REALITY MONITORING, METACOGNITIVE ACCURACY, AND

AGING: EXPANDING THE VIEW ON AGE-RELATED DEFICITS

FOR SOURCE INFORMATION

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REALITY MONITORING, METACOGNITIVE ACCURACY, AND

AGING: EXPANDING THE VIEW ON AGE-RELATED DEFICITS

FOR SOURCE INFOMRATION

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This dissertation is dedicated to the countless people in my proverbial corner. Thanks for always believing in me.

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LIST OF SYMBOLS AND ABBREVIATIONS

AR	Associate recognition
CJ	Confidence judgment
FOK	Feeling-of-knowing
IM	Item memory
JOL	Judgment of learning
JOS	Judgment of source
JOSL	Judgment of source learning
OA	Older adults
RMF	Reality monitoring framework
SCJ_1	Source recall confidence judgment
SCJ_2	Source recognition confidence judgment
SM	Source memory
SMF	Source monitoring framework
SRECAL	Source recall
SRECOG	Source recognition
YA	Younger adults

SUMMARY

Multiple studies have demonstrated age-related deficits in source memory (SM) where older adults perform worse on SM tasks than younger adults (e.g., Dodson & Schacter, 2001; Johnson et al, 1995; Old & Naveh-Benjamin, 2008). In contrast, metamemory research has demonstrated that age-related deficits are far from consistently demonstrated, leading to a general consensus that young and older adults' performances on most metamemory tasks are comparable (Hertzog & Hultsch, 2000). The research presented here focused primarily on an attempt to bridge these two literatures in a meaningful way. The contributions were two-fold: an investigation of the viability of a metacognitive judgment for SM: the judgment of source learning (JOSL), and a simultaneous investigation of the relationship of age and 'monitoring' in source memory and metacognition. In the first experiment, young participants (18-25 years of age) were asked to predict (using JOSLs) whether they would be able to discriminate between pictures that were presented to them during study, images of words they generated during study, or words they never studied in a later memory test. Participants made either immediate or delayed JOSLs (on a 0-100 scale) for each item presented during the study phase. Experiment 2 was a cross-sectional study comparing young and old adults (60-80 years of age) using a modified version of the previous task. In both experiments, intraindividual correlations of JOSLs with SM (gammas) indicated that delayed JOSLs were accurate predictors of future SM performance. There were no effects of age on gamma correlations of JOSLs with SM. Based on these results, although SM showed an age-related deficit, metacognitive predictions of SM did not show this same effect.

CHAPTER 1

INTRODUCTION

Reality and Source Monitoring

Johnson and Raye's (1981) reality monitoring framework (RMF) focused on how people discriminate between information that is externally derived versus what is internally generated. As part of a larger source monitoring framework (SMF: Johnson, Hastroudi, & Lindsay, 1993), numerous studies have branched off to shed light on the human ability to decide where the information, knowledge, or beliefs they possess actually originated. A basic tenet of how people actually carry out making source discriminations involves 'monitoring'. Monitoring processes in source discriminations refer to a set of processes used to generate evidence regarding source. Johnson and colleagues distinguished source monitoring and reality monitoring from each other by pointing out that the type of discrimination being made, whether between a real or imagined event (reality monitoring) or a wider range of sources (e.g., different speakers, contextual details for source monitoring) signals what type of monitoring one is discussing. Given a very basic interpretation of this distinction, it is safe to assume that a reality monitoring discrimination still falls under that of source since a person is still making a decision between the origins of the information, i.e. whether information has an internal or external basis. According to the SMF, similarity between sources (Ferguson, Hashtroudi, & Johnson, 1992), emotional arousal (Mather et al, 2006), and a person's imaging abilities (Johnson, Raye, Wang, & Taylor, 1979), are factors that can impact the accuracy of source judgments.

The general consensus is that, most often, source judgments are based on heuristics (Dunlosky & Metcalfe, 2009), which can be problematic and give rise to biases that can negatively impact the accuracy of source discriminations. Research has shown that people tend to rely on familiarity much more than recollection when making source discriminations (e.g., Lindsay & Johnson, 1989). During retrieval of events, Mitchell and Johnson (2000) argued that one can experience "…general feelings of familiarity or strength to memory for specific features…" (p. 180). In reality monitoring, reliance on perceptual cues and heuristic processing to make reality monitoring decisions (Johnson et al., 1988; McGinnis & Roberts, 1996) instead of a more deliberate examination of the information before making the discrimination leads to decision biases. Kelly and colleagues (2002) investigated the 'bias towards real,' in which participants were more likely under uncertainty to incorrectly attribute internally derived memories to externally derived sources. This bias was ameliorated when participants were given a demanding task during study that hampered their ability to pay close attention to source details of the stimuli. Johnson and Raye (1981) argued that the reality monitoring processes involved in discriminating the origin, whether it is internal or external, depends on task constraints and the nature of the information; therefore, whether the same biases will manifest across reality monitoring tasks remains an open question.

Age-related Deficits in Source/Reality Monitoring

The debate in the literature as to whether there is a larger age-related difference in memory performance for 'context' information (e.g., source, temporal, location) over 'content' information (e.g., recall of words, targets, prose) has concluded that there is a larger deficit for older adults for context information (e.g., Bornstein & LeCompte, 1995;

McIntyre & Craik, 1987; Old & Naveh-Benjamin, 2008; Spencer & Raz, 1994; 1995; but see also Siedlecki, Salthouse, & Berish, 2005), with the caveat that the magnitude of the context-based deficit may by task dependent (Onyper, Hoyer, & Verhaeghen, *in prep*). Spencer and Raz's (1994) meta-analysis found the largest age-related differences on tasks where participants had to determine whether actions were performed, imagined, or watched. This distinction was especially important for this dissertation because age-related deficits were likely given the reality monitoring task that was used.

Several studies point to an age-related deficiency in monitoring processes as the basis for the age-related deficit in source memory (Johnson, De Leonardis, Hashtroudi, & Ferguson, 1995). This is likely in large part to older adults' reliance on more on heuristic based processes such as familiarity and gist in memory tasks rather than recollection (e.g., Dehon & Brédart, 2004; Hashtroudi, Chrosniak, & Johnson, 1989). This has proved problematic especially in false memory paradigms, where effective source monitoring has been implicated as a remedy for older adults' increased propensity for false alarms (e.g., Dodson & Schacter, 2002). Dodson and Schacter (2001; 2002) showed older adults to be more susceptible to source retrieval and monitoring errors, but also showed that the use of a distinctiveness heuristic helps to reduce false alarm rates for source recognition tests. In their work, Dodson and Schacter have shown that older adults do not spontaneously engage in strategic processes to make source judgments unless specifically instructed to do so. According to Dodson and Schacter (2002), the *distinctiveness heuristic* refers to a strategic process where people reject items or information based on expectations about how vivid they expect their memories to be for actual items they studied. Encoding based on distinctiveness, as well as a retrieval search that seeks more

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recollective detail makes the source discrimination more resistant to false alarms (i.e. identifying new items as old). Use of the distinctiveness heuristic also reduced age differences in source monitoring accuracy. By attending to distinctive item features at encoding and then searching for those features at retrieval, older adults were able to reduce what Dodson, Bawa, and Slotnick (2007) referred to as 'illusory recollections' which they argued accounts for a large proportion of the increase in source memory deficits in older adults. In the aforementioned studies, asking older adults to attend to and monitor information in a manner they do not spontaneously implement led to the exertion of metacognitive control to improve performance.

It should be noted that not all source memory findings that show an age-related deficit are interpreted as monitoring deficits. Recent work by Luo and Craik (2009) supported the idea that source memory is impaired because older adults are more challenged than younger adults when the need to implement strategic control over retrieval arises. Like previous work, manipulating attention to perceptual details reduced the age-related deficit in source memory, but a distinction between performance on a high specificity judgment (remembering whether an item was presented as a photo or drawing) and a low specificity judgment (remembering whether an item was presented as any image or just a word) persisted. Simply, even with a task to orient participants to perceptual characteristics of the items and longer presentation times, older adults were encoding information in a shallower way than younger adults. This behavior led to lower memory performance. Their account suggests that this deficit arises from an overall 'reduced resources hypothesis' of aging (Craik & Byrd, 1982), where older adults are engaging in shallow encoding because of a lack of processing resources which then led to

deficient binding of specific details from the encoding phase in their experiments. The reduced resources were not specific to encoding either. They also went on to argue that also at retrieval, control -- which is critical to accessing highly specific detail, is also impaired due to age-related reductions in processing resources.

In the context of this dissertation, an important first step was to frame how the idea of monitoring is used in the reality monitoring/source monitoring frameworks – distinguishing it from what 'monitoring' is in the metamemory literature – and to focus on designing experiments that would incorporate these processes for measurement. This was especially important when the variable of age was added to the research question. In the case of reality monitoring, accuracy was defined by whether the source discrimination is correct. The argument was that if the monitoring process is carried out correctly, then the attribution of an event to either the internal or external source origin would be correct. This is not the same way monitoring accuracy has been conceptualized in metamemory theory (e.g., Nelson & Narens, 1990), which is discussed below.

Metamemory: Monitoring and Control

Metamemory typically refers to a person's cognitions about his or her own memory and is defined as one's ability to reflect on or monitor memory processes (Dunlosky & Metcalfe, 2009). Metamemory theory draws a sharp distinction between monitoring and control processes (Nelson & Leonesio, 1988). Metacognitive monitoring refers only to observations of the cognitive system by a meta-level process (Nelson & Narens, 1990). Dunlosky and Metcalfe (2009) explained that, "…metacognitive control is exerted whenever the meta-level modifies the object-level…you must monitor those object-level acts to influence the ongoing activity at the object-level" (p. 5).

Metacognitive monitoring can take place at several instances in the memory task setting. In this way, monitoring is distinct from action, although accurate monitoring enables effective control.

Koriat (2000) discussed how there was much more to remembering than just retrieving a piece of information. When remembering is effortful, there are several processes that one must engage in: preliminary monitoring and choosing of a strategy; specifying the initial context of the memory search; accessing partial information and zooming in on a memory target; probing one's memory; regulating the retrieval process; and, regulating of memory reporting. Research into these types of phenomena typically involved the use and evaluation of metacognitive judgments. In the simplest terms, the individual must engage in monitoring and control processes to reflect on and evaluate the information that is in memory in order to make a judgment about it.

Dunlosky and Metcalfe (2009) defined a metacognitive judgment as, "any reflection or judgment made upon an internal representation such as memory" (p. 145). The judgment of learning (JOL) is a metacognitive judgment that predicts the ability to remember future information (Dunlosky & Nelson; 1994). The accuracy of JOLs can be influenced by many factors such as the cues that are accessible at the time of judgment (Dunlosky & Matvey, 2001; Koriat, 1997) or when the judgments are made (Kelemen & Weaver; 1997; Nelson & Dunlosky, 1991; Thiede & Dunlosky, 1994). Koriat showed that intrinsic, extrinsic, and mnemonic properties of cues influence the accuracy of JOLs differentially.

A recent meta-analysis by Rhodes and Tauber (2011), which included data from Kelemen and Weaver (1997), Nelson and Dunlosky (1991), and Thiede and Dunlosky

(1994), compared the relative accuracy of immediate versus delayed JOLs. A sizeable effect (g = 0.93) indicated that by delaying the JOL, relative accuracy was significantly increased (Rhodes & Tauber, 2011). This phenomenon is commonly referred to as the 'delayed JOL effect'. The delayed JOL effect centers on the idea that delaying the timing of the judgment increases the relative accuracy of JOLs because delayed JOLs are more likely based on retrieval cues/processes than immediate JOLs. Relative accuracy is typically assessed by correlating predictions with memory outcomes (also called resolution). When JOLs were immediate –solicited directly after study of each item– they were less accurate predictors of memory outcomes than when JOLs were delayed. The theoretical explanations for the delayed JOL effect all included assumptions that participants monitored outcomes of retrieval processes in order to formulate the delayed JOL (Dunlosky & Metcalfe, p. 100).

In the literature, the term 'source judgment' has referred to the source discriminations, modality judgments (e.g., Kelley, Jacoby, & Hollingshed), as well as confidence judgments about the accuracy of source discriminations (Mitchell, Johnson, & Mather, 2003). As a kind of source judgment, reality monitoring discriminations are made as a participant is trying to recall and evaluate a specific aspect of the episodic memory—whether the information came from an external or an internal source. Theoretically, source memory is inferred. People use a variety of cues, attributions, and heuristics to retrieve source information more so than when retrieving the memory itself. Providing a predictive metacognitive judgment about one's future ability to remember a source, in theory, takes the evaluations of related cues and attributions one step further.

Conceivably, people could represent their confidence in the source information they retrieve during the time of the judgment, their confidence in the strategy they use for retrieval, and their confidence about the effectiveness of future applications of the retrieval and monitoring strategies, with a JOL for source information. Depending on their evaluation, they could choose to continue relying on their current task behavior or to change it. Metacognitive theory would argue that source monitoring actually is a complex process mixing monitoring and control. The studies conducted sought to extend the realm of source memory findings to what has already been discovered about other types of predictive metacognitive judgments such as JOLs.

Age-related Deficits in Metacognition

Unlike the studies that focused on age-related deficits in source memory, many studies of age differences in monitoring from a metacognitive perspective supported the idea of spared memory monitoring as one ages (see Hertzog & Hultsch, 2000 for a review). Hertzog and Hultsch (2000) provided a categorization of metacognitions, namely: a) knowledge about cognition and cognitive functions, b) the monitoring of the current state of the cognitive system, and c) beliefs about cognition (including beliefs about aging and cognition and beliefs about one's own cognition). One way metacognitive accuracy is typically assessed is by correlating judgments with subsequent memory outcomes, usually a Goodman-Kruskal gamma (Nelson, 1984). It is referred to as resolution and is a measure of how well participants discriminate between items they don't remember and items they do remember by assigning lower judgments or higher judgments accordingly.

Numerous studies have shown that for most metacognitive judgments, where monitoring is assumed to play a critical role, age-related equivalence in monitoring accuracy is typically found (e.g., for JOLs: Connor, Dunlosky, & Hertzog, 1997; Dunlosky & Hertzog, 1997). It is important to note that there are findings where an age-related deficit is seen for a particular metacognitive judgment, i.e., episodic feeling-of-knowing judgments (FOKs: Souchay et al., 2004), but there is counter-evidence that this deficit may be task specific and possibly an artifact of underlying memory strength (Hertzog, Dunlosky, & Sinclair, 2010). Even when age-related differences are seen in memory monitoring in the metamemory literature, the deficit could not be characterized as generalized.

Understanding the effects of age on metamemory is not restricted to just monitoring. Studies have shown mixed evidence for age-related differences in metacognitive control, which in some cases is directly affected by metacognitive monitoring. Naveh-Benjamin, Brav, and Levy (2007) provided evidence to support the idea that compared to younger adults; older adults were less likely to self-initiate use of effective strategies when studying new material. Souchay and Insigrini (2004) demonstrated that older adults did not use monitoring as effectively as younger adults to allocate study time in a memory task. While Miles and Stine-Morrow (2004) found age-related differences in how study time was allocated as represented by the correlation between JOLs and time spent on study, Stine-Morrow and colleagues (2006) did not find the same deficit. It may be the case that older adults were less likely to initiate metamemory processes, but when healthy older adults were introduced to or reminded of strategies they were able to implement them and improve memory monitoring (updating

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knowledge of effective strategies) and metacognitive control (allocating study time more efficiently).

To summarize, there seems to be a largely accepted idea that age-related deficits exist in reality monitoring or source discrimination, alongside a largely accepted notion of no age-related deficits in monitoring encoding and retrieval processes in metamemory research. The distinction between monitoring that is typically studied in metamemory research (e.g., monitoring represented by simple JOL resolution or study time allocation) and the monitoring processes referred to by Johnson and colleagues (e.g., monitoring needed to make a source discrimination) could reflect a distinction in the level of complexity in the monitoring processes being assessed. JOLs (and other metacognitive judgments) could represent judgments based on simpler monitoring processes, whereas source monitoring involves monitoring the output of metamemory control and monitoring processes. Mitchell, Johnson, and Mather (2002) referred to this complex process as a 'gating' procedure one engages in when trying to separate and extract memory details specific to source. In the former case, monitoring to form a JOL or to modify study behavior may be less susceptible to error, in the latter case, monitoring the by-products of the 'gating' procedure may be more susceptible if not carried out in a very systematic and deliberate fashion (which older adults tend not to do). The question then becomes whether it is necessary to think of monitoring in these different lines of literature as distinctly different processes or whether it is possible to identify shared characteristics of both kinds of monitoring.

