(1, 35) = 20.61$, $p < .001$, $\eta_p^2 = .371$. No other significant main effects or interactions were found: List x Stimulus Type x Distracter, $F(2, 70) = 1.95$, $p = .150$, $\eta_p^2 = .053$, List x Stimulus Type, $F(1, 35) = 2.13$, $p = .153$, $\eta_p^2 = .057$, Stimulus x Distracter, $F(2, 70) = 2.03$, $p = .139$, $\eta_p^2 = .055$, (all other effects F's < 1.1).

In sum, the analysis on old source targets only yielded a statistically significant effect of Stimulus Type, with picture accuracy being higher than words. There was a trend toward a significant effect of distracter for the Source Non-Constrained condition, with post-hoc comparisons yielding a significant facilitation effect from List 2 distracters compared to new distracters, but a non-significant difference between List 1 and List 2 distracters.

Old Non-Source Targets

The probability of responding "old" to Non-Source targets paired with List 1, List 2, or New distracters when instructed to constrain to List 1 or List 2 is displayed in

Tables 9a and 9b. Since these targets did not belong to the source list, responding "old" is considered to be a false alarm for the Source Constrained condition.

The Source Non-Constrained condition (see Table 9a) showed a significant effect of Stimulus Type, with higher recognition accuracy for pictures (.77) than words (.66), $F(1, 35) = 23.35$, $p < .001$, $\eta_p^2 = .400$. The interaction between list constraint and distracter was marginally significant, $F(2, 70) = 2.86$, $p = .064$, $\eta_p^2 = .075$. However, note that the nature of this interaction is not consistent with that found for the Source Constrained Condition, since in the Source Non-Constrained condition participants were not actually instructed to constrain to a particular target list. For List 1 constrained targets, hit rate was equivalent when paired with List 1 distracters (.73), List 2 (.72), and New (.73) distracters. However, for List 2 constrained targets, hit rate was matched when targets were paired with List 1 (.72) and List 2 (.72) targets but lower when targets were paired with New (.68) distracters. In other words, some overall facilitation occurred from old distracters for the items designated as being List 2 constrained, but this facilitation did not differ based on distracter list type. No other significant main effects or interactions were found: Main effect of List, $F(1, 35) = 2.39$, $p = .131$, $\eta_p^2 = .064$, (all other effects F's < 1.18).

The Source Constrained condition (see Table 9b) had a greater tendency to false alarm to pictures (.49) than words (.44), $F(1, 35) = 5.61$, $p < .001$, $\eta_p^2 = .371$. There was also a significant effect of Distracter, $F(2, 70) = 5.05$, $p = .009$, $\eta_p^2 = .126$. Importantly, there was a trend toward this distracter effect further depending upon the List being constrained to, as revealed by the marginally significant List x Distracter interaction, $F(2, 70) = 2.88$, $p = .063$, $\eta_p^2 = .076$. The nature of this interaction was consistent with that

Table 9a. *Probability of Judging Non-Source Target Items as "Old" as a Function of Target List, Distracter, and Stimulus Type for the Source Non-Constrained Condition in Experiment 3.*

	Target	
	List 1	List 2
Distracter		
	Picture Trials	
List 1	.78 (.16)	.77 (.17)
List 2	.75 (.20)	.78 (.15)
New	.78 (.15)	.74 (.13)
	Word Trials	
List 1	.68 (.18)	.67 (.21)
List 2	.68 (.19)	.66 (.20)
New	.68 (.17)	.61 (.24)

Note. Standard deviations are shown in parentheses.

Table 9b. *Probability of Judging Non-Source Target Items as "Old" as a Function of Target List, Distracter, and Stimulus Type for the Source Constrained Condition in Experiment 3.*

	Target	
	List 1	List 2
Distracter		
	Picture Trials	
List 1	.55 (.20)	.47 (.20)
List 2	.50 (.19)	.49 (.16)
New	.49 (.21)	.45 (.19)
	Word Trials	
List 1	.48 (.17)	.43 (.21)
List 2	.42 (.18)	.46 (.21)
New	.42 (.20)	.41 (.21)

Note. Standard deviations are shown in parentheses.

expected, such that the probability of responding "old" was higher when the distracter belonged to the list to which participants were instructed to constraint retrieval. Planned pairwise comparisons revealed that when constraining to List 1, false alarms were significantly higher for targets paired with List 1 distracters (.51) as compared to List 2 (.46) distracters, $p = .002$, and New (.45) distracters, $p = .01$. When constraining to List 2, such that false alarms were greater for targets paired with List 2 distracters (.47) as compared New (.43) distracters, $p = .034$. However, the comparison between List 2 and List 1 (.45) distracters was non-significant, $p = .333$, and. No other significant main effects or interactions were found: Main effect of List, $F(1, 35) = 2.39$, $p = .131$, $\eta_p^2 = .064$ (all other effects F's < 1.18).

