

**JUDGMENTS OF LEARNING FOR SOURCE INFORMATION IN A  
METAMEMORY PARADIGM: THE JUDGMENT OF SOURCE  
LEARNING**

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**JUDGMENTS OF LEARNING FOR SOURCE INFORMATION IN A  
METAMEMORY PARADIGM: THE JUDGMENT OF SOURCE  
LEARNING**

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## SUMMARY

This project introduces a judgment of source learning (JOSL), an evaluative judgment by which participants make predictions about their ability to remember the source or modality of stimuli in the future (at test). The JOSL is an open-ended judgment that encapsulates a) participants' confidence in the information they are able to retrieve at the time of the judgment, b) participants' confidence in the strategy that they are using for retrieval, and c) participants' confidence in how effective their current retrieval and monitoring strategies will be in the future. Younger and older adults studied a paired associate list comprised of unrelated text-sound, or text-picture stimuli. They provided judgments of learning for paired-associate memory (JOLs), and some provided judgments of source learning for target source memory (JOSLs). Participants also provided strategy reports for study. JOSLs did not reliably predict source recall, and level of source recall varied as a function of target type rather than condition. Age differences were found in JOL resolution, where younger adults were more accurate in their prediction of future paired associate memory than older adults. Confidence gammas showed that both younger and older adults could reliably identify which items they answered correctly; however, the confidence gamma for source recall of sound targets was reliably negative, mostly likely a result of a 'PICTURE' response bias and overconfidence in wrongly source attributed sound targets.

# CHAPTER 1

## INTRODUCTION

Research about the functioning of metamemory has created a general consensus that there exists both monitoring and control factors in metamemory (Nelson & Leonesio, 1988). Evidence that these components are continuously interacting when one engages in memory recollection and retrieval activities can be found in Mazzoni and Cornoldi (1993). Source monitoring is typically defined in the context of a metamemory control process, that is, a ‘gating’ procedure one uses when trying to remember something, attempting to separate and extract memory details specific to the source where information was originally encountered (e.g., Mitchell, Johnson, & Mather, 2002). A more comprehensive definition and discussion of source monitoring by Johnson, Hashtroudi, and Lindsay (1993), claims that source monitoring refers to all processes involved in making evaluations about where memories, beliefs, or knowledge a person possesses were derived. Johnson and colleagues said that source judgments are often made heuristically, and that people are often unlikely to engage in systematic evaluations to make a source judgment.

### **Source Monitoring Review**

There is an extensive literature discussing and investigating age-related differences of item and source memory (McIntyre & Craik, 1987) and source monitoring (Johnson, De Leonardis, Hashtroudi & Ferguson, 1995). In a recent comment on Siedlecki, Salthouse, and Berish (2005), Johnson (2005) sought to challenge the idea that source memory was not a construct distinct from episodic memory. Johnson argued that

episodic and source memory tasks recruit similar resources, and depending on the question of interest a task may be created to investigate one type of memory or another. Does this mean that there is no reason for source memory tasks? Johnson reasoned that the role of source memory tasks could be to provide researchers with other means to investigate features that frame episodic memory, binding processes that hold features together, and the processes that are used when we access and evaluate representations as part of the recollection experience.

Recent findings in the source monitoring literature explored source recall and monitoring decrements in several populations (Bruce, Phillips-Grant, Conrad & Bona, 2004; Dehon & Brédart, 2004; Watson, McDermott & Balota, 2004). Bruce and colleagues successfully decreased false recognition of critical lures by making younger adult participants focus on perceptual details of the stimuli (font, background, etc.) rather than categorical similarity of the words. They further explained the decrease of critical lures being judged as old and remembered by positing that by making participants focus on source details, a disruption of semantic categorization is accomplished and internal semantic activation of the critical lure is also decreased. Dehon and Brédart also implicated semantic activation of critical lures as the culprit for false recognition errors at test. They found an age-related difference with older adults having greater false alarms than younger adults, even when instructed to “examine the origin of memories” before making a final decision (Dehon & Brédart). This instruction resulted in a significant reduction in false recognition for younger adults, but not for older adults in the study. Watson and colleagues also found that older adults were prone to more source monitoring errors than younger adults. Their findings showed an increase in veridical recall

probability for both younger and older adults; however, the probability for false recall across trials only decreased for younger adults as a result of explicit warnings about critical lures in their study. Older adults were able to reduce false recall on trial 1, but the near complete elimination of false recall for younger adults across all later trials, was not observed in the older adult results. These findings are consistent with earlier work by Hashtroudi, Chronsniak, and Johnson (1989) who showed older adults had greater susceptibility to source misattributions, and Dodson and Schacter (2001; 2002a; 2002b) who investigated ways to reduce source recall and monitoring errors in younger and older adults using distinctiveness heuristic instructions.

### **Introduction of the Judgment of Source Learning**

Source judgments historically have referred to participant evaluations of the context in which they believed they previously encountered stimuli, i.e. ‘modality judgments’ (e.g., Kelley, Jacoby, & Hollingshed, 1989), or their confidence in how accurate they felt their evaluations/judgments were, (e.g., Mitchell, Johnson, & Mather, 2003). Previously studied JOSs (judgments of source) and the JOSLs (judgments of source learning) investigated in this study are the conceptually the same judgment. However, in past research, source discriminations would be referred to as a source judgment (Kelley, Jacoby, & Hollingshed, 1989), or a confidence judgment about a source discrimination would be called a source judgment (Mitchell, Johnson, & Mather, 2003). Referring to the metacognitive judgment as a judgment of source learning (JOSL) as opposed to just a judgment of source (JOS) provided a clearer name for the judgment and also makes the comparisons between the JOSL and the JOL easier to understand. To reiterate, the JOSL investigated in this study should not be confused with ‘source

judgments' (i.e. modality judgments) as they are represented in research currently. There is also a difference between JOSLs and the usual confidence judgment used in past source experiments. JOSLs are different than a confidence judgment about a source discrimination (i.e., I said I heard this pair, how confident am I that I gave the right answer), because it is a prospective judgment, rather than a retrospective confidence judgment about the accuracy of an answer recently provided by a participant.