Previous research from within the source monitoring framework has sought to characterize aspects of source memory in terms of metamemory. Johnson et al. (1993)

discussed the use of 'systematic' source judgments, whereby one retrieves and judges the importance of the details accessed in the source monitoring process. Later, Mitchell, Johnson, and Mather (2003) talked about 'source judgments' as confidence judgments about a source discrimination. Is it then possible to assess monitoring as discussed in the SMF and metacognitive monitoring as it is conceptualized in metamemory in an experiment and talk about the effects of one on the other?

Previous Research on Metacognitive Judgments and Source Memory

This dissertation represented an attempt to explicitly measure metacognitions about source memory. The fundamental concept was that instead of predicting memory for the target item (as in a JOL), individuals predicted whether they would be able to retrieve the source of the target information with a judgment of source learning (JOSL). There has already been some research focused on this predictive judgment of source memory (Kelley, Carroll, & Mazzoni, 2002; Lafferty, 2001; Sinclair, 2007). In previous work, JOSLs were called simply judgments of source (JOSs) and most often were conceptualized as predictive ratings of participants' confidence in their future source memory for a particular item. Sometimes JOSs were also used to refer to the source discrimination itself. I chose to refer to the predictive judgments in this work as JOSLs to avoid confusion with other interpretations of the JOS acronym. JOSLs are prospective judgments (like JOLs) about future source recall, rather than retrospective judgments about accuracy of item retrieval (like retrospective source confidence judgments about source accuracy: SCJs).

Considering the cue-utilization perspective as applied to JOLs (Koriat, 1997), JOSLs were assumed to capture the outcomes of source monitoring processes, the cues

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that were accessible at the time of the judgment, and the information a participant

believed would be accessible in the future. Carroll and colleagues were able to show that

participants predicted better memory for real over imagined events, but found that JOSLs

were not predictive of source recall (Carroll et al., 1999), or accurate reality monitoring

(Kelly et al., 2002). In an unpublished master's thesis, Lafferty (2001) found inconsistent

relationships between the JOSL and subsequent source memory. Lafferty was able to

show reliable resolution between immediate JOSLs and source memory performance

(gamma = 0.58) in one experiment where participants had to discriminate between items

presented by either a male or female voice, but was unable to replicate this finding for

other materials. In another unpublished master's thesis, Sinclair (2007) conducted several

studies looking at the relationship between delayed JOSLs and subsequent memory

performance for picture or spoken targets in a list of paired associates (e.g., APPLE-

ROBOT, where the target ROBOT was presented as either a picture or spoken aloud to

participants). A reliable relationship between source and JOSLs was not observed in the

findings reported in Sinclair's work, although JOSLs correlated significantly with paired

associate recall.

Studies finding no consistent predictive validity of JOSLs have nevertheless

uncovered some interesting phenomena. Carroll and Mazzoni (2002) showed that even

though JOSLs did not correlate significantly with source memory performance outcomes,

people did scale their JOSLs in some conditions to show their belief that real events

would be remembered more than imagined events. Lafferty (2001) showed a significant

relationship between immediate JOSLs and subsequent source discriminations for

male/female presented items. Sinclair (2007) found that SCJs significantly correlated

with source memory performance positively for picture targets, but negatively with sound targets. The reasons for the inconsistencies in the relationship between metacognitive judgments and source memory have been attributed to several factors: unfamiliar task context (Kelly et al., 2002); presence of other metacognitive judgments (like JOLs) that may have influenced the predictive judgment for source (Kelly et al., 2002; Sinclair, 2007); overshadowing of the source task by a concurrent item or associate memory task (Lafferty, 2001; Sinclair, 2007). It could be the case that either valid cues were not available, or that available cues were not accessed at the time of the JOSL. Indirect evidence for these arguments can be found in Sinclair (2007) where JOSLs correlated significantly with associative recognition—correlations of comparable magnitude to those between JOLs and associative recognition, indicating an 'overshadowing' or 'contamination' of cues available that were diagnostic for item memory, but not for source. Specifically for JOSLs, these inaccurate judgments possibly meant that the cues people attended to when making these predictive metacognitive judgments about their source memory were not diagnostic of source memory.

Even though participants were not able to accurately predict their source memory performance consistently, they were able to accurately monitor source memory performance under certain conditions. Source confidence judgments (SCJs) about source memory performance outcomes provided another opportunity to examine the nature of the relationship between source memory and metacognitive judgments. Specifically, (SCJs) correlated significantly with previous source memory performance. An open question was whether a predictive judgment, like the JOSL, was less accurate than a retrospective judgment, like the SCJ. Another idea was that age-related deficits may be

seen in one metacognitive judgment but not the other. Such dissociations could mean that, for source memory, age-related differences in metacognitive accuracy are sensitive to the timing and kind of metacognitive judgment being investigated.

Until now, previous work investigating age-related differences in JOSL resolution was limited to Sinclair's (2007) study. There is much evidence indicating an age-related deficit in source monitoring and utilization of control processes to make accurate source discriminations (Mitchell & Johnson, 2009). An open question was whether an age-related difference would be uncovered for JOSL resolution, despite the evidence of age-invariance in JOL resolution. Findings from Sinclair's work showed that JOSLs did not correlate with future source memory performance for neither young nor older adults. This made investigating age-related effects impossible. These issues were once again investigated in this dissertation.

Experiments

The two experiments in this dissertation addressed four main questions of interest. The first question was, could individuals differentiate accurately between self-generated and presented stimuli (i.e. engage in accurate reality monitoring)? Related to this question was whether or not older adults could perform this task and how would their level of performance compared to that of younger adults. The second question was, could individuals accurately predict their memory performance within modality (images) but across reality monitoring boundaries (internal versus externally derived information) using judgments of source learning (JOSLs)? Based on previous research, support for this outcome was slim to non-existent. Once again, whether older adults could be as accurate as younger adults was an important and related issue investigated. The third and fourth

questions were specific to the metacognitive judgments used: did metacognitive accuracy depend on the type of judgment (JOSL versus source retrospective confidence [CJs]) or simply on the timing of judgments (immediate versus delayed)?

Experiment 1 included younger adult participants because there were several methodological and experiment design questions I wanted to investigate before extending the study to include older adults. The source memory task was designed in a way to make it more salient over the item memory task by specifically informing participants through instruction that the memory tests would focus directly on the source discrimination. Essentially, participants were oriented to focus on remembering whether the source of images was externally or internally derived (presented images or generated images). Secondly, I investigated whether immediate or delayed predictions (i.e. JOSLs) were better suited for predicting source memory, employing both source recall and source recognition memory assessments. Participants were asked to make predictions about their source memory either immediately following each item, or in a delayed judgment block. Because distinctiveness and accessibility to detail was of interest, I manipulated the 'generate' instructions across conditions of participants in an attempt to elicit categories of items with significantly different levels of perceptual detail. Specifically, participants were either instructed, in the 'generate line' condition, to generate images like the line drawings presented by the experiment or in the 'generate real' condition, to generate images of items, as they would see them in real life. Retrospective source CJs were also collected in the experiments and accuracy of these judgments was assessed with a gamma correlation of source memory performance with the subsequent CJ for each item. Participants were asked to give ratings about their memory performance following each

item of the source recall and recognition tests. Finally, metacognitive accuracy between JOSLs (a forecasting judgment) and SCJs (a retrospective judgment) was investigated.

By employing a design that was specifically tuned to the encoding and retrieval of source information, the validity of participants' JOSLs was improved. JOSLs have not been shown to have above chance accuracy in previous work (probably because of task overshadowing, cue contamination, etc). The experiment design addressed these issues. A fundamental assumption that influenced the task design was that JOSLs would be based largely on the accessibility of perceptual details and the ease of accessing those details at the time of judgment. Specifically, by changing the item memory task from a paired associate word list to an item list shifted the participant's focus on encoding a word-word association to encoding a word-source association. Secondly, instructing participants that the tests would focus primarily on the source discrimination boosted the salience of the source discrimination task over the item memory task. Additionally, it was suggested that a good strategy for later distinguishing old from new items would be to focus on source details. Finally, by phrasing the JOSL to orient participants to predicting their ability to make the source discrimination, rather than as a prediction of whether they would be able to remember an item, resulted in accurate JOSLs in the delayed conditions. These design implementations were proposed as a way to ensure that the JOSL would be based on cues diagnostic of source memory rather than other cues that were present in previous research (e.g., Sinclair, 2007).

Borrowing from previous work, SCJs were included to provide an opportunity to see if individuals were aware of their memory performance and whether they would adjust confidence accordingly when they made correct or incorrect source

discriminations. Also a metacognitive judgment, SCJs provided a unique opportunity to compare relationships between prediction and retrospective judgments as they related to source memory performance. As discussed earlier, SCJs correlated with source memory for specific materials so including them once again to assess whether they were accurate in this experiment design was of interest. Including SCJs also allowed for an investigation into whether high confidence to incorrect discriminations played a role in reducing metacognitive accuracy.

Source recall and source recognition tasks were included to determine if the level of age-related deficits seen in source recognition would differ from the level seen in source recall as would be suggested by previous research (e.g., Onyper et al., *in prep*). It should be noted that this finding is reversed from what is typically found in item memory literature, i.e., source recognition deficits are larger than source recall deficits. Research by Cook, Marsh, and Hicks (1997) showed that accurate source memory can occur even when items are not recalled. This would lead to predicting that source recognition would still be good even if source recall were deficient. Thierry and colleagues (2005) found that when both types of source memory tests are used, source recall enhances source discriminations for children on a subsequent source recognition task.

The independent variables in the first experiment were JOSL timing (immediate, delayed), instruction condition (generate line, generate real), and item type (presented, generated, new). The dependent variables were judgments of source learning (JOSLs), item memory, source recall (SRECAL), source recognition (SRECOG), retrospective confidence judgments (SCJs), and several gammas (JOSL-SRECAL, JOSL-SRECOG, SRECAL-SCJ$_1$, SRECOG-SCJ$_2$, JOSL-SCJ$_1$ and JOSL-SCJ$_2$. The goals of the first

experiment were to establish whether JOSLs were significantly predictive of source memory outcomes, to assess the relationship between source memory and retrospective confidence, to investigate whether timing of the JOSL affected its predictive ability, to see if task instructions and/or the modality in which items were studied affected the dependent measures in any way, and to investigate whether the relationships between JOSLs, source memory performance, and source confidence judgments were influenced by the independent variables indicated.

In experiment 2, a new sample of younger adults was tested along with a sample of older adults. The dependent variables of interest were the same as in experiment 1. The overarching goal of experiment 2 was to extend the procedures from experiment 1 to an age cross-sectional design in an attempt to assess possible age-related effects on the dependent measures. Experiment 2 also served in part as an opportunity to investigate whether results from experiment 1 could be replicated in a new sample of younger adults which would provide strength to any inferences drawn from the results.

CHAPTER 2

EXPERIMENT 1

Method

Participants

A total of 126 younger adults between the ages of 18 and 25 (M_{age} = 20.2, SD = 1.75) participated in this study (see Table 1 for further sample characteristics). They were recruited from the Georgia Tech volunteer subject pool using Experimetrix. Participants chose between compensation of $25 or 2 hours of course extra credit.

Table 1 *Participant Demographics*

	Experiment 1			
	Immediate		Delayed	
	Generate Line	Generate Real	Generate Line	Generate Real
N	31	31	34	30
Age (years)	20.5 (1.99)	19.7 (1.36)	20.4 (1.92)	20.2 (1.68)
Education (years)	15.0 (1.15)	14.87 (0.81)	15.1 (0.90)	15.1 (0.64)
Female	41%	68%	35%	63%

Note. Standard deviations of means in parenthesis

Materials

JOSL Computer Task

The main source monitoring task was programmed in Visual Basic.Net and administered on personal computers. The input devices for the computer task were the keyboard and mouse, and the monitor resolution was set at 1024 X 768. The stimuli included 185 concrete nouns available in simple, black and white, line drawn picture format (see Appendix A). Five of the items were used for practice (WHEELBARROW, STETHOSCOPE, FISHTANK, PIGGYBANK, UNICYCLE) and the remaining 180 were used in the main experiment. The picture stimuli were acquired as freeware from

the Center for Research in Language – International Picture Naming Project database that is maintained by the University of California, San Diego. The names of the pictures were also used along with the images to ensure that no differences among word generation for the images would occur (Table 2). At the beginning of the program for each participant, items were randomly assigned to be presented as a line drawing, as a text word for generation, or presented only during test as a new item 'foil'. This resulted in 60 presented items, 60 generated items and 60 new items in the experiment.

Table 2 *Word List (Picture Names)*

ARROW	CASTLE	GLOBE	MOUSE	RAINBOW	STATUE
BABY	CHAIN	HAIR	NAIL	RAZOR	STOVE
BACKPACK	CHEESE	HAMBURGER	NEEDLE	RIFLE	STRAWBERRY
BAG	CHEST	HAY	NEST	ROAD	STROLLER
BALLOON	CHURCH	HELMET	OCTOPUS	ROBOT	SUBMARINE
BANDAID	CITY	HINGE	PACKAGE	ROCK	SWING
BANJO	CLOCK	HOOF	PANDA	ROCKET	TAIL
BAT	COMB	HOSE	PANTS	ROLLERSKATE	TANK
BATHTUB	COOKIE	JACKET	PAPERCLIP	ROOF	TEAPOT
BEARD	COWBOY	JUMPROPE	PARROT	ROPE	TEEPEE
BELT	CRAB	KING	PEACOCK	ROSE	TEETH
BENCH	CRACKER	KITE	PEAR	RUG	TELESCOPE
BIRD	CRIB	KNOT	PEAS	SALT	TENT
BOAT	CROSS	LADDER	PENGUIN	SCARF	THUMB
BOMB	CURTAINS	LAMP	PICTURE	SEESAW	TIE
BONE	DESERT	LEAF	PILLAR	SHARK	TIGER
BOTTLE	DIAPER	LETTER	PILLOW	SHELL	TOE
BOX	DRESS	LIGHTHOUSE	PITCHFORK	SHIRT	TOILET
BRA	DRILL	LION	PIZZA	SHOVEL	TOWEL
BRIDE	DRUM	LIZARD	PLATE	SINK	TROPHY
BRIDGE	DUSTPAN	LLAMA	POOL	SKATEBOARD	TURKEY
BROOM	EGG	LOG	POPCORN	SKELETON	TWEEZER
BRUSH	ELEPHANT	MAGNET	POPSICLE	SKIS	VASE
BUG	FAN	MAP	POT	SLIDE	VIOLIN
BUTTER	FEATHER	MICROPHONE	PRESENT	SLINGSHOT	VOLCANO
CACTUS	FIRE	MICROSCOPE	PUMPKIN	SNAIL	WALNUT
CAMEL	FIRETRUCK	MIRROR	PURSE	SPAGHETTI	WIG
CANE	FISH	MONKEY	PUZZLE	SPIDER	WINDMILL
CANOE	GHOST	MOOSE	RADIO	SQUIRREL	WORM
CAR	GLASS	MOP	RADISH	STAIRS	ZEBRA

For the source recall task, the word names of the items were presented to participants to make the reality monitoring discrimination. In the source recognition task, both the name and line drawing for each item was presented for discrimination. For both memory tasks, a forced choice test format was used. Participants had to select one of the answer choices in order to move on to the next item.

<u>Paper Tasks</u>

In addition, standard paper and pencil measures were administered to assess sample characteristics. These paper and pencil measures included a demographic questionnaire (personal data sheet: PDS), the Advanced Vocabulary Test – a recognition vocabulary test used to assess verbal ability (AVT: Ekstrom, French, Harman, & Dermen, 1976), the Pattern Comparison and Letter Comparison perceptual speed measures (PC and LC: Salthouse & Babcock, 1991), and measures of participant imaging ability: the Memory Characteristics Questionnaire (MCQ: Johnson et al., 1988) and the Vividness of Visual Imagery Questionnaire (VVIQ: Marks, 1973).

Design

The design of this first experiment was a 2 (timing of the JOSL: either immediate or delayed) X 2 (type of image generate instruction: 'generate line' images or 'generate real' images) X 2 (item type: presented or generated) mixed factorial. JOSL timing and generate instruction conditions were manipulated between subjects while item type was a within subject variable.

Procedure

Participants provided informed consent at the beginning of the experiment. After this was received, they completed the PDS, AVT, PC and LC paper and pencil measures. Following completion of these paper and pencil measures, participants began the main computer task of the experiment.