In sum, the Source Constrained condition showed differential false alarm rates, based on the list participants were instructed to constrain retrieval. The effect was marginal ($p = .06$), but the pattern was consistent for both List 1 and List 2 target items. The Source Non-Constrained condition did not show any difference in hit rate to List 1 vs. List 2 distracters, but did show partial facilitation effects from List 1 and List 2 distracters compared to new distracters paired with old targets. **New targets**

The probability of responding "old" to New Targets paired with List 1, List 2, or New distracters, when instructed to constrain to List 1 or List 2, is displayed in Table 10a and 10b. The Source Non-Constrained condition (see Table 10a) only yielded a reliable difference in the tendency to false alarm to new word targets (.25) as compared to new picture targets (.14), $F(1, 35) = 30.80$, $p < .001$, $\eta_p^2 = .468$. The Stimulus Type x

Table 10a. *Probability of Judging New Target Items as "Old" as a Function of Target List, Distracter, and Stimulus Type for the Source Non-Constrained Condition in Experiment 3.*

	Target	
	List 1	List 2
Distracter		
	Picture Trials	
List 1	.12 (.12)	.14 (.15)
List 2	.14 (.12)	.12 (.14)
New	.13 (.13)	.16 (.14)
	Word Trials	
List 1	.26 (.17)	.27 (.20)
List 2	.26 (.18)	.27 (.21)
New	.24 (.19)	.22 (.16)

Note. Standard deviations are shown in parentheses.

Table 10b. *Probability of Judging New Target Items as "Old" as a Function of Target List, Distracter, and Stimulus Type for the Source Constrained Condition in Experiment 3.*

	Target	
	List 1	List 2
Distracter		
	Picture Trials	
List 1	.20 (.16)	.13 (.18)
List 2	.15 (.15)	.17 (.19)
New	.15 (.15)	.12 (.15)
	Word Trials	
List 1	.25 (.20)	.22 (.20)
List 2	.27 (.20)	.26 (.21)
New	.22 (.18)	.20 (.17)

Note. Standard deviations are shown in parentheses.

Distracter interaction approached significance, $F(2, 70) = 2.28$, $p = .11$, $\eta_p^2 = .061$. The nature of this interaction indicated that the tendency to false alarm did not differ when judging new pictures paired with List 1 (.13), List 2 (.13), and New (.14) distracters. In contrast, false alarms were higher when judging new words paired with old List 1 (.26) or List 2 (.27) distracters as compared to new distracters (.23). All other effects were non-significant, all F's < 1.55.

Participants in the Source Constrained condition (see Table 10b) had a greater tendency to false alarm to new targets when instructed to constrain to List 1 (.21) than List 2 (.18), $F(1, 35) = 6.13$, $p = .02$, $\eta_p^2 = .149$. False alarms were also higher for new word targets (.24) than picture targets (.15), $F(1, 35) = 12.73$, $p = .001$, $\eta_p^2 = .267$. The main effect of distracter was also significant, $F(2, 70) = 4.52$, $p = .01$, $\eta_p^2 = .114$. Pairwise comparisons between distracter types showed significant differences between New distracters (.17) and List 1 distracters (.20), $p = .033$, and between New and List 2 distracters (.21), $p = .003$; but a non-significant difference between List 1 and List 2 distracters, $p = .14$, all one-tailed.

The main interaction of interest, between distracter and list constraint yielded a marginally significant difference, $F(2, 70) = 2.49$, $p = .09$, $\eta_p^2 = .067$. The nature of this interaction was fairly consistent with that expected. When participants were instructed to constrain to List 1, false alarms were somewhat higher for new targets paired with List 1 (.22) distracters, as compared to New (.18) and List 2 (.21) distracters. Similarly, when instructed to constrain to List 2, there was a slightly higher tendency to false alarm to new targets paired with List 2 (.21) distracters as compared to New (.16) or List 1 (.17) distracters. All other effects were non-significant, with all F's < 1.42. **Response Time**

Response time analyses were conducted in a similar fashion to the analyses conducted on accuracy. Separate analyses were conducted for the Source Constrained and Source Non-Constrained conditions, for Old Source Target items, Non-Source Target items, and for New Target items paired with List 1, List 2, or New distracters. All of the following analyses were restricted to correct response trials that fell within 3 standard deviations of each individual participants' average response time.