Evidence that participants can monitor and make predictions of future item memory, that is, judgments of learning (JOLs) can be found in several places (e.g. Dunlosky & Nelson, 1994; Koriat, 1997; Nelson, 1993; Weaver & Keleman, 1997). What has not been extensively investigated in the metacognition literature is whether people can monitor source learning and make accurate predictions about future source memory based on the monitoring process. Johnson et al. (1993) alluded to an idea of systematic source judgments, which they defined as the processes by which one retrieves and judges the importance of the details accessed in the monitoring process. Although several attempts have been made to identify a metamemory judgment that predicts future source recall, namely, the judgment of source (JOS) (see Carroll et al., 1999; Kelly, Carroll, & Mazzoni, 2002; Lafferty, 2001), the resulting data do not provide a clear answer. Carroll and colleagues asked participants to predict future recall for real and imagined events, and were able to show that participants could predict that they would remember more real events than imagined; however, the JOS in their manipulation was not predictive of source recall. In an unpublished master's thesis, Lafferty (2001) attempted to investigate the JOS using male/female voice discrimination in one study, and presentation of words by specific agents in another. JOSs were predictive of source

memory in the latter study where use of 20 agents to deliver stimuli resulted in higher resolution ( $\gamma$ ) for the immediate JOS (0.58), than the delayed JOS (0.36). Much is still unknown about the accuracy of JOSs, and the tendency is to think of them as metacognitive judgments much like JOLs. The extensive literature on the accuracy and behavior of JOLs has shown that JOL resolution is affected by the types of cues that are accessible to participants at the time they make JOLs (Koriat 1997), and when JOLs are made (Thiede & Dunlosky, 1994). Koriat (1997) reported findings that intrinsic, extrinsic and mnemonic properties of cues influence the accuracy of JOLs differentially, while Thiede and Dunlosky (1994) showed greater accuracy for delayed JOLs over immediate JOLs.

JOSLs are conceptualized as a rating that would reflect a composite metacognitive judgment that encapsulated the outcomes of source monitoring processes, the cues that were accessible, and information that the participant believed would be accessible in the future. A parallel can be drawn between JOSLs and the JOL (as explored by: Dunlosky & Hertzog, 1997; Kelemen & Weaver, 1997; Koriat, 1997). If making JOSLs trained people to attend to different cues than they would otherwise attend to when making predictions about their future memory performance, in theory they should also shape control functions such as strategies during encoding. One of the goals of this study was to try to understand the conditions under which a JOSL is predictive of source recall/recognition.

Whether there are age-related differences in JOSL resolution has not been investigated. Indirect evidence of an existing age-related effect comes from source monitoring studies which showed that older adults had difficulty with processing and

recalling source information. There are several findings in the literature where older adults showed a higher susceptibility to source retrieval and source monitoring errors than younger adults (Dodson & Schacter, 2001; 2002). For this study, the hypothesis was that, unlike JOLs, which have been shown to not have any age-related differences (Connor, Dunlosky & Hertzog, 1997; Dunlosky & Hertzog, 1997), JOSLs could show age-related differences, with older adults exhibiting a JOSL resolution decrement when compared to younger adults. Did poor source retrieval errors for older adults stem from source confusability, ineffective study strategies, or over confidence in their memory for source information? These are questions that were addressed, if only partially, by this study. If the JOSL showed differential resolution in this study between older and younger adults, this would have provided indirect evidence of a need for further explanation of the source recall deficit observed in older adult study samples outside of the ‘overall decline in memory’ reasoning.

### **Overview of JOSL study**

In this study, an experimental manipulation to empirically assess the effects of JOSLs on target source memory, the metacognitive component, source monitoring, and its metacognitive judgment counterpart, JOLs was attempted. The main hypotheses were that JOSLs would predict future source recall (evidenced by reliable positive gammas), that an age-related difference would be observed in JOSL resolution (evidenced by reliably lower gammas for older adults), and that making JOSLs would increase overall memory accuracy (evidenced by higher mean memory performance for participants in the JOL/JOSL condition).

Analogous to JOLs being predictive of paired-associate (item) memory, JOSLs should be predictive of source recall. The age comparison in this study was imperative in an attempt to identify divergences in participant behavior during encoding, and at time of making the JOSL, and how those differences could result in differences in performance and accuracy of retrospective confidence judgments. An age-related difference in the JOSL, given the reported lack of an age-related effect for JOLs (according to Hertzog & Hultsch, 2000), would support Johnson's (2005) assertion that source tasks provide important information about memory that episodic tasks alone may not be able to tap. Finally, the proposed boost to memory performance was argued based on the reasoning that since JOL/JOSL mixed condition participants would have presumably paid closer attention to perceptual details of the stimuli, the resulting added information from which to draw diagnostic cues would make their judgments more accurate and aid memory. Did JOSLs affect source monitoring ability and source memory? What were the similarities and differences between JOSLs and JOLs? Were JOSLs reactive, i.e., did making JOSLs influence participant monitoring or retrieval behavior? The JOSL experiment was designed with these questions in mind.