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In the first portion of the task, participants were given extensive instructions as to what they would be required to do to complete the task successfully. They were informed that they were attempting to learn the items for a later memory test that would focus on how they studied the item. They were told that they would be studying two kinds of items, images that were presented to them on the computer screen (Figure 1) and items where they would have to study by generating a mental image of the item.
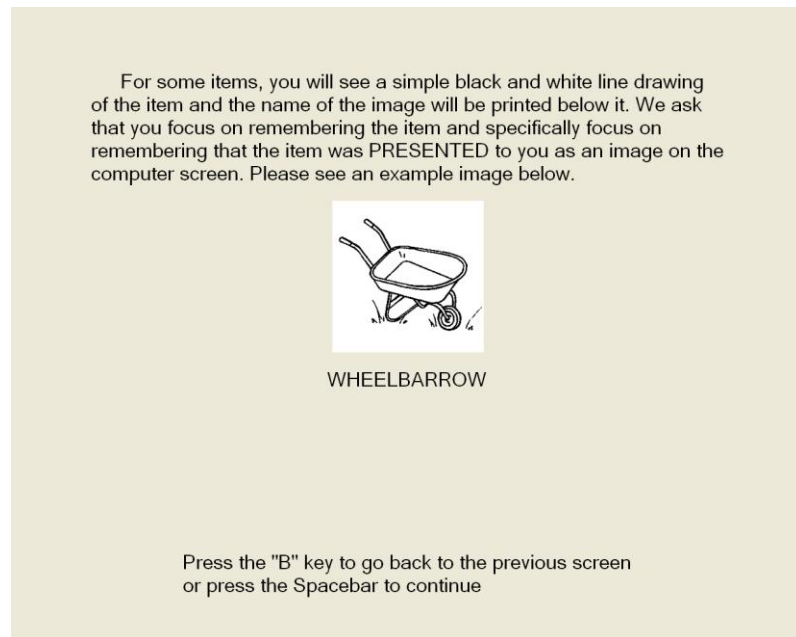
Figure 1. The 'presented item' study instruction example

Depending on the condition in which the participant was assigned, they either received instructions orienting them that when asked to generate an image they should, "Imagine a simple, black and white, line drawing of the item, like the images presented on the computer" ('generate line' instructions), or to "Imagine the item as it would appear in the real world" ('generate real' instructions). They were provided with three experimenter-designed examples for their respective instruction condition (WAFFLE, WOLF, ICECREAM), where either black and white line drawings were shown or a color

photo of each example was shown (Figure 2). Participants were then given the

opportunity to ask for further clarification if needed.
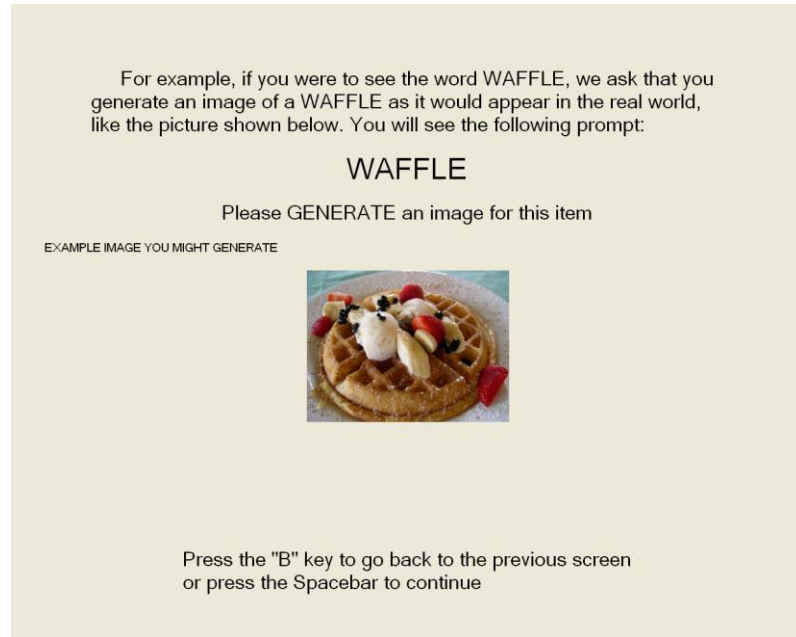
Figure 2. The 'generate real' study instruction example

Participants in all conditions received instructions on the respective judgments

they would be making, which included the JOSL as well as confidence judgments (CJs)

following each memory trial for the items. In the immediate JOSL conditions,

participants were informed that following the presentation of each item (whether a

presented line drawing, or generated image), they would be required to provide a

judgment rating following each item to the following prompt: "How likely are you to

remember whether the item shown here was an image PRESENTED to you or one that

you GENERATED an image of yourself?" They made their judgment on a 0 to 100 scale

where, 0 indicated that they "definitely will not remember" and 100 indicated "definitely

will remember". In the delayed JOSL conditions, participants were told that this same

judgment prompt for the JOSLs would be collected in a subsequent block following

presentation of all the items.

All participants were instructed that during the memory tests, a confidence judgment (CJ) for each item will be solicited thusly: "How confident are you that the answer you just provided was correct?" They made this judgment on a 0 to 100 scale, where 0 indicated that they are "not at all confident" and 100 indicated that they are "completely confident" that the answer they previously provided on the trial was accurate.

Following a brief (5 item) practice trial to orient participants to the study task and provide opportunities for participants to ask the experimenter questions, the main study phase began. During this phase participants were presented 120 items, one at a time, in the center of the screen. Sixty items were presented as black and white line drawings with their text name below the picture (Figure 3), and 60 items were presented as text only.

Figure 3. A 'presented' study item

Participants were instructed to generate an image of the word presented (Figure 4). All 120 study items were presented randomly to participants and picture and text items were randomly interspersed in the study phase of the experiment.
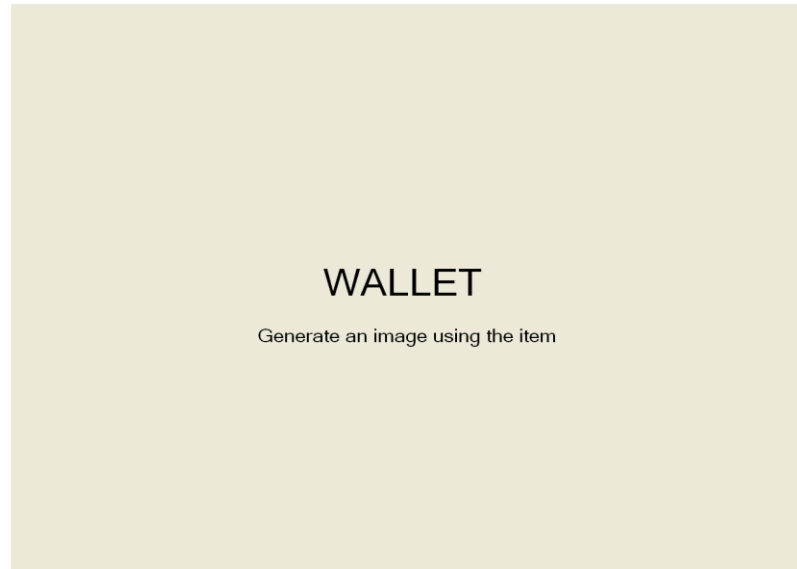
Figure 4. A 'generate' study item

In the immediate JOSL conditions, following the presentation of each item, participants were asked to make a JOSL before continuing on to the next item. In the delayed JOSL conditions, participants made all JOSLs in a judgment block following presentation of all 120 study items. JOSLs in both the immediate and delayed conditions were solicited using only the text format of each item (Figure 5).
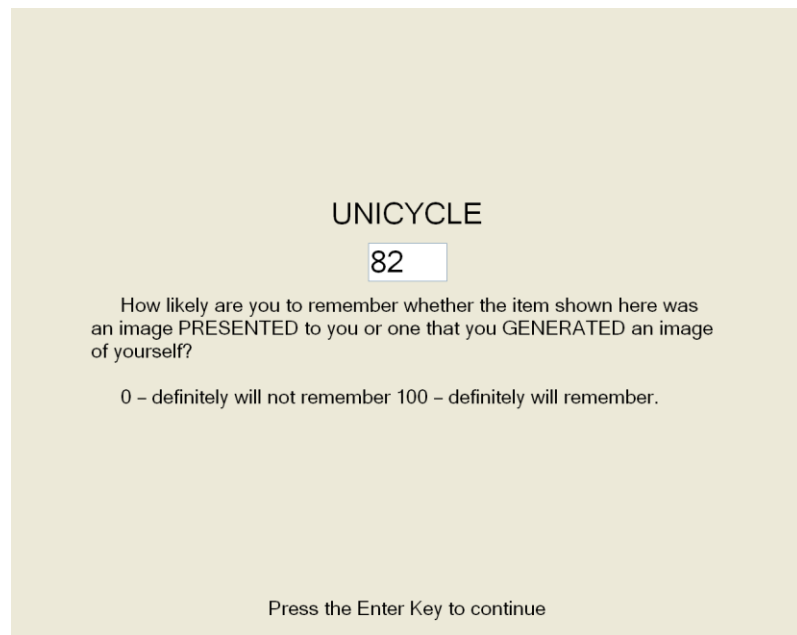
Figure 5. JOSL prompt

After the completion of the study and judgment phases, participants completed a short 5 minute filler task where they were asked to match patterns in a separate computer task. Following the pattern matching filler task, participants began the test phase.

In the first memory task, participants completed a source recall task where they were presented with the text version of the item (Figure 6). They typed in whether they studied the item or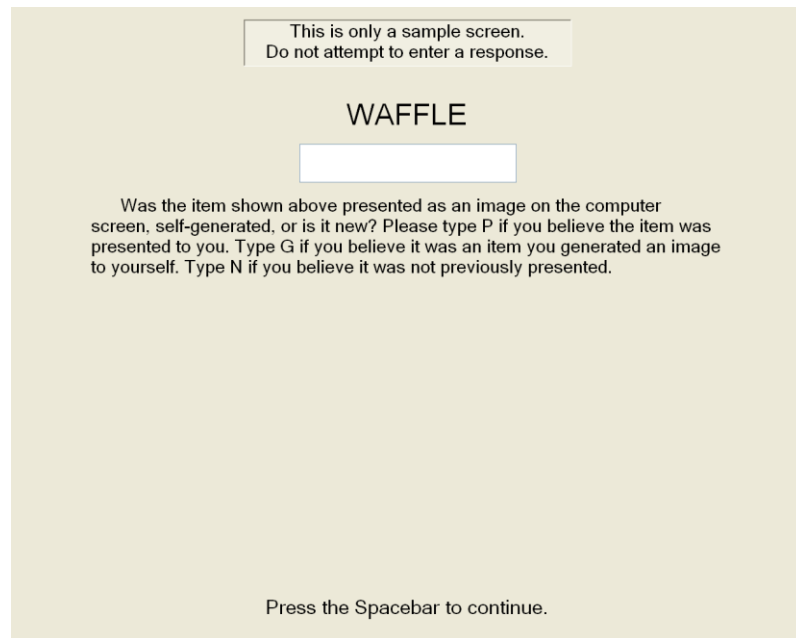iginally as a picture that was presented to them on the computer (P), one that they generated (G), or an item that they never studied (N). All 120 studied items were randomly presented along with 60 new foils randomly interspersed. After each source recall trial, participants gave a retrospective confidence rating to indicate their confidence in their answer for the trial.

This is only a sample screen.
Do not attempt to enter a response.

WAFFLE

Was the item shown above presented as an image on the computer
screen, self-generated, or is it new? Please type P if you believe the item was
presented to you. Type G if you believe it was an item you generated an image
to yourself. Type N if you believe it was not previously presented.

Press the Spacebar to continue.

Figure 6. Source recall item

In the second memory task, participants completed a source recognition task where they were presented with both the black and white line drawn version of the item as well as the text only version (Figure 7). They had to choose which way they originally studied each item by clicking on the circle beneath the version of the item they believe

they studied previously. After each trial, participants provided a confidence judgment (CJ) to rate their confidence in the answer they provided for each trial. Only the 120 originally studied items were used in this task.
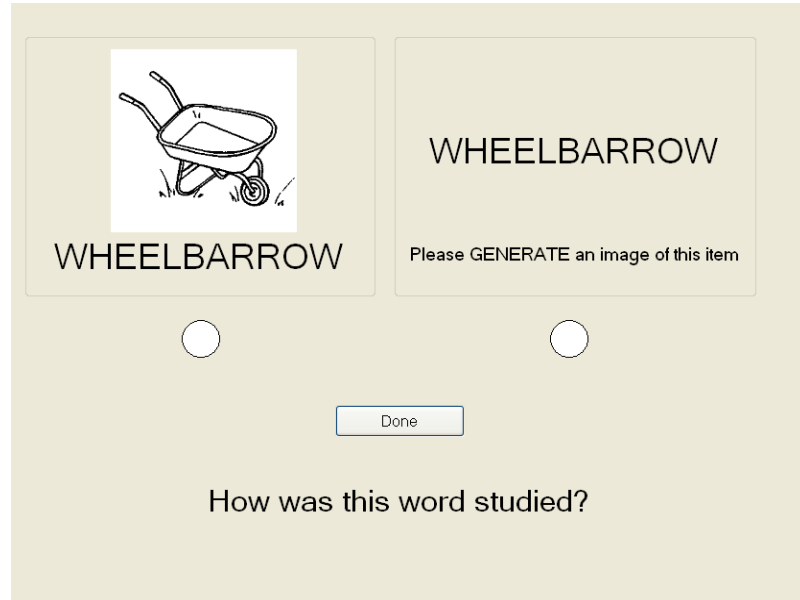
Figure 7. Source recognition item

Following the completion of this task, participants completed both versions of the MCQ and the VVIQ (Appendix B). Finally, participants were debriefed and the session concluded.

Data Analyses and Results

Effects are identified as significant at the $p < 0.05$ level for all subsequent analyses. The value italicized in parenthesis following the F statistic is the calculated Cohen's d effect size statistic. For Cohen's d, a "small" effect ranges from 0.20-0.30, "medium" effects range near 0.50, and effects are considered "large" when d is greater than 0.80 (Cohen, 1988). For interactions, a modified Cohen's d (d*) was calculated as an effect size measure. Marginal means are reported for significant effects and interactions where applicable. Values in parenthesis following means are standard errors.

Data from paper and pencil measures were digitally consolidated and relevant means are reported below. In Table 3, mean performance data on the perceptual speed and vocabulary measures are reported. Across conditions, the groups were comparable on all paper data variables (need F stats for LC, PC, and AVT).

Table 3 *Perceptual Speed and Vocabulary Test Means (SD)*

	Experiment 1			
	Immediate		Delayed	
	Generate Line	Generate Real	Generate Line	Generate Real
Letter Comparison	28.3 (8.70)	28.4 (5.59)	27.5 (5.45)	27.5 (6.34)
Pattern Comparison	45.3 (8.91)	47.3 (6.93)	47.5 (7.29)	46.9 (7.94)
Advanced Vocabulary Test	0.58 (0.13)	0.56 (0.12)	0.62 (0.13)	0.60 (0.12)

In Table 4, the imaging ability scores are reported for all imaging measures. The percentages in the table are the proportion of participants in each condition who were classified as high imagers. Imaging ability as measured by the VVIQ and MCQ was comparable across conditions.

Table 4 *Imaging Ability Questionnaires Means (SDs)*

	Experiment 1			
	Immediate		Delayed	
	Generate Line	Generate Real	Generate Line	Generate Real
VVIQ*	2.5 (0.86)	2.5 (0.99)	2.9 (1.0)	2.5 (1.1)
High Imagers	66%	63%	38%	55%
MCQ-Real**	5.4 (0.89)	5.5 (0.67)	5.3 (0.61)	5.6 (0.55)
High Imagers	51%	55%	48%	55%
MCQ-Dream**	4.1 (0.98)	3.8 (0.92)	3.8 (1.0)	3.6 (0.98)
High Imagers	62%	55%	45%	32%

*Note*. *Ratings closer to 1 indicate highly vivid imagery. **Ratings closer to 7 indicate more detail.