To anticipate, the bulk of the analyses on response times did not reveal any consistent patterns across the comparisons for source, non-source, and new targets. There was generally faster response time to pictures compared to words, which was expected. The Source Constrained condition also showed marginal facilitation effects from List congruent picture distracters paired with old source word targets and showed significant overall interference from old distracters when judging new targets. Note that the response times were also explored by analyzing standardized response times, given the high degree of variability. This analysis converted each individual's RT into a standardized (z) score based on their overall mean and standard deviation (see Faust, Balota, Spieler, Ferraro, 1999) and focuses the analyses on differences across conditions for each individual while controlling for individual differences in baseline response time. Analyses on the z-score transformed RT's yielded the same pattern as those reported for mean RT

Old Source Target Items

The analysis of response times to old source targets (see Table 11a) in the Source Non-Constrained condition only revealed a significant List x Stimulus Type interaction, $F(1, 35) = 8.78$, $p = .005$, $\eta_p^2 = .20$. Participants were somewhat faster to respond to pictures from List 2 (1073) than List 1 (1136), but slightly slower to respond to words

from List 2 (1347) than List 1 (1321). The main effect of distracter approached

significance, $F(2, 70) = 2.52$, $p = .106$, $\eta_p^2 = .067$, and post-hoc pairwise comparisons

between distracter types all yielded non-significant differences. All other effects were

also non-significant, F's < 1.59.

The analysis on the Source-Constrained condition's response times to old source

targets (see Table 11b) revealed a significant interaction between list, stimulus type, and

distracter, $F(2, 70) = 4.79$, $p = .011$, $\eta_p^2 = .120$. To examine this interaction, separate 2x3

ANOVAs on distracter and list were conducted for the picture and word judgments. For

the picture judgments, no significant main effect or interaction was found, all F's < 1.68.

In contrast, the analysis of word judgments revealed a significant List x Distracter

interaction, $F(2, 70) = 3.49$, $p = .036$, $\eta_p^2 = .091$. Further analyses were conducted

separately for List 1 and List 2 word targets paired with List 1, List 2, or New picture

distracters. When constraining to List 1 source target words, response times were

somewhat faster for targets paired with new pictures (1366) compared to List 1 (1422)

and List 2 (1472) pictures, although this effect was non-significant, $F(2, 70) = 1.84$, $p =$

.166, $\eta_p^2 = .05$. Pairwise comparisons on distracter type also yielded non-significant

differences. When constraining to List 2 source target words, response times were fastest

for targets paired with List 2 (1352) compared to List 1 (1439) and New (1438) picture

distracter, although this effect was also non-significant, $F(2, 70) = 1.90$, $p = .157$, $\eta_p^2 =$

.052. Pairwise comparisons between distracter types yielded non-significant differences,

although the comparison between List 2 and New distracters approached significance, p =

.062.

Table 11a. *Response Time (in ms) to Source Target Items as a Function of Target List, Distracter, and Stimulus Type for the Source Non-Constrained Condition in Experiment 3.*

	Target	
	List 1	List 2
Distracter		
Picture Trials		
List 1	1119 (415)	1085 (241)
List 2	1104 (297)	1034 (316)
New	1184 (325)	1100 (327)
Word Trials		
List 1	1356 (383)	1367 (392)
List 2	1307 (318)	1324 (346)
New	1300 (301)	1350 (391)

Note. Standard deviations are shown in parentheses.

Table 11b. *Response Time (in ms) to Source Target Items as a Function of Target List, Distracter, and Stimulus Type for the Source Constrained Condition in Experiment 3.*

	Target	
	List 1	List 2
Distracter		
Picture Trials		
List 1	1263 (404)	1263 (460)
List 2	1227 (358)	1327 (458)
New	1274 (417)	1282 (461)
Word Trials		
List 1	1422 (519)	1439 (510)
List 2	1472 (484)	1352 (516)
New	1366 (464)	1438 (504)

Note. Standard deviations are shown in parentheses.