Delayed JOLs and JOSLs were used, as work by Kelemen and Weaver III (1997) and Nelson and Dunlosky (1991) showed that delayed JOLs for items proved a better predictor of memory performance at test, i.e. were more accurate. The argument to use delayed JOSLs was less compelling as Lafferty (2001) only observed a delayed JOS effect in his first study, failed to find the effect in his second study, and found a reverse effect in the third (immediate JOS resolution was better than delayed JOS resolution with the use of multiple agents). There existed more evidence against the predictive validity

of immediate JOSLs in Carroll et al (1999) and Kelly, Carroll and Mazzoni (2002), who collected immediate JOSs that were found not to be predictive. JOLs and JOSLs were prompted from a cue alone as research has shown that generation of targets/responses provided more accurate JOLs than just reading cues along with responses at time of judgments (Mazzoni & Nelson, 1995; Nelson & Dunlosky, 1991).

Participant use of strategies was also explored. All participants were provided with descriptions of possible study strategies and were asked to report which one, if any, they used to study each pair. Including strategy reports stemmed from the idea that they would provide some insight into possible differences in the study strategies of younger and older adults that would account for some of the differences in overall memory performance. Was it possible that participants who did well on target source recall studied differently than participants who did not perform as well? An example of how strategy use could have differed between age groups, or items would have been if the type of strategy utilized depended on the type of pair being studied (e.g., imagery for text-picture, rote repetition for text-sound) - essentially a strategy switching approach.

The independent variables in this study were condition (JOL alone, JOL/JOSL), and target type (picture, sound). The dependent variables for which analyses are provided were judgments of learning (JOLs), judgments of source learning (JOSLs), associative recognition performance (AR), source recall performance (SR), confidence judgments (CJs), a variety Kruskal-Goodman gammas (for JOLs, JOSLs, and CJs) computed according to methods described in (Nelson, 1984), and strategy reports. The grouping variable was age (young and old).

## CHAPTER 2

### METHOD

#### Participants

A total of 125 (62 younger (18-25), 63 older (60-80)) adults participated in this study ( $M_{\text{ageYA}} = 20.5$ ,  $SD = 1.54$ ;  $M_{\text{ageOA}} = 70.43$ ,  $SD = 5.43$ ). Older adults had more years of education than younger adults ( $M_{\text{educationYA}} = 12.2$ ,  $SD = 0.81$ ;  $M_{\text{educationOA}} = 15.4$ ,  $SD = 2.42$ ), and had comparable reported health (Very Good) as younger adults ( $M_{\text{healthYA}} = 2.1$ ,  $SD = 0.81$ ;  $M_{\text{healthOA}} = 2.2$ ,  $SD = 0.80$ ). Only data from 60 younger and 60 older adults were used in the analyses (total of 120). The 5 participants whose data were not used were excluded because of incomplete data due to computer malfunction. All older adults received \$25 for participation, whereas younger adults chose between receiving extra credit or pay.

#### Materials

##### Paper Measures

Participants completed informed consent and the Participant Demographic Survey (PDS). They also completed perceptual speed tasks including Pattern Comparison (Salthouse, 1996), and Letter Comparison (Salthouse, 1996). Additionally, they were given a vocabulary test, the Shipley Vocabulary Assessment (Zachary, 1986). Although these tasks are not directly related to the study hypotheses, they were used to provide characteristics of the sample. Additionally, participants filled out a JOSL Post-

Experiment Questionnaire (JOSL-PEQ) where they were asked about their own study behavior specific to the computer task (Appendix A).

### **JOSL Computer Task**

The source monitoring, paired-associate learning task was programmed in Visual Basic 6.0 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 consisted of 69 unrelated noun pairs (Table 1). Five of the pairs were used for practice and the remaining 64 were used as stimuli for the experiment study block. The pair formats were presented as either text-sound or text-picture, randomly assigned in the program at the beginning of the session for each participant.

Table 1 Paired Associate Word List

<i>STUDY PAIRS</i>		
ANKLE – ELEPHANT	BUTTON – LADDER	FOG – SQUIRREL
APPLE – ROBOT	CABIN – BAND-AID	FORK – HOOF
APPLIANCE – PUMPKIN	CALENDAR – ROPE	FORT – FISH
ASHTRAY – TURKEY	CANE – MOOSE	GARBAGE – NAIL
BALLOT – POOL	CAPE – ROSE	GERM – SCARF
BARREL – COMB	CIGAR – FAN	GLOBE – SUBMARINE
BASKET – LEAF	CLOCK – TWEEZERS	GRASS – WINDOW
BASSINET – LION	CLOUD – MAGNET	GRAVEL – CHURCH
BED – OCTOPUS	COIN – ROOF	GUITAR – BENCH
BELL – SKELETON	COMPASS – LAMP	HALO – MAILBOX
BLOCK – CAMEL	CORK – BELT	HINGE – SKATEBOARD
BLOSSOM – FEATHER	CURTAIN – TOWEL	HOLE – GHOST
BOARD – VOLCANO	DANDRUFF – TELESCOPE	JELLY – WINDMILL
BOAT – JACKET	DESK – TENT	JEWEL – BONE
BRICK – HELMET	DOCK – BABY	JUNK – TAIL
BRIDGE – HOSE	DOLL – FISH	KETTLE – ROCK
BUCKET – KITE	DOUGH – DRESS	MARBLE – PEAR
BULB – BROOM	FAUCET – PANTS	MASK – CAR
BULLET – STRAWBERRY	FLANNEL – CACTUS	MEDAL – TOILET
BUTTER – ROCKET	FLASK – ARROW	MIRROR – BOX