<u>Computer Task</u>

The independent variables of importance were the timing of the JOSL (immediate vs. delayed), and the type of 'generate' instruction participants were told to implement (generate line vs. generate real). The dependent variables evaluated were JOSLs, SRECAL, source recall confidence (SCJ_1), SRECOG, and source recognition confidence (SCJ_2). Additionally, Goodman-Kruskal gammas were generated and analyzed for JOSLs with SRECAL, JOSLs with SRECOG, retrospective CJs with their respective source recall (SCJ_1) and source recognition trials (SCJ_2), and lastly for JOSLs and CJs (both types). Gender was included as a grouping variable in the results reported because significant gender-related effects for memory performance were uncovered during data analysis. Analyses were carried out using a 2 X 2 X 2 X 2 (Gender X JOSL timing X Instruction type X Item type) model in repeated measures ANOVAs. There were no significant effects of instruction type; therefore, this variable was dropped from most of the reported results and subsequent discussion.

Mean Judgments of Source Learning (JOSLs)

JOSLs were aggregated for each participant and then analyzed. A main effect of JOSL timing was found, $F(1, 118) = 11.26$ (*0.60*), where participants in the delayed JOSL condition produced JOSL means higher than participants in the immediate condition (Figure 8). An effect of delay was expected, though the direction of the effect was not. It was argued that at the time of the immediate judgment, participants would be misled into making very high JOSLs based on the salient perceptual trace of the item they just studied. Conversely, participants in the delayed JOSL conditions were expected to downgrade their JOSLs because their task experience up to that point (presentation of the entire list, fatigue, etc) would have influenced their judgments. Whether items were presented as drawings or generated did not seem to have an effect on the mean JOSLs. I proposed that details from salient perceptual traces of the items would drive the JOSL. If

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this were the case, I expected to see an interaction of item type with delay. The results did not show this effect, $F(1, 118) = 0.67$. Mean JOSLs for generated items $M_{IMMEDIATE} = 67.4$ (2.36), $M_{DELAYED} = 79.4$ (2.58), and presented items $M_{IMMEDIATE} = 69.4$ (2.31), $M_{DELAYED} = 79.9$ (2.27) are plotted in Figure 8. In summary, participants in the delayed JOSL conditions predicted higher reality monitoring performance than those in the immediate conditions. There was no distinction made between the types of items, where participants in both delays predicted comparable memory performance for both generated and presented images.
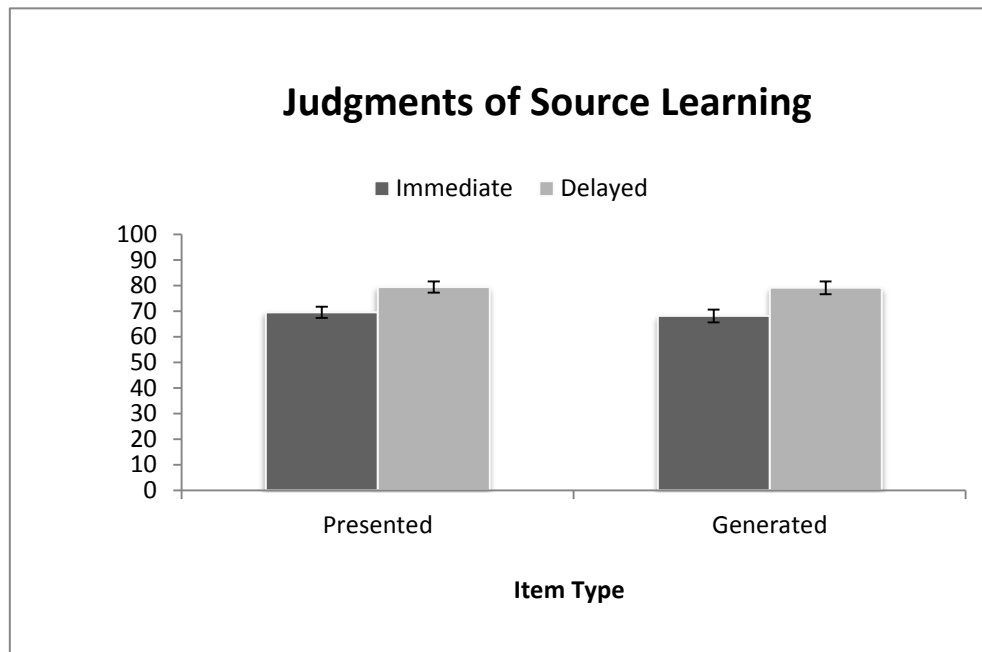
Figure 8. JOSL means by JOSL timing and item type

In general, participants were highly confident in their future memory performance. A frequency distribution of the JOSLs sorted into six bins (0-20%, 21-40%, 41-60%, 61-80%, and 81-100%) showed most JOSL ratings falling in the 81-100% range (Figure 9).
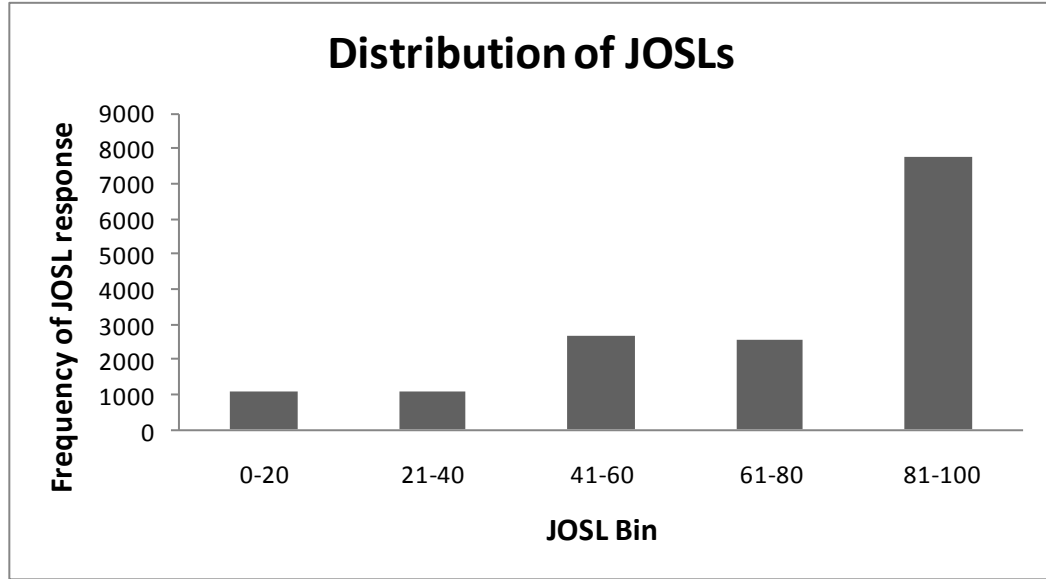
Figure 9. Frequencies of JOSL ratings (predictions of source memory performance)

Mean Source Recall Accuracy

For the source recall task data, the mean proportions of correct source recall for participants were analyzed. There were three item categories in this analysis because I included memory performance for 'new' items along with 'presented' and 'generated' item types. Women performed significantly better than men on this task, $F(1, 118) = 8.73$ (*0.53*), $M_{MEN} = 0.78$ (0.02), $M_{WOMEN} = 0.87$ (0.02). There were also significant effects of JOSL timing, $F(1, 118) = 6.41$(*0.45*) and item type, $F(2, 118) = 22.08$ (*0.57*) where source recall was higher for participants in the immediate JOSL condition [$M_{IMMEDIATE} = 0.86$ (0.02), $M_{DELAYED} = 0.79$ (0.02)], and source recall for generated items was highest of all the item types [$M_{PRESENTED} = 0.79$ (0.02), $M_{GENERATED} = 0.89$ (0.01), $M_{NEW} = 0.79$ (0.02)] (Figure 10).
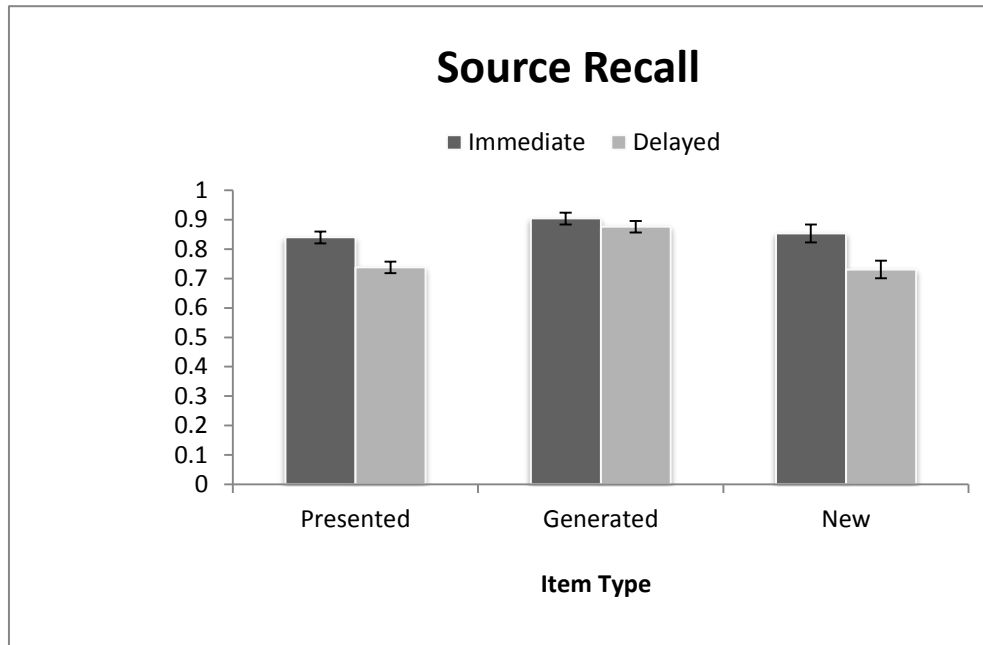
Figure 10. Source recall by JOSL timing and item type

Analyzing the recall data according to an old vs. new item type categorization indicated that participants were much better at attributing the correct source to old items (presented + generated) than new items, $F(1, 122) = 4.92$ (*0.41*), $M_{OLD} = 0.84$ (0.01), $M_{NEW} = 0.79$ (0.02). Participants had slightly more accurate memory for items they previously studied than for items presented as new foils during the source recall task.

Mean Source Recognition Accuracy

Source recognition performance was analyzed using mean proportions of correctly sourced items. Like source recall performance, women outperformed men, $F(1, 118) = 6.08$ (*0.44*), $M_{MEN} = 0.88$ (0.01), $M_{WOMEN} = 0.92$ (0.01). In contrast to what was predicted, there were significant effects of delay and item type on source recognition (Figure 11). There was a significant interaction of delay and item type, $F(1, 118) = 14.01$ (d* = *0.71* for presented items, d* = *0.06* for generated items) where participants in the immediate conditions outperformed those in the delayed conditions on source recognition memory, and were also significantly better at recognizing presented items. The interaction of delay and item type was driven particularly by lower mean source

recognition for presented items in the delayed conditions, $M_{\text{IMMEDIATE-PRESENTED}} = 0.91$ (0.02), $M_{\text{DELAYED-PRESENTED}} = 0.79$ (0.02), $M_{\text{IMMEDIATE-GENERATED}} = 0.96$ (0.01), $M_{\text{DELAYED-GENERATED}} = 0.95$ (0.01).
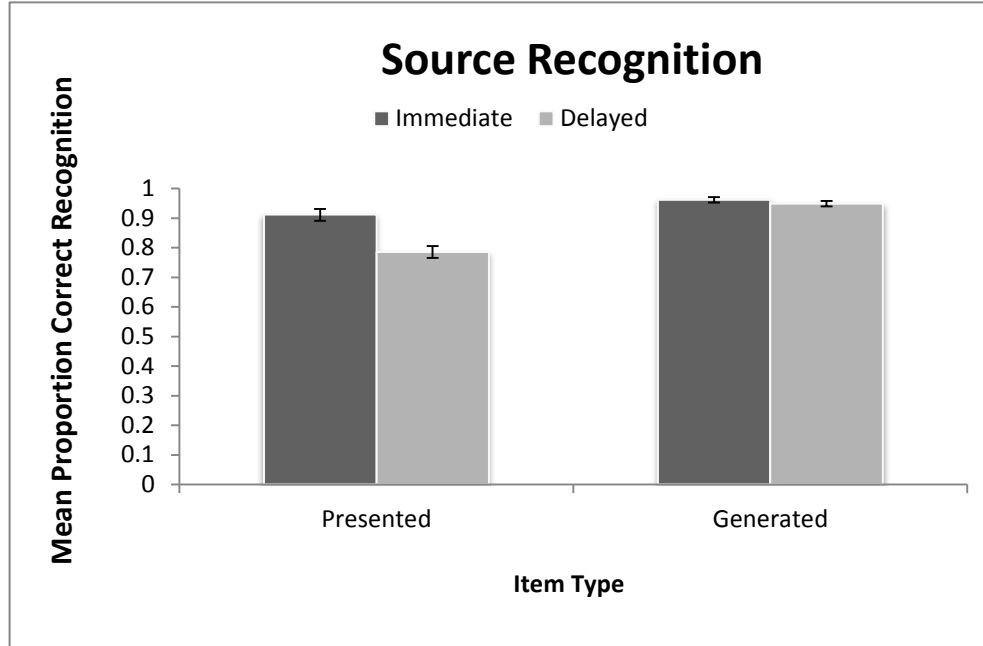
Figure 11 Source recognition by JOSL timing and item type

I predicted that participants would perform better on the source recognition task when compared to source recall. The results supported this prediction, $M_{\text{SRECAL}} = 74.0$ (0.06), $M_{\text{SRECOG}} = 96.7$ (0.02). The source recognition task should have been easier for participants given that the study episode was reinstated by re-presenting the studied items in their previously studied formats, and there were no 'new' foils to misattribute. Finally, these results replicated previous findings that showed source recall boosting later source recognition (Thierry et al, 2005).

Mean Confidence

The retrospective confidence ratings for source recall were aggregated and the means were analyzed. There was a significant interaction of JOSL timing and item type (note: item type was defined in this analysis as old versus new), $F(1, 122) = 5.41$ (d* = *0.45* for immediate, d* = *0.68* for delayed). As illustrated in Figure 12, all participants

were less confident in their ability to correctly identify new items as NEW, but the difference in confidence between old and new items was even more pronounced in the delayed conditions, $M_{IMMEDIATE-NEW} = 78.1$ (2.8), $M_{DELAYED-NEW} = 66.8$ (2.7), $M_{IMMEDIATE-OLD} = 89.9$ (1.8), $M_{DELAYED-OLD} = 88.4$ (1.8). SCJs for source recognition showed a significant effect of delay where participants in the immediate condition showed higher mean level confidence in their source recognition memory performance $F(1, 118) = 12.17$ (*0.62*), $M_{IMMEDIATE} = 94.3$ (1.3), $M_{DELAYED} = 87.7$ (1.3).
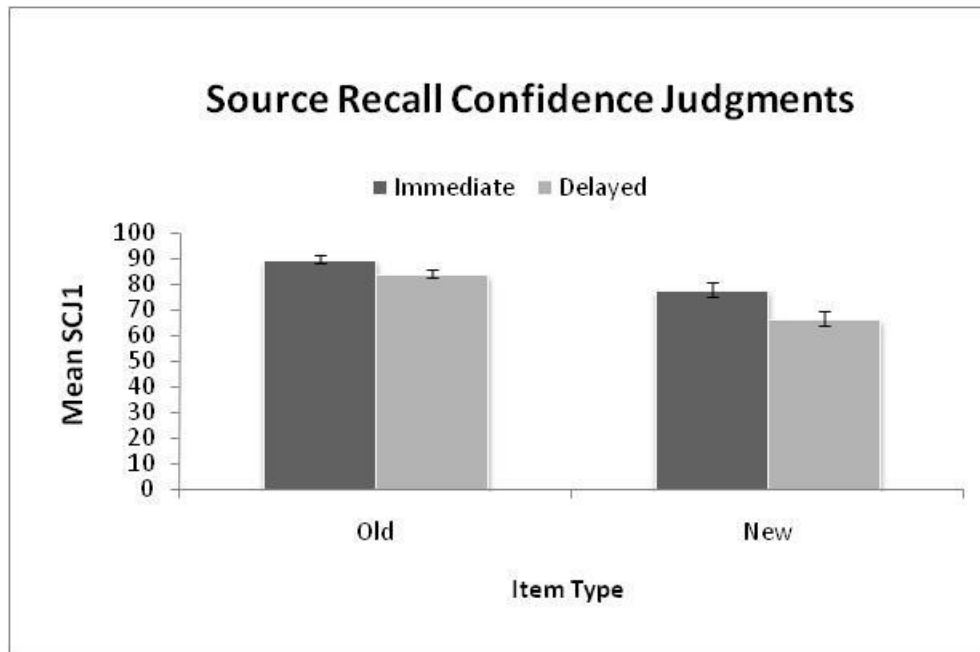
Figure 12. Source recall confidence judgments by JOSL timing and item type (New-Old)

Metacognitive Accuracy: JOSL and Memory Performance Gammas

What were the best conditions under which JOSLs were most predictive or 'accurate'? Resolution is represented by gamma correlations of JOSLs and the two memory performance outcomes (source recall and source recognition), which were computed and analyzed using the model already specified in a repeated measures ANOVA.