Old Non-Source Targets

The analysis on response times to old non-source targets for the Source Non-Constrained (see Table 12a) condition only yielded a significant difference between response time to pictures (1092) and words (1325), $F(1, 35) = 85.66$, $p < .001$, $\eta_p^2 = .710$. All other effects were non-significant, all F's < 1. Response time analyses on old non-source targets did not yield any significant differences for the Source Constrained condition (see Table 12b), all F's < 1.68.

Table 12a. *Response Time (in ms) to Non-Source Target Items as a Function of Target List, Distracter, and Stimulus Type for the Source Non-Constrained Condition in Experiment 3.*

	Target	
	List 1	List 2
Distracter		
	Picture Trials	
List 1	1084 (309)	1104 (266)
List 2	1087 (274)	1094 (281)
New	1103 (244)	1078 (255)
	Word Trials	
List 1	1300 (330)	1341 (352)
List 2	1310 (272)	1351 (382)
New	1321 (327)	1327 (375)

Note. Standard deviations are shown in parentheses.

Table 12b. *Response Time (in ms) to Non-Source Target Items as a Function of Target List, Distracter, and Stimulus Type for the Source Constrained Condition in Experiment 3.*

	Target	
	List 1	List 2
Distracter		
	Picture Trials	
List 1	1382 (496)	1317 (569)
List 2	1327 (511)	1436 (490)
New	1394 (488)	1358 (612)
	Word Trials	
List 1	1398 (535)	1423 (572)
List 2	1365 (458)	1376 (585)
New	1374 (427)	1434 (595)

Note. Standard deviations are shown in parentheses.

New Targets

The analyses on the Source Non-Constrained condition response times to New Targets (see Table 13a) revealed that response times to pictures (1165) was faster than words (1339), $F(1, 35) = 42.29$, $p < .001$, $\eta_p^2 = .547$. There was also a significant main effect of List constraint, with response times to List 1 (1267) slower than List 2 (1237), $F(1, 35) = 4.30$, $p = .045$, $\eta_p^2 = .109$. Again, note that this condition did not actually constrain to a particular list source, making this effect difficult to interpret. All other effects were non-significant, F's < 1.69.

The analyses on the Source Constrained condition response times to New Targets (see Table 13b) indicated that response time was faster when responding to pictures (1228) than to words (1319), $F(1, 35) = 18.48$, $p < .001$, $\eta_p^2 = .346$. Response time also differed according to Distracter type, $F(2, 70) = 8.86$, $p < .001$, $\eta_p^2 = .202$. Pairwise comparisons between the List 1 (1273), List 2 (1313), and New (1235) distracters yielded significant differences for all comparisons, all p's $< .045$, two tailed. All other effects were non-significant, F's < 2.14.

Table 13a. *Response Time (in ms) to New Target Items as a Function of Target List, Distracter, and Stimulus Type for the Source Non-Constrained Condition in Experiment 3.*

	Target	
	List 1	List 2
Distracter		
	Picture Trials	
List 1	1154 (199)	1154 (275)
List 2	1213 (256)	1136 (248)
New	1178 (258)	1155 (253)
	Word Trials	
List 1	1382 (365)	1335 (327)
List 2	1359 (316)	1309 (329)
New	1316 (371)	1331 (388)

Note. Standard deviations are shown in parentheses.

Table 13b. *Response Time (in ms) to New Target Items as a Function of Target List, Distracter, and Stimulus Type for the Source Constrained Condition in Experiment 3.*

	Target	
	List 1	List 2
Distracter		
	Picture Trials	
List 1	1215 (359)	1230 (451)
List 2	1238 (345)	1285 (424)
New	1167 (335)	1236 (411)
	Word Trials	
List 1	1352 (398)	1294 (477)
List 2	1371 (454)	1361 (494)
New	1252 (404)	1286 (432)

Note. Standard deviations are shown in parentheses.

The results from Experiment 3 were somewhat consistent with the proposed hypotheses, with greater influence from distracters from the list being constrained to for the Source Constrained condition compared to the Source Non-Constrained condition. The Source Non-Constrained condition was not instructed to constrain memory to a particular list source and was expected to yield facilitation and interference effects that had previously been observed. While there are several limitations and caveats to the results of Experiment 3, in general, the pattern of results was somewhat consistent with those expected, showing marginally significant facilitation effects from old distracters when judging old targets and significant interference effects from old distracter pictures when judging new words. More importantly, the Source Non-Constrained condition did not show differential effects from distracters that were previously studied in List 1 vs. List 2. However, the Source Constrained condition did provide partial evidence in support of the relativity pattern. Marginally significant List Constraint x Distracter interactions were observed in which interference was higher for distracters belonging to the list being constrained to when these judgments were made to non-source targets ($p = .06$), and new targets ($p = .09$).