Table 1 continued

ONION – BALLOON	PLAQUE - STAIRS	PRODUCT – DRUM
RADIO – PENGUIN		
<i><b>PRACTICE PAIRS</b></i>	RED - SNAIL	PINK – TUB
YELLOW - WAFFLE	GREEN - SHARK	BLUE – POT

The picture stimuli were acquired as freeware taken from the Center for Research in Language - International Picture Naming Project database which is maintained by the University of California, San Diego (Table 2). The ones used in this study have been normed on naming frequency, and reaction time. A further step to identify pictures for use in this study was taken with candidate items presented in a listing task to 12 volunteer participants who were lab technicians in the Hertzog Adult Cognition lab. They were instructed to write the name of the picture that first came to mind. Pictures were excluded from selection to the experimental study list if they were named incorrectly by any of the participants. Incorrect naming included correct alternate names for the object (i.e. ‘handbag’ for ‘purse’), shortened names (i.e. ‘tub’ for ‘bathtub’), and obscure objects that participants found difficult to name. Some of the excluded items were used as practice items.

Table 2 Picture Targets



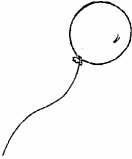
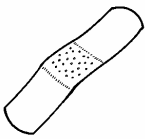
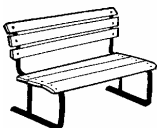
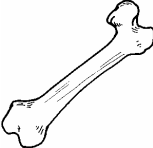

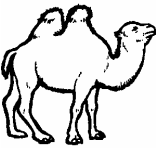

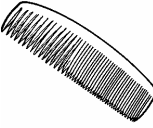


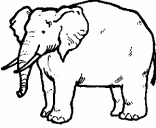
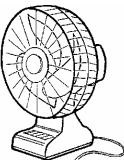





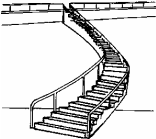

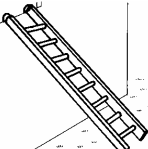
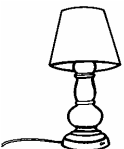

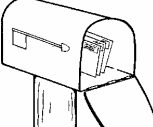




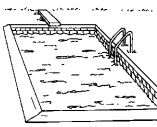
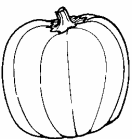




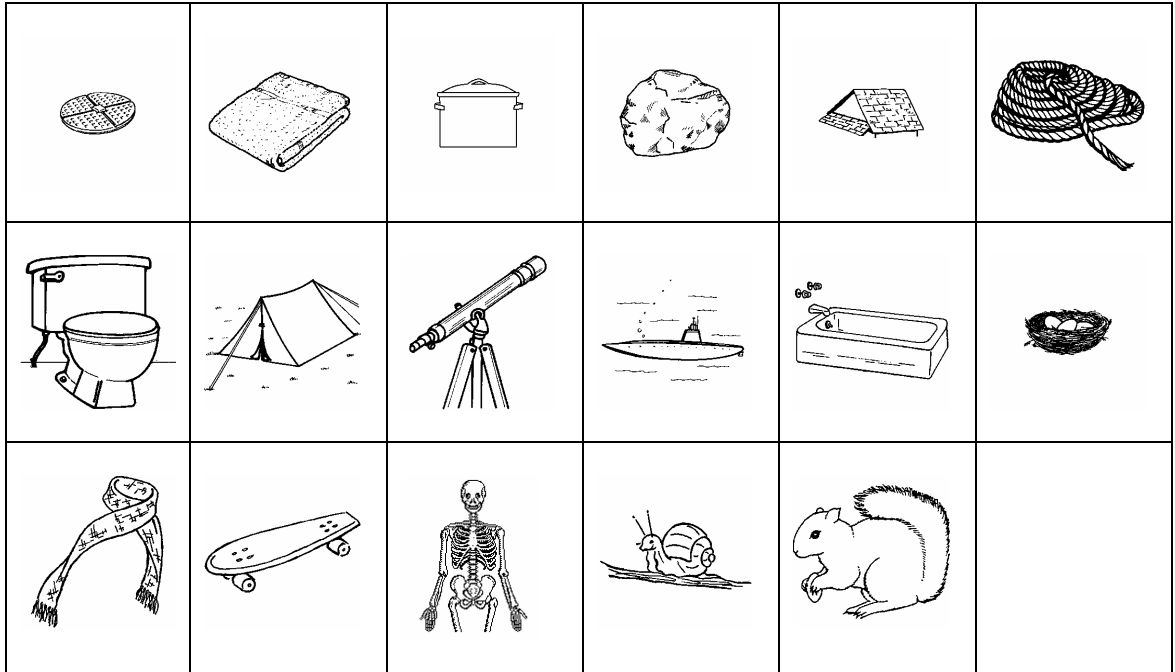
					
					
					
					
					
					
					

Table 2 continued



The names of the pictures selected at this phase were then digitally recorded using a single female voice, resulting in the sound targets for our text-sound pairs. The text cues were derived from a list of nouns taken from the Free Association Norms (Nelson, McEvoy, & Schreiber, 1998) database and were matched with their respective targets on the basis of concreteness and absence of direct forward (cue-target) or backward (target-cue) associations. The targets were not selected in the same manner as the cues because their selection was based on object naming and image simplicity criteria. The program was configured to randomly assign items to one of the two presentation formats (text-sound/text-picture) prior to study for each participant, resulting in a list of 32 unrepeated text-sound pairs, and 32 unrepeated text-picture pairs. Additionally, for the JOL/JOSL mixed condition, word pairs were also randomly assigned to be judged by JOL or JOSL,

resulting in a further breakdown of the list into 16 JOL text-picture, 16 JOSL text-picture, 16 JOL text-sound, and 16 JOSL text-sound pairs.