Analysis of the judgments of source learning and source recall (JOSL-SRECAL) gammas showed two main effects: an effect of JOSL timing, $F(1, 111) = 76.43$ (1.56),

and item type, $F(1, 111) = 7.86$ (0.35). In the delayed JOSL conditions, not only were gamma correlations higher than in the immediate conditions, but they were significantly different from zero. Means are reported in Table 5. Thus participants could accurately predict their source recall, but only when judgments were delayed. This 'delayed JOSL effect' is consistent with the delayed JOL phenomenon already demonstrated in the metacognitive judgment literature. Gamma correlations for presented items were higher than generated items, indicating better resolution for images presented on screen during study.

Table 5 *Recall Gamma Means (SE)*

Experiment 1		
	Presented	Generated
Immediate	0.09 (0.05)	0.03 (0.07)
Delayed	0.74 (0.05)	0.45 (0.07)

Analysis of gamma correlations of JOSLs with source recognition (JOSL-SRECOG) yielded the delayed JOSL effect for presented items, $M_{\text{IMMEDIATE-PRESENTED}} = 0.16$ (0.06), $M_{\text{DELAYED-PRESENTED}} = 0.76$ (0.06), but not for generated items, $M_{\text{IMMEDIATE-GENERATED}} = 0.16$ (0.10), $M_{\text{DELAYED-GENERATED}} = 0.15$ (0.10). The interaction of JOSL timing and item type was significant, $F(1, 101) = 15.06$ (d* for presented items = *0.76*, d* for generated items = *0.02*) (Figure 13).
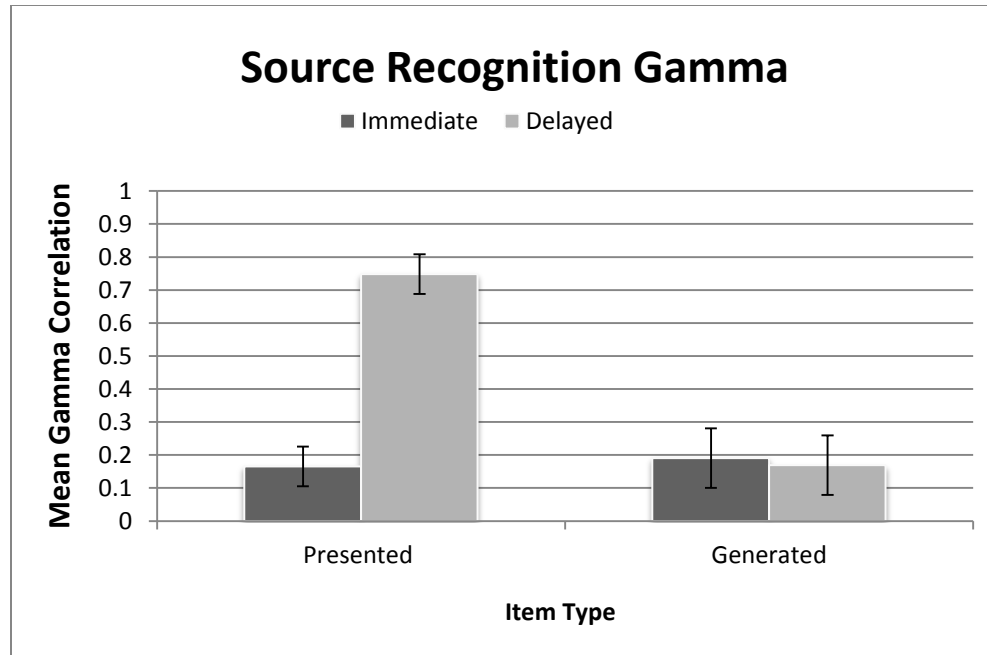
Figure 13. Source recognition gammas by JOSL timing and item type

Metacognitive Accuracy: Memory Performance and SCJs

The second measure of metacognitive accuracy --the SCJ gamma correlations with their respective memory measures-- allowed the evaluation of whether participants were differentially aware of items they correctly sourced versus items they did not. For source recall, only a main effect of item type was found, $F(1, 114) = 6.41$ (*0.30*), where participants were more accurate monitoring their memory performance for presented items compared to generated items (Table 6). The SRECOG-SCJ2 gamma correlations showed the same pattern (Table 6), with the effect of item type significant, $F(1, 103) = 5.35$ (*0.26*).

Table 6 *Confidence Gamma Means (SE)*

Experiment 1		
	Presented	Generated
SRECAL	0.77 (0.04)	0.61 (0.06)
SRECOG	0.63 (0.05)	0.50 (0.07)

Two Metacognitive Ratings: JOSLs and SCJs

The relationship between JOSLs and SCJs was also evaluated using gamma correlations. These two classes of metacognitive judgments were related for participants across items. When analyzing the correlations between JOSLs and the source recall confidence gammas, a significant interaction of JOSL timing and item type, $F(1, 113) =$ 13.34 (d* for presented items = *1.26*, d* for generated items = *0.76*) was found. The marginal means were: $M_{IMMEDIATE\text{-}PRESENTED} = 0.08$ (0.04), $M_{DELAYED\text{-}PRESENTED} = 0.73$ (0.04) and $M_{IMMEDIATE\text{-}GENERATED} = 0.20$ (0.05), $M_{DELAYED\text{-}GENERATED} = 0.59$ (0.05). The gamma correlations between JOSLs and source recognition confidence judgments showed a similar effect where the measures showed a more consistent relationship to each other in the delayed conditions relative to immediate: $M_{IMMEDIATE} = 0.17$ (*0.04*) versus $M_{DELAYED} = 0.53$ (*0.04*). The significant effect of JOSL timing, $F(1, 112) = 38.46$ (*1.10*), lends evidence to the idea that the details used to make delayed JOSLs and SCJs were more consistent with each other than immediate JOSLs. The higher correlations between the delayed JOSLs and SCJs corroborate theoretical arguments that delayed judgments are largely based on outcomes of retrieval processes at the time the judgment is formed. Because SCJs were given after a test trial, where a retrieval attempt has been made, those processes should overlap with retrieval processes at the time of the delayed JOSL.

Discussion of Experiment 1 Results

In evaluation of metacognitive accuracy, I assumed that transfer appropriate monitoring and other congruent processes at the time of encoding and retrieval would heavily influence the correlation between the judgments and source memory performance. A robust delayed JOSL effect added credibility to the argument that participants could accurately predict their future memory performance when JOSLs were

based on cues that were diagnostic of retrieval ability. This finding parallels the delayed JOL effect previously seen in the literature (see Rhodes & Tauber, 2011 for a review). Perhaps at the time of the JOSL, participants were evaluating several classes of cues on which to base the judgment. What cues they emphasized over others remain an open question. In the conditions where JOSLs were accurate, JOSL gammas for generated items were consistently lower for both SRECAL and SRECOG. One way to explain this effect of item type may be that individuals could have been misled by the salience of perceptual detail, or some other misleading cue when making JOSLs. Finding that immediate JOSLs did not correlate with subsequent source memory performance could mean that individuals were putting more emphasis on the quality of perceptual traces (not as diagnostic of retrieval) rather than actual ability to retrieve diagnostic details about the item and/or the encoding episode.

For metacognitive accuracy using the retrospective SCJs, I predicted that participants would be able to accurately monitor their test performance and discriminate between items they got wrong and items they answered correctly. Presented or generated item type did not matter, as confidence was comparable across these types; however, mean SRECAL confidence for discriminating new items was significantly lower. The gammas were accurate across all conditions, item types, and source memory tasks. Even though participants could monitor their source recall performance with significant accuracy, they were less sure about their ability to correctly source new items versus old items. Perhaps the difference in familiarity between new and old items led to higher confidence for items they were exposed to more than once.

A lot of the expected outcomes for this first experiment were based on an underlying assumption that JOSLs would be heavily influenced by accessible perceptual detail. As such, it was expected that participants would demonstrate illusory high confidence in the immediate JOSL condition because they would have more salient perceptual traces on which to base their judgment. This was not the case. Instead, mean JOSLs in the immediate conditions were lower than in the delayed conditions. One possible explanation could be that this phenomenon was just an artifact of group differences in anchoring of their judgment responses. Also tied to the assumption that perceptual detail was going to be an important factor in participant behavior, I anticipated that participants in conditions where the instructions should have led them to generate images of far richer perceptual detail would show superior memory and prediction. Finding no significant effects of instruction type was surprising, but not entirely unexplainable. The superior memory performance on generate items across the board indicates that just the act of generating images was enough to boost memory for those items. An alternative explanation could be that, even though participants were instructed to imagine line drawings in the condition which was supposed to result in less detailed images, spontaneous generating of more perceptually complex images was not controlled or assessed in this experiment. Participants in the different instruction groups may have engaged in similar generation strategies even though they were instructed differently.

Reality monitoring is boosted by differences in the types of detail available to make the internal/external source discrimination. I assumed that source memory would be boosted by the availability and saliency of perceptual details. Finding that source recall and recognition were higher for generated items supported this prediction. Rhodes and

Tauber (2011) reported a small, but reliable benefit to memory performance for delayed JOL items ($g = 0.08$). The original argument for source memory performance in the delayed conditions to be higher was in line with this effect and rooted in the idea that additional retrieval opportunities for participants in the delayed JOSL conditions would lead to superior performance. Although higher source memory performance for participants in the delayed JOSL conditions was predicted, the results did not follow this prediction. Source memory performance was actually higher for participants in the immediate conditions. What I did not anticipate was that because the JOSL was not time-limited, participants in the immediate conditions could have taken extra time during the study phase trials to rehearse the items prior to making their judgments. On average, participants in the immediate conditions took 469ms longer to make JOSLs than participants in the delayed JOSL conditions.

When comparing levels of source memory performance (SRECAL versus SRECOG), I predicted that recognition performance would be higher than recall memory performance. Although previous research indicated that source recall is usually better than source recognition across studies, very few studies have included both types of tasks simultaneously to investigate what effects could arise when both source recall and source recognition are measured for the same participants. In one study, Thierry and colleagues (2005) showed that source recall actually boosted source recognition so that memory performance on source recognition was higher. SRECOG was indeed higher than SRECAL across all conditions of experiment 1.

The experiment's design allowed for appraisal of the relationship between JOSLs and SCJs. Interestingly, JOSLs and SCJs did correspond to each other in the delayed conditions. I have already argued that delayed JOSLs incorporated more retrieval based

cues than their immediate counterparts. If SCJs were based largely on similar retrieval cues as well, then finding a significant relationship between these judgments makes theoretical sense. The greater the consistency between the evidence used to form a JOSL and a SCJ, the larger the correlation between these judgments should be. If a participant is able to retrieve significant detail about the target at the time of the judgment, this can translate into greater likelihood of retrieving the information at test, and ultimately higher confidence at test.

In the case of delayed JOSLs, differences between JOSLs for correctly sourced items (regardless of test format) related to measures of source memory confidence. In work on feeling-of-knowing judgments (FOKs), even in the absence of successful target recall, participants were able to monitor retrieval and accurately predict future recognition (Dunlosky & Metcalfe, p. 61). Hertzog, Dunlosky, and Sinclair (2010) also reported significant-above chance- gamma correlations between FOKs and confidence judgments. These correlations were biggest for correctly recognized items argued to be because differences in FOKs, "…align with influences that generate confidence in the accuracy of forced choice recognition…" (p. 778). A parallel can be drawn between delayed JOSLs and FOKs. Even though (in the case of delayed JOSLs) there was not an explicit recall prompt at the time of the judgment, participants could engage in retrieval and monitoring of retrieval outcomes. Should participants base JOSLs on cues related to retrieval monitoring, this mirrors participant behavior when making FOKs, which ask participants to predict future recognition following an attempt to recall information.

CHAPTER 3

EXPERIMENT 2

The results from the first experiment were crucial to the design of experiment 2. In order to investigate the developmental trajectory of JOSLs, the second experiment was a cross-sectional study of younger and older adults. Based on experiment 1 results, the instruction manipulation was dropped. Even though immediate JOSLs were not accurate, this feature was retained in the design in order to see whether the delayed JOSL effect was also applicable to older adults. The second experiment was conducted to answer the specific question of whether age-related deficits in source memory performance also extended to age-related deficits in source metacognitive accuracy as measured by JOSL and SCJ resolutions.

Method

Participants

Eighty-three younger adults ($M_{AGE} = 19.4$, SD = 1.3) and 80 older adults ($M_{AGE} = 68.6$, SD = 5.9) participated in this study. Younger adults were recruited from the Georgia Tech volunteer subject pool using Experimetrix and were given the choice of receiving compensation of $25 or 2 hours of course extra credit. Participation was restricted to individuals who had not participated in the first experiment. Older adults were recruited through an existing database of participant names and received $35 pay.

Table 7 *Participant Demographics*

	Experiment 2			
	Young Adults		Older Adults	
	Immediate	Delayed	Immediate	Delayed
N	43	40	40	40
Age (years)	19.3 (1.48)	19.5(1.27)	70.0 (5.16)	69.3 (6.56)
Education (years)	14.2 (1.00)	14.5 (0.78)	16.4 (2.17)	16.4 (2.34)
Female	70%	55%	52%	57%

Materials, Design, and Procedure

The same materials from the first experiment were used. The design was the same as experiment 1 with the exceptions of the exclusion of instruction conditions and addition of age as a grouping variable. All participants received 'generate real' instructions. Experiment 2's design was 2 (Gender) X 2 (Age group) X 2 (JOSL timing) X 2 (Item type: presented or generated). JOSL timing as manipulated between subjects while item type was once again a within subject variable. The procedure was also the same as experiment 1.

Data Analyses and Results

Paper Data

Data from paper and pencil measures were digitally consolidated and relevant means are reported below. In Table 8, mean performance data on the perceptual speed and vocabulary measures are reported. Consistent with observed norms, younger adults outperformed older adults on perceptual speed measures (LC and PC), while older adults scored higher on vocabulary (AVT) (Fstats).

Table 8 *Perceptual Speed and Vocabulary Test Means (SD)*

	Experiment 2			
	Younger Adults		Older Adults	
	Immediate	Delayed	Immediate	Delayed
Letter Comparison	25.1 (4.54)	24.4 (4.11)	17.6 (5.67)	17.7 (4.86)
Perceptual Comparison	44.4 (6.97)	44.7 (7.13)	31.2 (6.74)	32.0 (7.37)
Advanced Vocabulary Test	0.54 (0.13)	0.56 (0.12)	0.61 (0.17)	0.60 (0.23)

In Table 9, the imaging ability scores are reported for all imaging measures. The percentages in the table are the proportion of participants in each condition who were classified as high imagers.

Table 9 *Imaging Ability Questionnaires Means (SD)*

	Experiment 2			
	Younger Adults		Older Adults	
	Immediate	Delayed	Immediate	Delayed
VVIQ*	2.5 (0.89)	2.7 (0.92)	2.1 (0.87)	2.0 (1.1)
High Imagers	58%	51%	57%	52%
MCQ-Real**	5.4 (1.6)	5.3 (1.7)	5.5 (1.7)	5.5 (1.5)
High Imagers	51%	56%	53%	57%
MCQ-Dream**	3.6 (1.8)	3.6 (1.9)	3.8 (1.8)	3.4 (1.4)
High Imagers	49%	54%	60%	40%

Note. *Ratings closer to 1 indicate highly vivid imagery. **Ratings closer to 7 indicate more detail.

Computer Task

The grouping variables of age and gender and the independent variables of JOSL timing and item type were the main focus. The dependent variables collected and analyzed were: JOSLs, SRECAL, source recall confidence (SCJ1), SRECOG, and source recognition confidence (SCJ2). Additionally, Goodman-Kruskal gammas were once again generated and analyzed for JOSL-SRECAL, JOSL-SRECOG, SRECAL-SCJ1, SRECOG-SCJ2, and JOSL-SCJ (with SCJs from both recall and recognition). Analyses were carried out using the full 2 X 2 X 2 X 2 (Gender X Age group X JOSL timing X Item type) model. Statistics referring to younger adults are denoted with a 'YA' subscript whereas those referring to older adult data are denoted with an 'OA' subscript.