It should be noted that this experiment was very exploratory in nature and there are potential problems to consider. First, the Source Constrained condition showed a high false alarm rate to Non-source target items. This suggests that the participants may have had difficulty constraining to the appropriate source list. Such difficulty in constraining to the correct source list may have been due to the segmentation of the 2 list contexts being ineffective. Lists were only separated in time and with a brief buffer task. Perhaps a blocked study format for each stimulus type or a smaller number of items per list would

have freed more resources to think effectively back to the appropriate context being cued. Further, constraint demands may have also been increased by the design used, which alternated the order of List 1 vs. List 2 constraint from run to run. It is possible that such a design may have led to some confusion for the participant about which List they should be constraining to. A set sequence, involving List 1 decisions followed by List 2 decisions may have decreased demands for participants. Another possible manipulation may have been to tie the context to the items more effectively via some kind of processing overlap such as using different judgment tasks for the two lists.

The memory Stroop task is assumed to place demands on cognitive resources when switching between picture and word targets. The additional requirement to constrain selectively to loosely discriminable list contexts may have overextended resources. Further, it is possible that source confusion may have occurred for the stimulus type on which the participant was attempting to make their decision. However, these possibilities do not fully explain the increased tendency toward distraction for items belonging to the source toward which participants were attempting to orient memory. The pattern found is consistent with the relativity of automaticity, which will be more thoroughly discussed along with the results from Experiments 1 and 2 in the following.

General Discussion

Spontaneous recognition was investigated in the current studies by using the Memory Stroop paradigm, which provided an indirect measure of spontaneous recognition by assessing the influence of old vs. new distracters on target recognition. The approach taken toward understanding the phenomenon of spontaneous recognition was to manipulate factors thought to influence the ability to constrain retrieval to goal

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relevant information. The rationale for taking this approach was guided by prior experimental research showing that spontaneous recognition tends to occur when controlled processing is compromised (Anderson, et al., under review; Ste. Marie & Jacoby, 1993) and by diary studies on autobiographical occurrences of involuntary memory which suggest that such memories have a tendency to occur when in a non-focused state (Berntsen, 2007). A central premise of the current studies was that the seemingly automatic occurrences of spontaneous recognition may depend upon the way that control is being directed (i.e., the relativity of automaticity).

As hypothesized, spontaneous recognition occurred more often when there was decreased ability to constrain retrieval. This was most clearly evidenced by the results from Experiment 1, wherein a switching manipulation showed that spontaneous recognition occurred when having to alternate between decisions to the picture vs. the word component, but not when participants made consistent decisions to the same stimulus type. Consistent results were also found in Experiments 2 and 3, but the pattern of results in those experiments were somewhat more complex. For Experiment 2, significant interference effects were found from old as compared to new distracters. Further, distracters that were repeated had a greater influence than non-repeated distracters on false alarms to new targets. However, reliable facilitation effects on old target hit rate were only found in the comparison between repeated distracters as compared to new distracters. Taken together, the results from Experiment 2 suggest that the increased fluency of distracting information is generally associated with an increased tendency for spontaneous recognition. For Experiment 3, marginal facilitation effects were found for the Source Non-Constrained condition across old target items, and

significant interference was found when judging new target words paired with old distracter pictures. The Source Constrained condition did not yield facilitation effects but did show interference effects when judging non-source and new targets paired with old rather than new distracters.

The overall pattern of results across the three experiments suggest that conditions that place demands on the ability to use controlled retrieval are associated with an increased tendency to spontaneously recognize distracting information. These findings are consistent with prior results found by Ste. Marie and Jacoby (1993) and Anderson et al. (in press) who found spontaneous recognition for younger adults under conditions of divided attention but not when attention was fully devoted to the task.