An associative recognition test format was used to assess paired-associate memory. The associative recognition test included 32 of the original pairs intact and presented in text-text format (e.g., the target 'SCARF' was presented in the test pair instead of the picture or sound presentation), while the other 32 test items were mismatched cue-target pairs, also presented in text-text format for a total of 64 items. The list was constructed so that the new mismatched pairs (foils) created would also remain unrelated, i.e., retain the absence of associative strength (forward or backward) of the cue to the target, as established by information from the Free Association Norm database. For source recall, a forced choice test format was used. The source recall test included the same pairs from the associative recognition test and targets were categorized as either a previously studied picture or sound.

### **Design and Procedure**

All participants read and signed the informed consent form. They completed the demographic questionnaire and the perceptual speed and vocabulary assessment tasks per established measurement protocol. The computerized study task followed the paper-pencil assessments. Older and younger adults were randomly assigned to either the JOL alone or JOL/JOSL mixed conditions, resulting in 30 participants per condition. Following the paired-associate learning computer task, participants filled out a post-experiment questionnaire, were then debriefed, and compensated for their participation.

The computer task began with standard paired-associate learning instructions that informed participants that they were studying word pairs for a later recognition test.

Then participants received instructions on types of strategies they could use to study the word pairs. Examples of rote repetition, sentence generation and interactive imagery strategies were provided. The next set of instructions informed participants about the serial presentation of the pairs as well as the picture and sound nature of the targets (examples were provided) and that fixation cues (i.e., LOOK or LISTEN) would be used to alert them as to which type of pair they would be studying next (Figure 1). They were also shown the answering format they would be using to indicate strategy use (Figure 2).