Mean Judgments of Source Learning (JOSLs)

JOSLs were aggregated for each participant and then analyzed using a repeated measures ANOVA. There was a significant main effect of age, $F(1, 156) = 6.26$ (*0.39*), $M_{YA} = 73.7$ (2.11) and $M_{OA} = 81.3$ (2.14), where older adults predicted higher memory

performance by producing higher mean JOSLs than younger adults. This result raised the question as to whether this difference was a product of older adult overconfidence, or conversely, younger adult under-confidence. As found in experiment 1, a main effect of JOSL timing was significant, $F(1, 156) = 17.44$ (0.65), $M_{IMMEDIATE} = 71.2$ (2.14) and $M_{DELAYED} = 83.8$ (2.12),where participants in the delayed JOSL condition predicted higher memory performance than participants in the immediate condition (Figure 14). There was no interaction of age and delay, $F(1, 156) = 0.61$, indicating that the effect was consistent across age groups. There were once again no effects of item type, $F(1, 156) = 3.54$ (0.08), $M_{PRESENTED} = 78.3$ (1.46) and $M_{GENERATED} = 76.7$ (1.65). Both younger and older adults predicted comparable source memory performance across item types in their respective conditions.
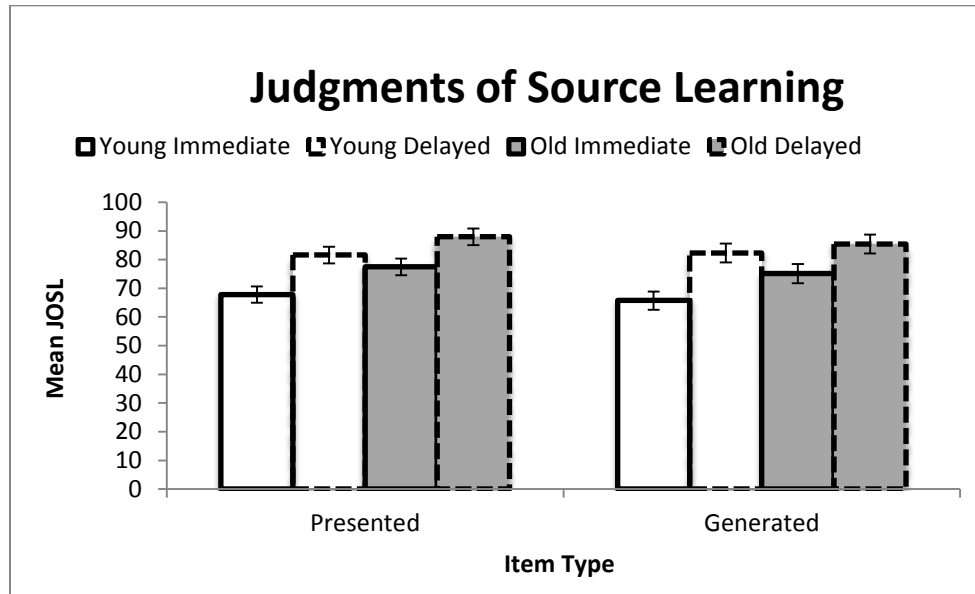
Figure 14. JOSLs by age group, JOSL timing and item type

Mean Source Recall Accuracy

For the source recall task data, the mean proportion of correct source recall (SRECAL) for participants was computed and analyzed in a repeated measures ANOVA. There was a significant effect of age, $F(1, 156) = 11.84$ (0.47), which was consistent with predictions. Younger adults had higher source recall performance than older adults, M_{YA}

= 0.83 (0.02) and M_{OA} = 0.75 (0.02). The JOSL timing effect seen in previous results was not significant in this sample, F (1, 156) = 0.53 (*0.10*). There was a significant main effect of item type, $F(2, 156)$ = 3.72, $M_{PRESENTED}$ = 0.77 (0.02), $M_{GENERATED}$ = 0.81 (0.02), and M_{NEW} = 0.79(0.02). With the exception of older adults in the delayed condition, SRECAL was once again highest for generated items (Figure 15). The item type effect was most pronounced for younger adults.
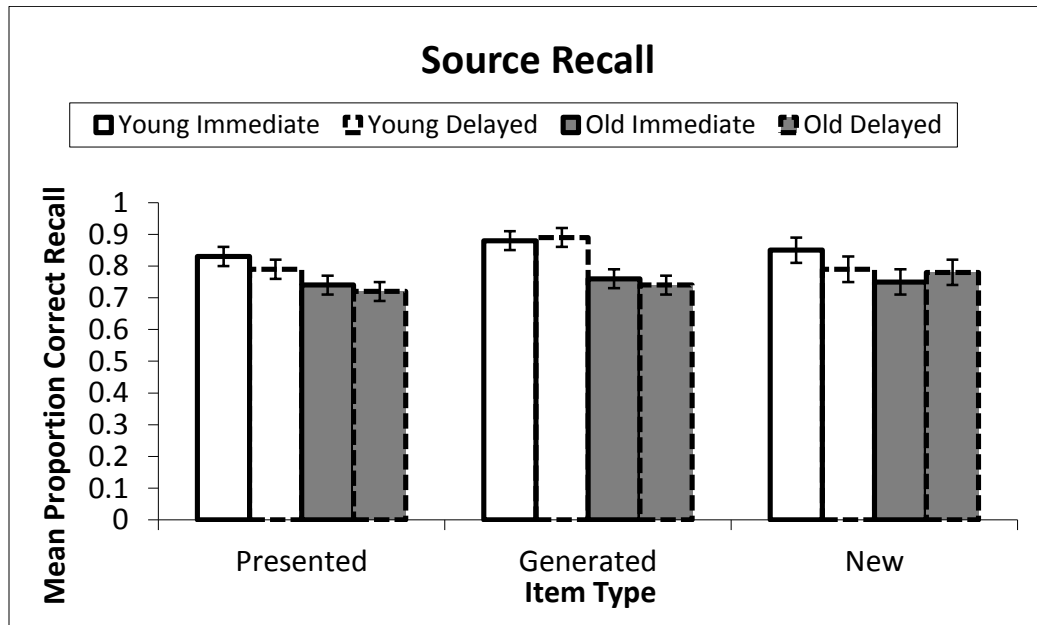
Figure 15. Source recall by age group, JOSL timing and item type

To address whether older adults were overconfident and younger adults under-confident in their prediction of source memory performance a difference measure was computed between mean JOSLs and mean source recall for each participant (JOSL – SRECAL). This difference was analyzed according to the same repeated measures model. Results included significant effects of age, JOSL timing, and item type. The age effect, $F(1, 156)$ = 33.69 (*0.91*), indicated that younger adults under-predicted their performance whereas older adults were overconfident: M_{YA} = -10.3 (2.2) and M_{OA} = 7.6 (2.2). For the JOSL timing effect, $F(1, 156)$ = 22.40 (*0.74*), participants in the immediate condition were under-confident, while those in the delayed condition predicted higher memory performance than they delivered, $M_{IMMEDIATE}$ = -8.7 (2.2) and $M_{DELAYED}$ = 6.0 (2.2). The

item type effect, $F(1, 156) = 10.60$ (*0.27*), $M_{PRESENTED} = 1.7$ (1.7) and $M_{GENERATED} = -4.4$ (1.9), indicated that participants were under-confident in their ability to remember generated items.

Mean Source Recognition Accuracy

Source recognition performance was computed as the mean proportion correct for each individual and analyzed using a repeated measures ANOVA. The predicted age-related effect on source recognition was significant, $F(1, 156) = 22.35$ (*1.3*), $M_{YA} = 0.91$ (0.01) and $M_{OA} = 0.82$ (0.01). Once again younger adults outperformed older adults in the source memory task. The main effect of item type was also significant, $F(1, 156) = 16.18$ (*0.63*), $M_{PRESENTED} = 0.83$ (0.01) and $M_{GENERATED} = 0.91$ (0.01), where generated items were sourced more accurately than presented items. This effect was consistent for both younger and older adults (Figure 16). JOSL timing did not produce any significant effects on source recognition, $F(1, 156) = 0.53$ (*0.11*). Similar to the experiment 1 result, source recognition was higher than source recall, $M_{RECOG} = 0.89$ (0.04) and $M_{RECAL} = 0.78$ (0.05).
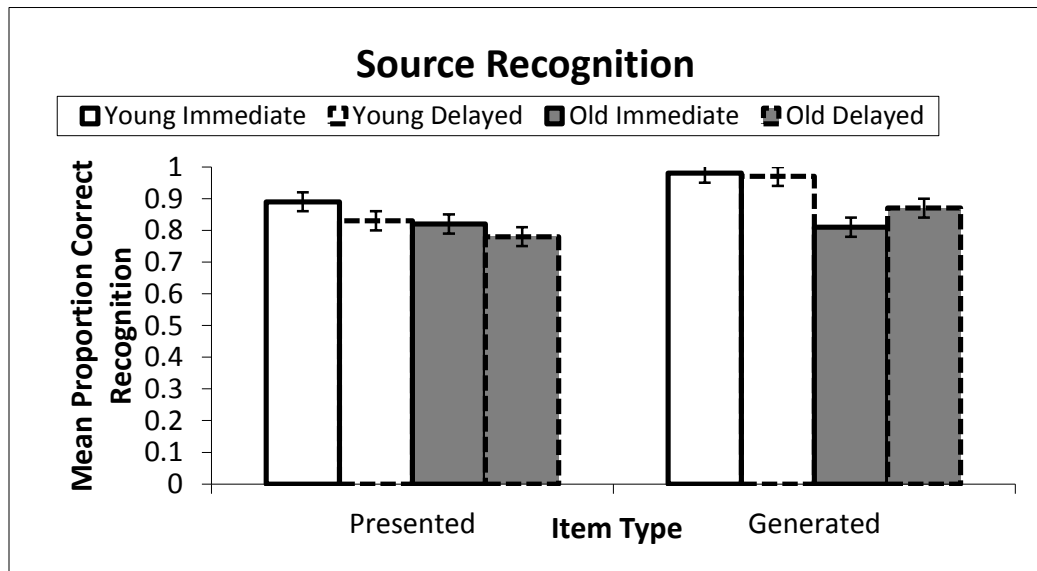

Figure 16. Source recognition by age group, JOSL timing and item type

Mean Confidence

The mean retrospective confidence ratings for source recall (SCJ1s) were analyzed using a repeated measures ANOVA. The significant interaction of age and item type, $F(2, 156) = 3.48$ (d* for presented items = *0.01*, d* for generated items = *0.03*, d* for new items = *0.17*), indicated that even though both younger and older adults were most confident in their source recall for old items (presented and generated), younger adults were significantly less confident than older adults in their ability to correctly discriminate new items (Table 10). When looking at how mean confidence matched up to mean source recall, older adults seemed to be showing consistent overconfidence in their memory performance, $M_{RECALLOA} = 0.75$ (0.02) and $M_{SCJ1OA} = 82.4$ (1.9), while younger adults' confidence, at least in magnitude, seemed to be in line with their actual performance, $M_{RECALLYA} = 0.83$ (0.02) and $M_{SCJ1YA} = 82.3$ (1.9).

No significant effects on SCJ2s were found for source recognition as all individuals exhibited high confidence in their source memory performance across age groups, conditions, and item types (Table 10).

Table 10 *Mean (SE) source recall and recognition confidence judgments*

		Experiment 2			
		Younger Adults		Older Adults	
		Immediate	Delayed	Immediate	Delayed
Source Recall (SCJ₁)	Presented	88.7 (2.5)	85.8 (2.5)	85.7 (2.5)	89.5 (2.5)
	Generated	88.9 (2.5)	87.2 (2.5)	84.3 (2.5)	89.7 (2.5)
	New	73.3 (3.8)	70. 3(3.8)	75. 7 (3.8)	79.2 (3.8)
Source Recognition (SCJ₂)	Presented	92.6 (2.0)	89.8 (2.0)	87.8 (2.0)	90.5 (2.0)
	Generated	92.2 (2.0)	90.4 (2.1)	87.5 (2.1)	92.2 (2.1)

Metacognitive Accuracy: JOSL and Memory Performance Gammas

Analysis of the judgments of source learning and source recall (JOSL-SRECAL) gammas was conducted using proc mixed procedure in SAS, which allowed every cell of available data to be utilized in the analysis. A repeated measures ANOVA approach was used. As predicted, there was no effect of age on metacognitive accuracy as measured by

the JOSL, $F(1, 146) = 1.42$ (*0.19*), $M_{YA} = 0.32$ (0.04) and $M_{OA} = 0.24$ (0.05). A robust main effect of JOSL timing was observed, $F(1, 146) = 52.57$ (*1.2*), where, once again, delayed JOSL gammas were predictive of future source recall while immediate JOSL gammas were no different than zero, $M_{IMMEDIATE} = 0.04$ (0.04) and $M_{DELAYED} = 0.51$ (0.05). JOSL timing interacted significantly with item type whereby delayed JOSLs provided the most accurate prediction for presented items, $F(1, 146) = 7.38$ (d* for presented items = *0.83*, d* for generated items = *0.37*), $M_{DELAYED\text{-}PRESENTED} = 0.68$ (0.06), $M_{DELAYED\text{-}GENERATED} = 0.34$ (0.07), $M_{IMMEDIATE\text{-}PRESENTED} = 0.03$ (0.06), and $M_{IMMEDIATE\text{-}GENERATED} = 0.06$ (0.07). Both younger and older adults' in this experiment demonstrated the delayed-JOSL effect (Figure 17). This result replicated findings from experiment 1.
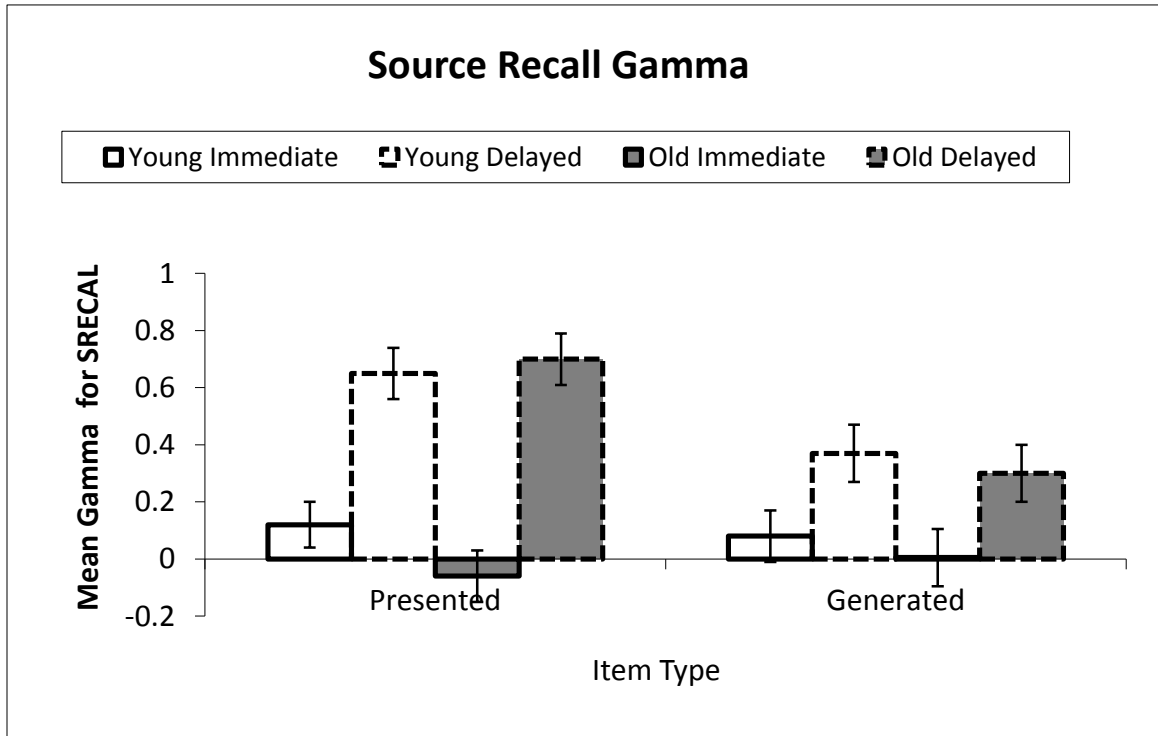

Figure 17. Source recall gammas by age group, JOSL timing and item type

Analysis of gamma correlations of JOSLs with source recognition revealed an interaction of JOSL timing and item type, $F(1, 135) = 4.03$ (d* for presented items = *0.53*, d* for generated items = *0.12*) (Table 11). The delayed JOSL-effect was observed

in the gammas for presented items for both younger and older adults, but only for generated items in the young.