The notion of source-constrained retrieval provides a useful way of understanding the conditions in which spontaneous recognition may be more likely to occur. When retrieval is constrained by source information, the early selection of relevant information prevents the influence of irrelevant information on memory judgments. In contrast, a less constrained retrieval orientation involves increased processing of the irrelevant or distracting information (e.g., Jacoby, et al., 2005; Jacoby, Kelley, & McElree, 1999; Marsh et al., 2009). When participants were able to maintain a consistent retrieval orientation toward the same source of information, spontaneous recognition of distracters was less likely to occur, as found for the pure testing condition in Experiment 1. However, when participants were less able to constrain to source relevant information during test as a result of having to switch between retrieval orientations, there was an increased tendency for spontaneous recognition.

Note that the results found in the current experiments may not have been purely due to the decreased ability to constrain retrieval to source relevant information. Rather, it is possible that the distracting stimuli may have had their influence via drifts in attentional focus or goal monitoring processes. While the current results are not able tease apart these components, further work could shed light on these possibilities by incorporating a further manipulation that would separate out responses made to the picture vs. the word target items. The design could involve a separate "old/new" button response to the picture targets and "old/new" button response to word targets. As such, it would be possible to separate out source error responses (e.g., mistakenly a recognition decision to the word, when cued to respond to the picture) from responses that were correctly made to the word target, for example. Thus, spontaneous recognition in such a design would be assessed by comparing the influence of old vs. new distracters on correctly designated source decisions, while controlling for cases when the participant was mistakenly responding to the incorrect target stimulus as a result of inefficient cue utilization.

The dynamics between retrieval constraint and spontaneous recognition were further explored in Experiments 2 and 3. The relativity of automaticity pattern would have been supported in Experiment 2 by increased spontaneous recognition from distracters that matched the number of prior presentations of the target item being judged. Most intriguing would have been the effect from a 1x presented distracter having greater influence than a 3x presented distracter on a 1x presented target, a pattern that was observed in the Ste. Marie and Jacoby studies. However, the results from Experiment 2 did not fit this pattern. Rather, the influence from repeated distracters was only found in

interference, and the degree of facilitation from either 3x or 1x presented distracters did not interact with relative target presentation.

The general pattern of results found in Experiment 3 was partially in line with the relativity of automaticity. The source-constrained condition showed trends toward significantly greater influence from distracters that belonged to the same, rather than different, list to the target participants were instructed to constrain to. In contrast, the Source Non-Constrained condition did not show differential influence from distracters belonging to the same list as the target. However, several limitations regarding the design of Experiment 3 should be considered prior to drawing firm conclusions about whether the relativity of automaticity pattern and generalizes to contexts involving voluntary search toward source information. Thus, more work is necessary to determine whether top-down or goal relevant search processes influence the type of distracting information that may be processed.

Prior results from Ste. Marie and Jacoby (1993) also suggest that task orientation may set the context for the differential effects of distracters belonging to the same vs. other source of information. In those experiments, stimulus modality was manipulated such that heard targets could be surrounded by read, heard, or new distracters (Experiment 4a) and read targets could be surrounded by read, heard, or new distracters (Experiment 4b). In both experiments, the distracters belonging to the same modality to that being tested caused greater spontaneous recognition than the other modality. Interestingly, post-experiment questioning from those studies revealed that none of the participants claimed to have noticed the homogeneity of old targets being tested. The authors suggested that participants may have adopted an "unconscious set" during

retrieval, in which the divided attention conditions led to greater reliance on correlated attributes between the target and distracter. Thus, the testing conditions used in those experiments may have facilitated the processing of distracters belonging to the same modality as the targets, despite the participants' lack of awareness for the source of the target information.

Results from Experiment 3 suggest that spontaneous recognition of source congruent distracters may not necessarily be limited to situations in which attention is divided and familiarity is used to guide retrieval. Rather, a goal driven attempt to retrieve information from a particular source showed a trend toward spontaneous recognition of distracters belonging to that source. The common denominator across this study and that by Ste. Marie and Jacoby is the role of a task set in determining the type of information that is processed. It seems that a task set may influence distraction in cases in which retrieval processing is allocated more automatically, as well as in cases in which retrieval processing is allocated in a more controlled or intentional manner. Further work is necessary to determine whether spontaneous recognition of source relevant distracters is more likely when information is contextually bound in a way that allows more efficient constraint to source relevant information.