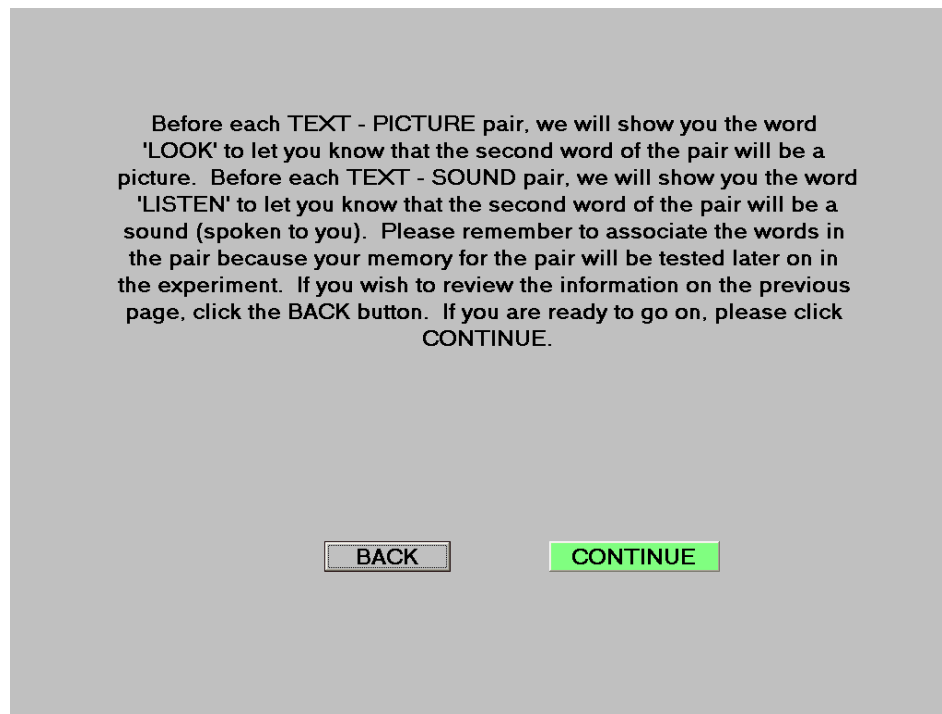


Figure 1 JOSL computer task fixation instructions

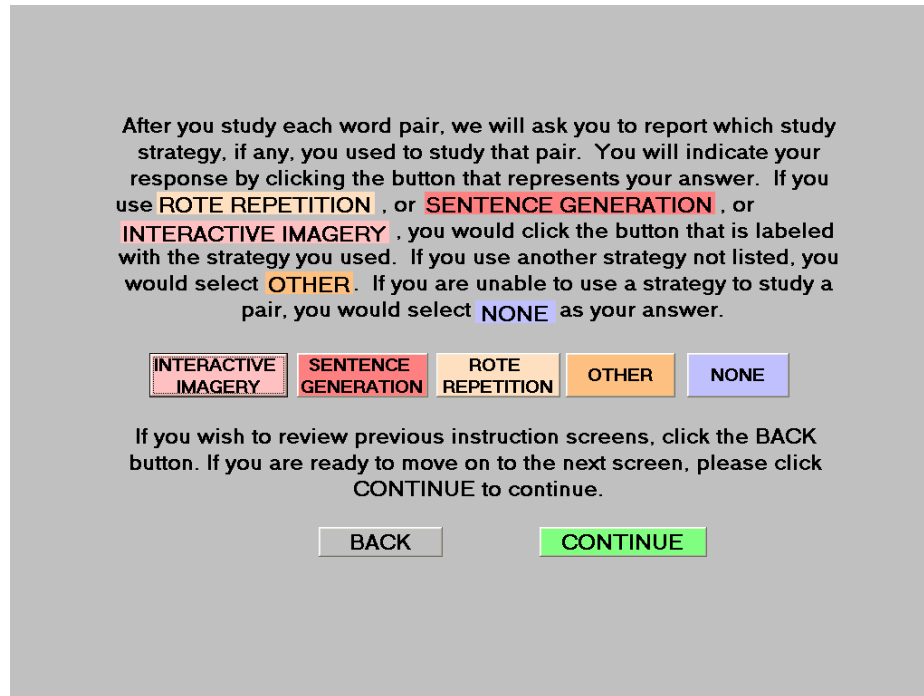


Figure 2 JOSL computer task strategy report instructions

The fixation before each text-picture trial was LOOK, while the fixation before each text-sound trial was LISTEN. Finally, all participants were given instructions on both JOLs (Figure 3) and JOSLs (Figure 4).

After you have studied all of the word pairs, we will ask you how likely you will be to remember each pair. For the pair, DOG - WHEELBARROW, we will show you DOG - ??? and we will ask you: How confident are you that in about 10 minutes you will be able to remember the 2nd word that was previously paired with the word show here? (0 = not likely to remember, 100 = completely likely to remember)

You would then use the number keypad to enter your response. You are allowed to enter any whole number from 0 - 100. If you have questions or need clarification, please ask the experimenter now. If you wish to review previous instructions, click the BACK button. Otherwise, please click CONTINUE.

BACK

CONTINUE

Figure 3 JOSL computer task JOL instructions

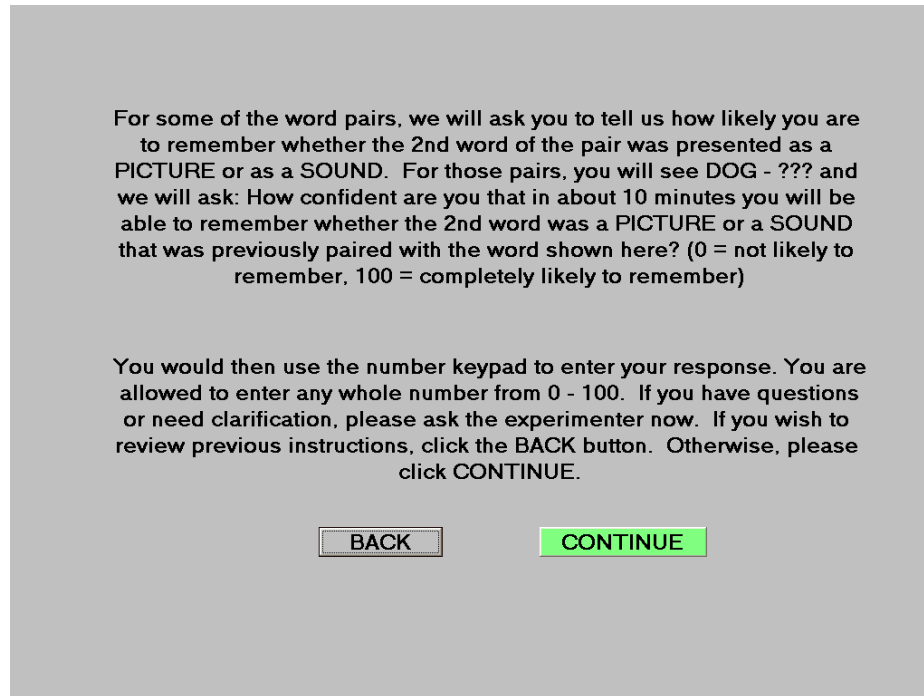


Figure 4 JOSL computer task JOSL instructions

They were oriented to how they would provide their ratings and given examples of how each question would be phrased. These instructions stressed that participants could be asked to make a prediction about their ability to remember the item pair, or make a prediction about their ability to remember whether the target, i.e., the second word of the pair, was presented as a picture or sound. Participants were allowed to go back through the instruction pages as needed until they felt comfortable with what they were required to do to complete the computer task.

Following instructions, participants completed a short practice block where they studied 5 pairs in order to become familiar with the presentation format, providing strategy reports, and making judgments. The pairs were presented serially, first the fixation was presented for 1500 ms in the center of the screen, and then a 1000 ms blank screen was presented followed by the text cue being presented in the center of the screen

for 3500 ms. The cue was followed by a 1000 ms blank gray screen, then the picture target was presented for 3500 ms to the screen or the audio target presented during a 3500 ms blank screen through headphones. Following each pair, another blank screen was presented for 2500 ms followed by the strategy report screen. They were prompted to report any strategies they used to study the pair by selecting rote repetition, sentence generation, interactive imagery, other, or none from a set of button choices on the screen. Strategy report time was not limited to ensure that participants took as much time as needed to encode the pair to their satisfaction. The practice block also allowed participants to practice answering the judgment prompts and do any volume adjustments needed to ensure sound level comfort during the experiment. Participants were allowed to repeat practice as needed to ensure acclimation to the task. This was especially important given the complexity of the stimuli and metacognitive judgment prompts. Once participants indicated completion of the practice block to satisfaction, they were moved on to the main study block. There was no criterion performance set as the practice was just on orientation to the study, strategy report, and judgment reporting formats.