Table 11 *JOSL and Source Recognition Gamma Means (SE)*

	Experiment 2			
	Younger Adults		Older Adults	
	Immediate	Delayed	Immediate	Delayed
Presented	0.07 (0.11)	0.61 (0.10)	-0.05 (0.11)	0.33 (0.10)
Generated	0.10 (0.12)	0.30 (0.12)	0.11 (0.11)	0.12 (0.12)

Metacognitive Accuracy: Memory Performance and CJs

The second class of metacognitive judgments analyzed was the SCJ gammas with their respective source memory outcomes. For the source recall and SCJ1 correlations, a main effect of age was observed, $F(1, 150) = 8.90$ (*0.47*) (means in Table 12). Although both younger and older adults accurately monitored their SRECAL performance, younger adults were better at discriminating between items they got correct and incorrect. The SRECOG-SCJ2 gamma analysis uncovered no significant effect of age, $F(1, 135) = 0.07$. The effect of item type was significant, where accuracy was higher for presented items, $F(1, 135) = 6.72$ (*0.31*) (means in Table 12).

Table 12 *Confidence Gammas (SE)*

	Experiment 2			
	Younger Adults		Older Adults	
	SRECAL	SRECOG	SRECAL	SRECOG
Presented	0.76 (0.06)	0.68 (0.07)	0.52 (0.06)	0.56 (0.06)
Generated	0.65 (0.06)	0.37 (0.1)	0.49 (0.06)	0.45 (0.08)

Discrimination and Bias

In order to explore the age-related effect seen in the SRECAL-SCJ gammas, source recall task data were analyzed using a probit transformation and then bias (C) and discrimination (d') measures were computed and analyzed (see Snodgrass & Corwin, 1988). I wondered if a response bias in older adults that could lead to high confidence errors was the reason their confidence gammas were not as accurate as younger adults.

For d', values close to 0 indicated chance responding while values of C significantly different from 0 in either direction indicated a response bias (Table 13). While both groups showed above chance responding (d' = 2.6 for young, 1.6 for old), there was evidence for bias, but not in the older adult data. Young adults showed a bias to answer generate, which led to an age effect, $F(1, 159) = 4.65$ (*0.31*), $M_{YA} = -0.31$ (0.1) and $M_{OA} = -0.03$ (0.1). While this does not help explain the age-related deficit in the accuracy of the SCJs for SRECAL, this finding is interesting because of previous work by Kelly and colleagues (2002) that bias should be towards a 'presented' or 'real' response rather than a 'generated' or 'imagined' response. In the case of these results, it seems that when younger adults were faced with uncertainty, they shifted their response characteristics to say 'generate'.

Table 13 *Discrimination (d') and Bias (C) Means (SE)*

	Experiment 2			
	Younger Adults		Older Adults	
	Immediate	Delayed	Immediate	Delayed
d'	2.5 (0.2)	2.6 (0.2)	1.6 (0.2)	1.5 (0.2)
C	-0.20 (0.1)	-0.42 (0.1)	-0.04 (0.1)	-0.01 (0.1)

Two Metacognitive Ratings: JOSLs and SCJs

The relationship between JOSLs and SCJs was once again evaluated using gamma correlations between the two judgments. For SRECAL, the JOSL-SCJ1 correlation analysis revealed significant effects of both age and JOSL timing. The judgments correlated more highly for younger adults than for older adults, $F(1, 145) = 4.46$ (*0.34*), $M_{YA} = 0.32$ (0.05) and $M_{OA} = 0.17$ (0.05). The most robust effect was for JOSL timing, $F(1, 145) = 33.93$ (*0.94*), $M_{IMMEDIATE} = 0.04$ (0.05) and $M_{DELAYED} = 0.45$ (0.05). Once again delayed JOSLs correlated highest with CJs. Both younger and older adults showed the delayed JOSL effect (Figure 18).
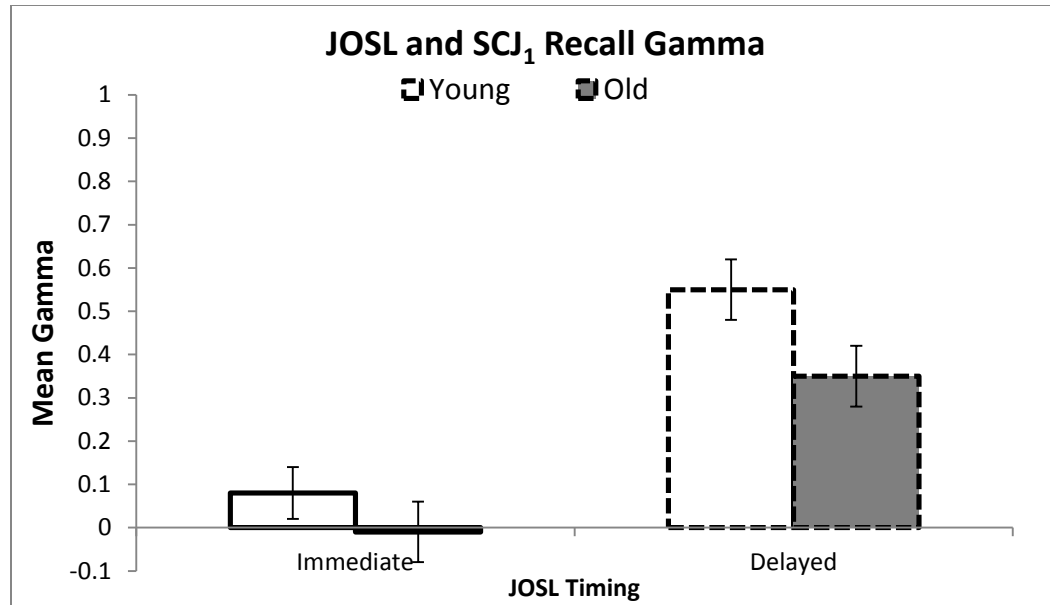
Figure 18. Gamma correlations of JOSL with SCJ_1 by age group and JOSL timing

In the case of JOSL-SCJ_2 gamma correlations, there was a significant interaction of JOSL timing and item type, $F(1, 137) = 6.44$ (d* for presented items = *0.59*, d* for generated items = *0.28*), $M_{IMMEDIATE-PRESENTED} = 0.06$ (0.06), $M_{DELAYED-PRESENTED} = 0.52$ (0.06), $M_{IMMEDIATE-GENERATED} = 0.16$ (0.06), and $M_{DELAYED-GENERATED} = 0.38$ (0.06). The expected delayed JOSL effect was present, and resolution was best for presented items in the delayed condition (Figure 19).
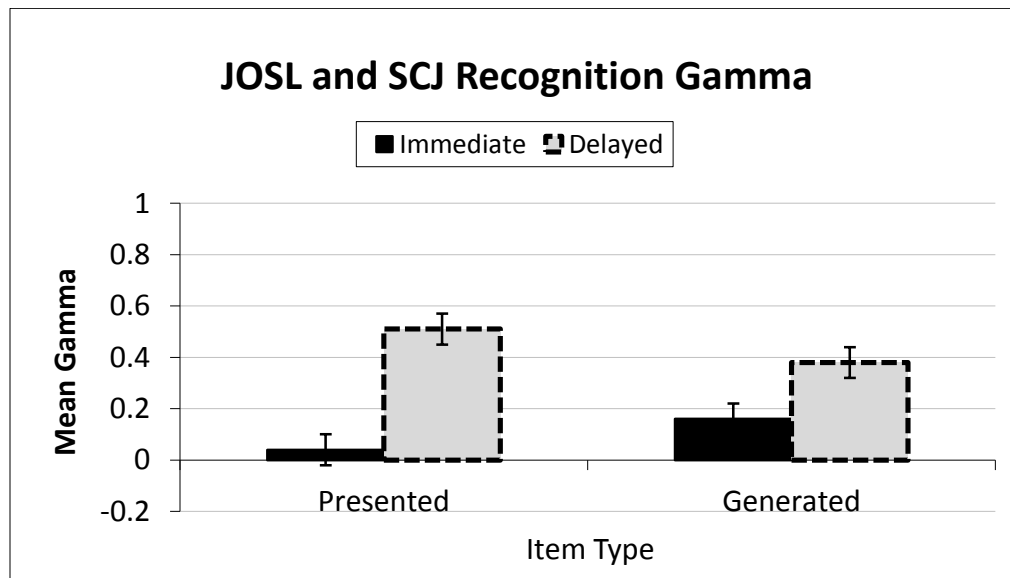
Figure 19. Gamma correlations of JOSL with SCJ_2 by JOSL timing and item type

Discussion of Experiment 2 Results

The focus of this experiment was to investigate whether age-related deficits in source memory were also found in source metamemory as assessed with metacognitive judgments. Although younger adults showed better source memory performance than older adults on both source tasks, JOSL resolution with source recall and source recognition showed no age-related deficits. Aligning with the first experiment's results, source memory for generated items, on average, was best. This result was consistent across both age groups. Whether just the engaging in generating study behavior or the availability of more perceptual detail was enough to make memory for generated items superior in this study remains an open question.

Based on previous work, I expected to see age-related differences in source memory performance in the reality monitoring tasks employed in this experiment (Dodson, 2002; Hashtroudi et al, 1989). The open question was whether delayed JOSLs, which had been shown to predict future source memory performance in younger adults, would show the same predictive accuracy in an older adult sample. Not only did delayed JOSLs correlate significantly with future source memory performance in both recall and recognition tasks, the gammas were comparable across age groups. Older adults were as accurate as younger adults at predicting their future source memory performance using JOSLs, even when source memory performance was significantly lower. Both age groups replicated the delayed JOSL effect seen in the first experiment and mirrored the delayed JOL effect seen in previous work dating back to Nelson and Dunlosky (1991). Both groups also showed best resolution for presented items over generated items.

While metacognitive accuracy of the predictive measure of source memory failed to show age-related effects, the same could not be said for the retrospective measure. Specifically, age-related deficits were found in the resolution of confidence judgments with source recall outcomes. Both younger and older adults were able to accurately monitor their performance on the source memory tasks; however, younger adults were

more accurate. Further investigation into the possible causes for this difference revealed that although there was an age-related bias to respond 'generate', this bias was for younger adults, not older adults. Another way to see whether older adults were experiencing illusory high confidence would be to look at SCJs for incorrect answers. Disproportionate rates of high confidence judgments to errors, in the older adult data, would help to explain why confidence resolution with source recall was lowered for older adults. A later analysis of this variable revealed the aforementioned pattern. Older adults on average were highly confident in source recall errors, $M_{OA} = 75.2$ (2.4), when compared to younger adult confidence, $M_{YA} = 59.7$ (2.4). This difference was significant, $F(1, 154) = 20.46$ (*0.71*).

The age-related deficit in confidence judgment resolution was not consistent. There were no age-related effects with source recognition. To explain possible mechanisms behind misrecollections and older adults' greater propensity to misremember and be highly confident in misrecollections, Dodson and Krueger (2006) pointed to an age-related reduction in older adults' abilities to bind and associate features of events, and a reliance on familiarity which can be misleading. I posit that a possible explanation for discovering an age-related deficit in the source recall task, but not source recognition can be found in the 'misrecollection account'. In the source recognition task, participants did not have to generate the candidate items from memory and then make the source attribution. If older adults were unable to recollect enough detail to provide good candidate answers to choose from, they were not hurt in the recognition task which provided the candidates for them. In the source recall task, there was more room for error because older adults may not have had enough detail available to them at the time of test, or they may have engaged in what Henkel, Johnson, and De Leonardis (1998) referred to as miscombinations—combining features across items—which would lead to high familiarity and high confidence errors. If the misrecollection account is correct, older adults were at a clear disadvantage in the source recall task that was more generative in

nature when compared to the source recognition task used in this experiment. Perhaps the age-related deficit in source memory performance and confidence judgment resolution stemmed from the same impaired recollective and binding processes.

Research has shown that even when source memory is comparable between age groups, the age-related deficit in confidence still appears. Dodson, Bawa, and Krueger (2007) showed that even when matched on source memory performance with younger adults, older adults still showed illusory high confidence when incorrectly attributing the source of information previously studied. It should be noted that Dodson and colleagues only found this age-related deficit when looking at the calibration of confidence judgments with source memory. They did not find significant age-related effects when they computed a resolution index (gamma). Similarly, Shing and colleagues (2009) demonstrated that older adults exhibited disproportionately more instances of high confidence to errors when compared to children, teenagers, and young adults in the same task. Once again, calibration of confidence judgments with memory outcomes was evaluated. Two theoretical accounts for this phenomenon include the misrecollection account and age-related declines in associative memory functions, particularly those associated with hippocampal functioning.

The relationship between JOSLs and SCJs in experiment 2 was largely consistent with effects previously reported in experiment 1. Resolution between the two metacognitive judgments was strongest for delayed JOSLs in line with the idea that both delayed JOSLs and SCJs were based on some similar retrieval processes at the time of these judgments. An age effect was seen only for JOSL-SCJ resolution for source recall. High confidence to source recall errors for older adults would degrade the relationship between any gammas computed using the SCJ measure.

CHAPTER 4

GENERAL DISCUSSION

In the source monitoring and metamemory literatures, monitoring processes are simultaneously blamed and credited for age-related effects seen in research on older and younger adults. In the former case, impaired monitoring of source information partially resulting from an over-reliance on familiarity is said to contribute to age-related deficits in source memory performance (Mitchell et al., 2003). In the latter case, spared monitoring abilities which inform metacognitive judgments about memory outcomes is said to contribute to comparable performance across age groups for metamemory performance (Hertzog & Dunloksy, 2011). The main thrust of the work presented here was to investigate a potential crossroad to bring ideas about monitoring from the source memory literature and ideas about the role of monitoring in the metamemory literature together in a meaningful way. In both experiments presented in this dissertation, monitoring was a critical component in both the source memory task and the source metacognitive judgment.

The first question of whether individuals could differentiate accurately between self-generated and presented stimuli (i.e. engage in accurate reality monitoring) was answered with a resounding 'yes'. Source memory performance overall was substantial in both source recall and recognition tasks. Age-related differences in source memory performance were consistent with expectations based on previous work. Younger adults outperformed older adults on both source memory tasks.

The second question was whether individuals could accurately predict their memory performance within modality (images) but across reality monitoring boundaries

(internal versus externally derived information) using judgments of source learning (JOSLs). Like most phenomena in our field, the answer starts with, "it depends". Yes, reliable and significant resolution was found for individual predictions of their source memory performance in both tasks, but factors such as timing of the metacognitive judgment and item characteristics had their unique and sometimes interactive effects. Previously, consistent relationships between source memory and source metamemory measures proved difficult to find. In both experiments presented, metacognitive accuracy of JOSLs was demonstrated for delayed JOSLs, but not for immediate JOSLs. The delayed JOSL effect ties together with previous research done which concluded that delayed metacognitive judgments proved more accurate than immediate judgments (see Rhodes & Tauber, 2011 for a review).

Thirdly, I was interested in whether metacognitive accuracy for source information was judgment dependent, that is, were individuals just as good at predicting memory performance using JOSLs as they were at monitoring their performance using confidence judgments. Resolution for confidence judgments indicated accuracy across studies, and that individuals were able to discriminate between correct and incorrect source attributions. However, age-related difference in the accuracy of these retrospective judgments may indicate that not all metacognitive judgments are equal. Findings presented by several researchers (e.g., Dodson & Krueger, 2006; Jacoby et al., 2010) have indicated that retrospective confidence judgments made by older adults were less accurate that those made by younger adults. In Experiment 2, older adults showed significantly reduced resolution of the source confidence judgments compared to younger adults. One could argue that this reduction could be an artifact of overall memory

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performance, yet recent work by Wong, Cramer, and Gallo (2012), examining whether or not age-related deficits in metamemory accuracy as measured by confidence judgments could be ameliorated if older and younger adults' memory performance was matched, showed that even when matched, reduced metamemory accuracy was still found.

Ultimately, I wanted to know if age-related deficits in monitoring would simultaneously manifest in impaired source memory performance and impaired metamemory accuracy for older adults. What I was found were two dissociations. First, although a consistent age-related deficit was found for source recall performance, there were no age-related effects in resolution of the delayed JOSL for older and younger adults. Second, although there were no age-related deficits in metamemory accuracy as measured by the predictive JOSL metacognitive judgment, there were age-related deficits in accuracy of the retrospective SCJ metacognitive judgments.