The relationship between spontaneous and directed processes is pervasive across research conducted on attention, recognition memory, and involuntary autobiographical memory. Neumann (1984) suggested that automatic processes are not independent of one's current attentional state, based on research indicating that the engagement of seemingly automatic motor behavior depends upon higher order processes of motor planning. Research investigating selective attention has revealed similar patterns. Folk,

Remington, and Johnston's (1992) theory on the contingent orienting of attention also states that an attentional set establishes the type of information that may be selectively attended to in one's environment, and that capture from distracting information often occurs when the target and distracting information share features that are relevant to the current task demands (also see Lavie, 2005; Ruz & Lupiáñez, 2002). Finally, involuntary autobiographical memory research implicates a connection between the current goal state or task engagement of an individual and the nature of the involuntary memory retrieved (e.g., Ball & Little, 2006; Berntsen, 2010). Thus, the results found across these domains and the current results implicate a contingency between top-down orientation and the type of information that involuntarily captures attention/memory.

The current experiments investigated spontaneous recognition in a context wherein memory was actively being directed toward target information. More generally, involuntary memory in daily life has been reported to occur across a wide variety of contexts that vary in the extent to which memory is actively engaged in the ongoing task (e.g., Ball & Little, 2006). Involuntary memory has been described by others as suddenly "popping" into mind (e.g., Kvavilashvili & Mandler, 2004) during situations when it is not evident that the individual was in a "retrieval mode" (see Tulving, 1985). These observations suggest that involuntary memory may be more obligatory in nature. Thus, research might be directed toward determining whether similar results would have been found if individuals were not actively engaged in a memory task. Such a manipulation might produce similar results to those previously found using the memory Stroop paradigm, wherein decreased use of cognitive control during that task would lead to

increased likelihood of processing other information in the environment. This conjecture requires further investigation.

To what extent was spontaneous recognition accompanied by awareness of the source of the feeling of familiarity? In more naturalistic cases (e.g., Berntsen, 2007; 2010), involuntary memory often involves recollection of episodic details. The spontaneous recognition memory that is measured by the current procedures may be somewhat different from these naturalistic occurrences. The latter typically leads to awareness of the source of the familiarity (e.g., recognizing an acquaintance) whereas an influence of spontaneous recognition in a flanker task or a Stroop-like task might arise without people being aware of the source of the influence. However, such awareness of the source may not be required for effects of spontaneous familiarity. For example, Jacoby and Whitehouse (1989) found that participants were more likely to falsely recognize words when the same word (i.e., a *context* word) had been flashed immediately before the target of the recognition judgment. The preceding context word created a false sense of familiarity for the new target word, yet participants were unaware that the context word had been flashed. These results suggest that spontaneous familiarity may influence recognition memory even when participants are not aware of its source. In the current study, it is conceivable that the oldness of the distracting information may have been misattributed to the target being judged without participants' awareness of the source of oldness. In contrast, participants may have been aware of the oldness of the distracting items but unable to avoid the unwanted influence of this familiarity on target judgments. Along this line, it is interesting to note that when response times did yield reliable effects, the oldness of a distracter was associated with slowed responding for

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responses to both old and new targets. A speculative possibility is that this slowing may have been associated with participants' awareness of old distracters.

Further research is needed to address the issue of awareness in spontaneous recognition. The awareness of distracters could be assessed via post experiment questionnaires designed to gauge the degree to which participants were aware during the task (e.g., Richardson-Klavehn & Gardiner; 1995; Ste. Marie & Jacoby, 1993). Another possibility would be to test participants' subsequent memory for distracters that were shown during test (see Jacoby, et al., 2005). In this case, higher recognition for the previously shown as compared to novel distracters would suggest that participants were aware of the distracters to the extent that further processing of the distracters had occurred.

In conclusion, spontaneous memory is common in daily life (Rubin & Berntsen, 2009) but rarely studied in the laboratory (e.g., Anderson et al., in press; Mace, 2006; Ste. Marie & Jacoby, 1993). The current studies tested the dynamics of spontaneous recognition within an experimental setting, allowing manipulations on ability to maintain retrieval goals, the fluency of targets and distracters, and the extent to which intentional retrieval was oriented to source information. Spontaneous recognition was more likely to occur when retrieval constraint was made difficult as a result of having to alternate between decisions to different components in the environment. The results also suggest that the type of information that is spontaneously recognized seems to be partially regulated by one's retrieval orientation toward source information. Further insight into the elusive phenomenon of spontaneous recognition might be gained by considering how cognitive control sets the stage for its occurrence.

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