Each pair in the study block was presented just like those described in the previous practice block. Once again, after each pair, participants reported their strategy use, if any, before moving to the next pair presentation. The study block included 64 unrelated pairs, randomly assigned to text-picture or text-sound format. Participants studied all 64 pairs before moving on to the judgment block.

Participants in the JOL/JOSL mixed condition made both paired-associate memory and target source memory predictions. The computer program randomly

selected which type of judgment was made for each of the 64 pairs, resulting in half of the pairs being JOL judged items and the other half being JOSL judged items.

Participants in the JOL only condition only made paired-associate memory predictions after study. At the time of the paired-associate judgment (JOL), participants saw the cue, “RED - ???”, and then the statement, “How confident are you that in about 10 minutes you will be able to remember the 2<sup>nd</sup> word that was previously paired with the word shown here? (0 = not likely to remember, 100 = completely likely to remember) Using the keyboard, enter any whole number from 0 – 100”. Participants then typed in a number within this range to indicate their response and proceeded to the next item. In the JOL/JOSL mixed condition, the source-memory response cue was similar to the paired-item response cue, but the statement said specifically, “How confident are you that in about 10 minutes you will be able to remember whether the 2<sup>nd</sup> word was a PICTURE or a SOUND that was previously paired with the word shown here? (0 = not likely to remember, 100 = completely likely to remember) Using the keyboard, enter any whole number from 0 – 100”. Participants entered a response within the 0-100 range to indicate their response and then moved on to the next item. After all judgments were made for all 64 items, participants completed a 5-minute unrelated pattern matching filler task.

The associative-recognition test instructions immediately followed the filler task. The instructions informed participants about the presence of mismatched pairs, i.e. foils. They were instructed that the test would include items that were originally paired together during study as well as items that were not previously paired together. Participants were also instructed that both the words in the pair would be in text format and that they will provide a ‘MATCH’ response for pairs that were studied previously

(matched) and a 'MISMATCH' response for pairs that were not (mismatched). Participants were also informed that they would be required to provide source discrimination for all targets. Regardless of whether the pair was an intact pair or not, participants were told to indicate whether the 2nd word of the pair on the screen at that moment was studied as a picture or spoken (sound) previously. Finally, they were told that they would be providing a confidence rating after each associative-recognition item and target source discrimination.

The pairs for the associative-recognition test were randomly presented; one at a time, on the screen and the participant indicated MATCH or MISMATCH to each pair with the appropriate button click on the screen (Figure 5).

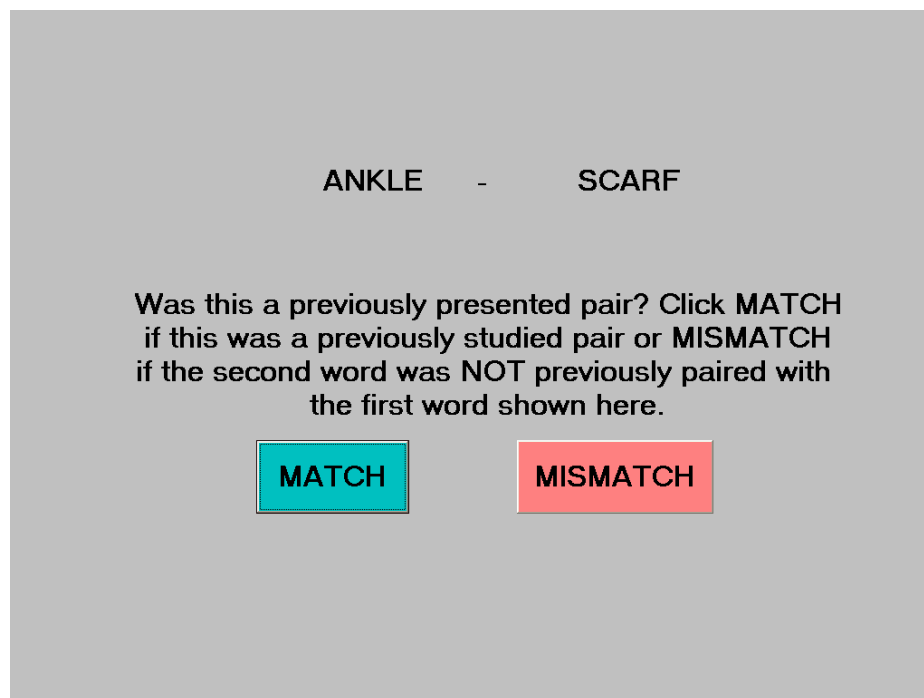


Figure 5 Example of associative recognition test item

After this, participants were asked to provide a retrospective confidence judgment about their response. Participants saw the question, “How confident are you that the answer you just gave was correct? Enter any whole number from 0 – 100. 0 = not at all confident, 100 = completely confident.” Once participants entered their numeric response to the paired-associate confidence prompt, they clicked continue to go on to the source memory question (Figure 6).