A major contribution of this dissertation was the discovery of a consistent, predictive metacognitive judgment for source memory. The judgment of source learning (JOSL) did predict future source memory outcomes in both source recall and source recognition tasks. Like previous findings on judgments of learning (JOLs), the JOSL was most accurate when judgments were delayed. This delayed JOSL effect was not only consistent with source memory outcomes, it was found in both age groups and across two experiments. Although this was not the first time that a relationship was found between judgments of this type and memory performance, it was the first time that the relationship replicated across experiments. By making the source memory task the salient aspect of the study, in this case a reality monitoring discrimination, participants had very clear expectations of what information they would be required to remember. I believe that this feature of the experiments' design was critical in ensuring a stable and consistent measure.

Many studies have documented the prevalence of an age-related deficit in source memory, namely, older adults do consistently worse on source tasks that younger adults, yet still show comparable metamonitoring ability. Theorists point to several potential explanations of this dissociation. A 'misrecollection account' for source material proposed by Dodson, Bawa, and Krueger (2007) stated that age-related deficits for source information were a result of high-confidence errors older adults make to misrecollected or misinformation. Essentially, even if information retrieved is incorrect, older adults seem unable to adjust their overall confidence to the wrong information, instead judging this information to be just as accurate as correct recollections. Declines in associative or binding processes with age (e.g., Naveh-Benjamin et al, 2003) have also been implicated in the debate of what is the root cause of age-related deficits in source memory performance. Johnson and colleagues call the 'fly in the ointment' impaired source monitoring. So, what is 'monitoring' anyway? Metamemory research has shown that older adults seem unimpaired when it comes to monitoring how well they have learned information. Kuhlmann and Touron (2011) suggested that while metacognitive monitoring is indeed spared in older adults, the ability to utilize the knowledge from those monitoring processes may be the culprit for impaired source memory.

The results of the experiments in this dissertation showed that finding an age-related deficit in source memory performance did not necessarily go hand in hand with an age-related deficit in the ability to monitor source information in memory. Hinging an explanation of age-related deficits in source memory on an impaired source monitoring assumption is not sufficient when no age-related differences were found for predictions about one's ability to remember source information. These results supported the idea that there are significant differences in the types of source monitoring required to form metacognitive judgments versus making a reality monitoring decision. It seems more likely that source monitoring is a collection of monitoring processes, and more than likely, the 'monitoring' required to make judgments like JOSLs and SCJs is qualitatively

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different than what is needed to make a correct source discrimination. Disentangling the monitoring processes was not the goal of this research; however, by identifying an area in the source literature where age-related deficits were not present, one can raise the question of whether a blanket 'age-related deficit in monitoring' explanation is sufficient to explain differences in source memory performance across the lifespan.

APPENDIX A

PICTURE STIMULI
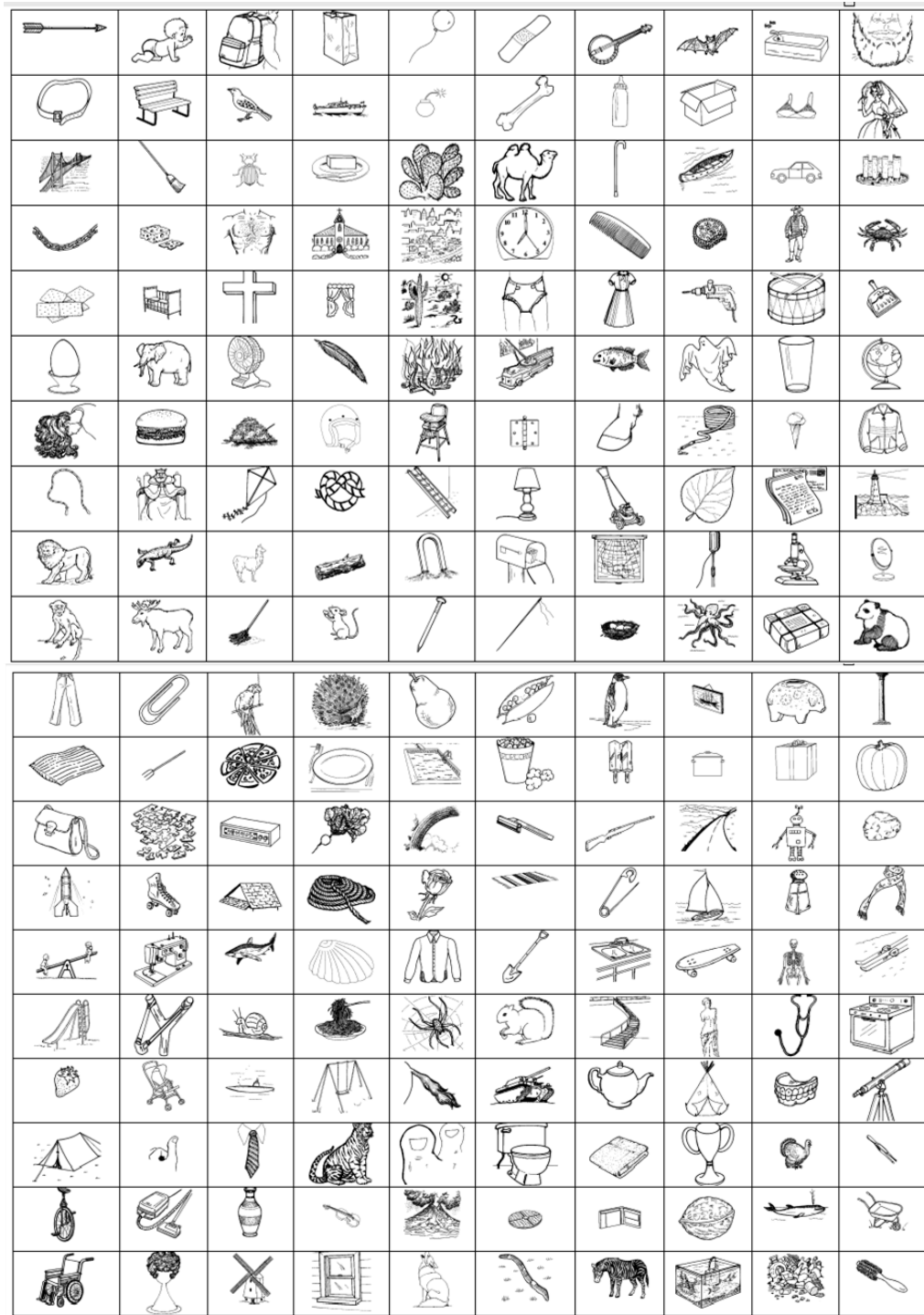
APPENDIX B

IMAGERY ABILITY QUESTIONNAIRES

Vividness of Visual Imagery Questionnaire

In this task, we will ask you to perform some visualization. We would like you to rate each visualized image according to the following scale:

1- Perfectly clear and as vivid as normal vision
2- Clear and reasonably vivid
3- Moderately clear and vivid
4- Vague and dim
5- No image at all, you only 'know' that you are thinking of the object

Please CIRCLE the number which reflects your response.

For items **1-4**, think of some relative or friend whom you frequently see (but who is not with you at present) and consider carefully the picture that comes before your mind's eye.					
1. The exact contour of face, head, shoulders, and body.	1	2	3	4	5
2. Characteristic poses of head, attitudes of body, etc.	1	2	3	4	5
3. The precise carriage, length of step, etc., in walking.	1	2	3	4	5
4. The different colors worn in some familiar clothes	1	2	3	4	5

For items **5-8**, visualize a rising sun. Consider carefully the picture that comes before your mind's eye.					
5. The sun is rising above the horizon into a hazy sky.	1	2	3	4	5
6. The sky clears and surrounds the sun with blueness.	1	2	3	4	5
7. Clouds. A storm blows up, with flashes of lightning.	1	2	3	4	5
8. A rainbow appears.	1	2	3	4	5

For items **9-12**, think of the front of a shop which you often go to. Consider the picture that comes before your mind's eye.					
9. The overall appearance of the shop from the opposite side of the road.	1	2	3	4	5
10. A window display including colors, shapes and details of individual items for sale.	1	2	3	4	5
11. You are near the entrance. The color, shape and details of the door.	1	2	3	4	5

12. You enter the shop and go to the counter. The counter assistant serves you. Money changes hands.	1	2	3	4	5

For items **13-16**, think of a country scene which involves trees, mountains and a lake. Consider the picture that comes before your mind's eye.					
13. The contours of the landscape.	1	2	3	4	5
14. The color and shape of the trees.	1	2	3	4	5
15. The color and shape of the lake.	1	2	3	4	5
16. A strong wind blows on the trees and on the lake causing waves.	1	2	3	4	5

Memory Characteristics Questionnaire

Your goal in this task is to think about a real memory of an event and to provide ratings on several scales. We will not ask you to describe the memory in detail or reveal anything personal.

Think of a recent social occasion—party, dinner, or a gathering of some sort that involved more than two people including yourself.

Please provide your ratings below by circling a number on the scale that reflects your response.

1. My memory for this event is
            1   2   3   4   5   6   7
          dim   sharp/clear

2. My memory for this event is in
            1   2   3   4   5   6   7
      black & white   entirely color

3. My memory for this event involves visual detail
            1   2   3   4   5   6   7
      little or none   a lot

4. My memory for this event involves sound
            1   2   3   4   5   6   7
      little or none   a lot

5. My memory for this event involves smell
            1   2   3   4   5   6   7
      little or none   a lot

6. My memory for this event involves touch
            1   2   3   4   5   6   7
      little or none   a lot

7. My memory for this event involves taste
            1   2   3   4   5   6   7
      little or none   a lot

8. Overall vividness of my memory for the event is

        1   2   3   4   5   6   7

    vague   very vivid

9. My memory for the event is

        1   2   3   4   5   6   7

    sketchy   very detailed

10. My memory for the order of events is

        1   2   3   4   5   6   7

    confusing   comprehensible

11. The story line for this event is

        1   2   3   4   5   6   7

    simple   complex

12. The story line for this event is

        1   2   3   4   5   6   7

    bizarre   realistic

13. My memory for the location where the event takes place is

        1   2   3   4   5   6   7

    vague   clear/distinct

14. The general setting for this event is

        1   2   3   4   5   6   7

    unfamiliar   familiar

15. The relative spatial arrangement of objects in my memory for the event is

        1   2   3   4   5   6   7

    vague   clear/distinct

16. The relative spatial arrangement of people in my memory for the event is

        1   2   3   4   5   6   7

    vague   clear/distinct

17. My memory for the time when the event takes place is

        1   2   3   4   5   6   7

    vague   clear/distinct

18. My memory for the year the event takes place is

        1   2   3   4   5   6   7

    vague   clear/distinct

19. My memory for the season the event takes place is

          1   2   3   4   5   6   7
          vague   clear/distinct

20. My memory for the day the event takes place is

          1   2   3   4   5   6   7
          vague   clear/distinct

21. My memory for the hour the event takes place is

          1   2   3   4   5   6   7
          vague   clear/distinct

22. The event seems

          1   2   3   4   5   6   7
          short   long

23. The overall tone of the memory is

          1   2   3   4   5   6   7
          negative   positive

24. In this event I was

          1   2   3   4   5   6   7
          a spectator   a participant

25. At the time, the event seemed like it would have serious implications

          1   2   3   4   5   6   7
          not at all   definitely

26. Looking back, this event did have serious implications

          1   2   3   4   5   6   7
          not at all   definitely

27. I remember how I felt at the time when the event took place

          1   2   3   4   5   6   7
          not at all   definitely

28. My feelings at that time were

          1   2   3   4   5   6   7
          negative   positive

29. My feelings at that time were

          1   2   3   4   5   6   7
          not intense   very intense

30. As I am remembering now, my feelings are
      1 2 3 4 5 6 7
    not intense   very intense

31. I remember what I thought at the time
      1 2 3 4 5 6 7
    not at all   clearly

32. This memory reveals or says about me
      1 2 3 4 5 6 7
    not much   alot

33. Overall, I remember this event
      1 2 3 4 5 6 7
    hardly   very well

34. I remember events relating to this memory that took place in advance of the event
      1 2 3 4 5 6 7
    not at all   yes, clearly

35. I remember events relating to this memory that took place after the event
      1 2 3 4 5 6 7
    not at all   yes, clearly

36. Do you have any doubts about the accuracy of your memory for this event?
      1 2 3 4 5 6 7
   a great deal of doubt   no doubt whatsoever

37. Since it happened, I have thought about this event
      1 2 3 4 5 6 7
    not at all   many times

38. Since it happened, I have talked about this event
      1 2 3 4 5 6 7
    not at all   many times

39. About when did this event happen? Check one:
____ just today
____yesterday
____few days ago
____last week
____few weeks ago
____last month
____few months ago
____last year
____longer (if childhood, indicate age)

Memory Characteristics Questionnaire

Your goal in this task is to think of a memory for an event and to provide ratings on several scales. We will not ask you to describe the memory in detail or reveal anything personal.

Think of a recent dream—any dream you think you can remember fairly well.

Please provide your ratings below by circling a number on the scale that reflects your response.

1. My memory for this event is
        1   2   3   4   5   6   7
      dim   sharp/clear

2. My memory for this event is in
        1   2   3   4   5   6   7
    black & white   entirely color

3. My memory for this event involves visual detail
        1   2   3   4   5   6   7
   little or none   a lot

4. My memory for this event involves sound
        1   2   3   4   5   6   7
   little or none   a lot

5. My memory for this event involves smell
        1   2   3   4   5   6   7
   little or none   a lot

6. My memory for this event involves touch
        1   2   3   4   5   6   7
   little or none   a lot

7. My memory for this event involves taste
        1   2   3   4   5   6   7
   little or none   a lot

8. Overall vividness of my memory for the event is

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11. The story line for this event is

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14. The general setting for this event is

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     unfamiliar   familiar

15. The relative spatial arrangement of objects in my memory for the event is

            1   2   3   4   5   6   7

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16. The relative spatial arrangement of people in my memory for the event is

            1   2   3   4   5   6   7

     vague   clear/distinct

17. My memory for the time when the event takes place is

            1   2   3   4   5   6   7

     vague   clear/distinct

18. My memory for the year the event takes place is

            1   2   3   4   5   6   7

     vague   clear/distinct

19. My memory for the season the event takes place is

         1   2   3   4   5   6   7

    vague   clear/distinct

20. My memory for the day the event takes place is

         1   2   3   4   5   6   7

    vague   clear/distinct

21. My memory for the hour the event takes place is

         1   2   3   4   5   6   7

    vague   clear/distinct

22. The event seems

         1   2   3   4   5   6   7

    short   long

23. The overall tone of the memory is

         1   2   3   4   5   6   7

    negative   positive

24. In this event I was

         1   2   3   4   5   6   7

   a spectator   a participant

25. At the time, the event seemed like it would have serious implications

         1   2   3   4   5   6   7

    not at all   definitely

26. Looking back, this event did have serious implications

         1   2   3   4   5   6   7

    not at all   definitely

27. I remember how I felt at the time when the event took place

         1   2   3   4   5   6   7

    not at all   definitely

28. My feelings at that time were

         1   2   3   4   5   6   7

    negative   positive

29. My feelings at that time were

         1   2   3   4   5   6   7

   not intense   very intense

30. As I am remembering now, my feelings are

         1   2   3   4   5   6   7

not intense   very intense

31. I remember what I thought at the time
                1   2   3   4   5   6   7
            not at all   clearly

32. This memory reveals or says about me
                1   2   3   4   5   6   7
            not much   alot

33. Overall, I remember this event
                1   2   3   4   5   6   7
            hardly   very well

34. I remember events relating to this memory that took place in advance of the event
                1   2   3   4   5   6   7
            not at all   yes, clearly

35. I remember events relating to this memory that took place after the event
                1   2   3   4   5   6   7
            not at all   yes, clearly

36. Do you have any doubts about the accuracy of your memory for this event?
                1   2   3   4   5   6   7
        a great deal of doubt   no doubt whatsoever

37. Since it happened, I have thought about this event
                1   2   3   4   5   6   7
            not at all   many times

38. Since it happened, I have talked about this event
                1   2   3   4   5   6   7
            not at all   many times

39. About when did this event happen? Check one:
____ just today
____yesterday
____few days ago
____last week
____few weeks ago
____last month
____few months ago
____last year
____longer (if childhood, indicate age)

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