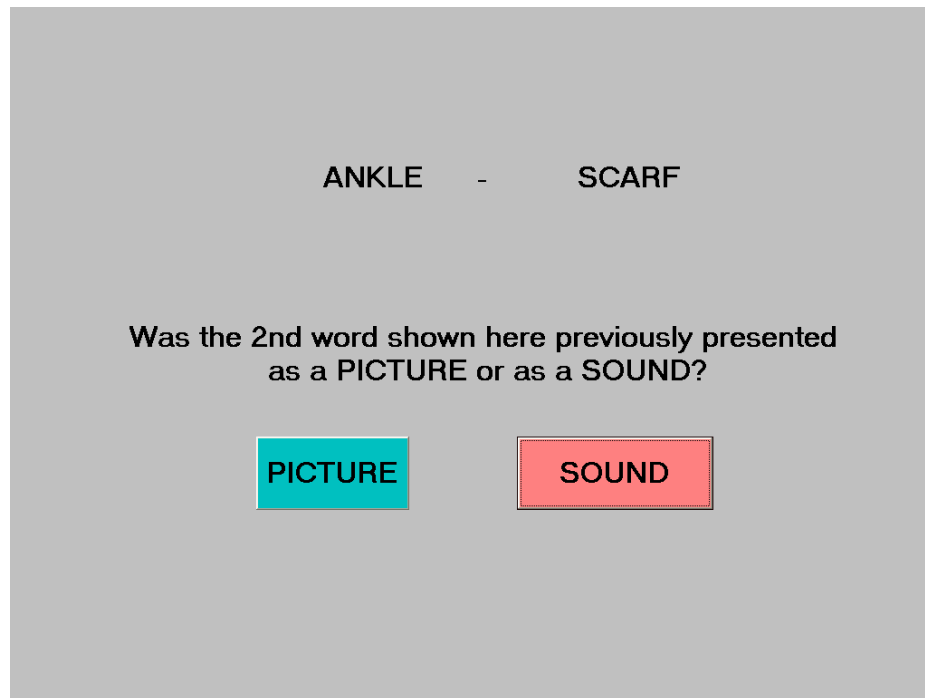


Figure 6 Example of source recall test item

Participants were asked to indicate the original source of the 2<sup>nd</sup> word in the test pair, i.e., the target, to which they either clicked a button marked PICTURE to indicate a previously studied picture target or a button labeled SOUND to indicate a previously studied sound target. They received the source recall confidence probe, “How confident

are you that the answer you just gave was correct? Enter any whole number from 0 – 100. 0 = not at all confident, 100 = completely confident” (Figure 7) after each item.

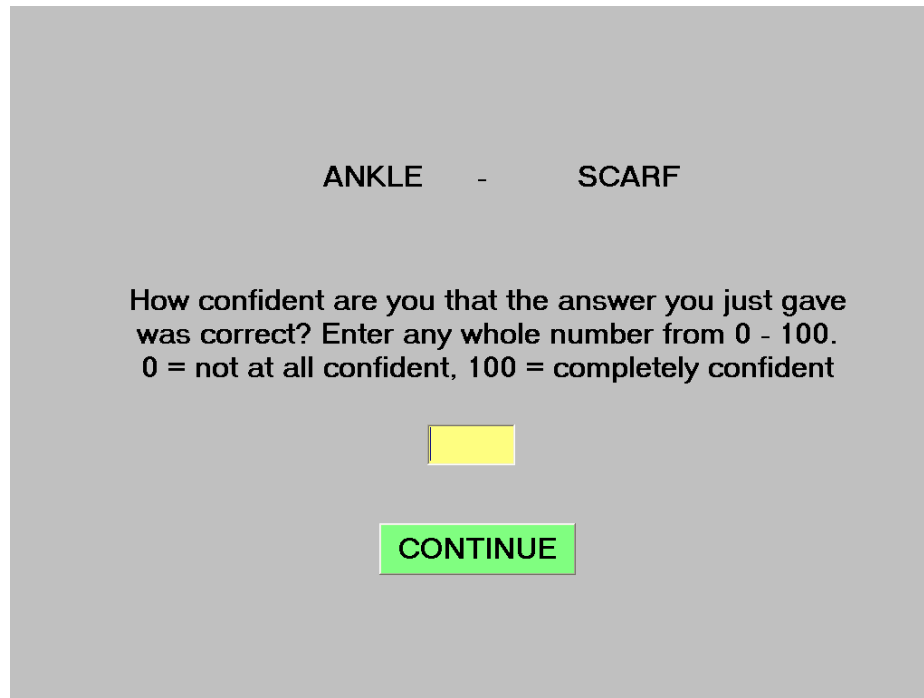


Figure 7 Example of confidence judgment report screen

The test was self-paced, and required that the participant provide a response in order to continue. Once participants completed the test they were asked to fill out the JOSL-PEQ. This was also self-paced. When participants indicated that they were finished, there were debriefed, compensated and thanked for their participation.

## CHAPTER 3

### RESULTS

Effects are identified as significant when  $p$  is less than 0.05 for all subsequent analyses. The value italicized in parenthesis following the  $F$  statistic is the partial eta squared effect size estimate. Marginal means are reported for significant effects and interactions where they are applicable. Values in parenthesis that are not italicized are standard errors.

#### Paper Tasks

Values for the Pattern Comparison (PC: Salthouse, 1996), Letter Comparison (LC: Salthouse, 1996), and Shipley (Zachary, 1986) for young and old are reported in Table 3. In summary, younger adults completed more items on both perceptual speed tasks [PC:  $F(1, 117) = 96.03 (0.45)$ ; LC:  $F(1, 117) = 64.27 (0.35)$ ], whereas older adults were more accurate than younger adults on the vocabulary measure [Shipley:  $F(1, 117) = 6.35 (0.05)$ ].

Table 3 Paper Task Results

Paper Task	Pattern Comparison	Letter Comparison	Shipley Vocabulary
Young	45.9 (7.25)	26.8 (5.47)	0.78 (0.09)
Old	32.6 (6.81)	19.0 (4.45)	0.82 (0.16)

## JOSL Computer Task

### Judgments of Paired Associate Learning and Source Learning

#### Mean JOLs

The first analysis focused on JOLs as the dependent measure. A 2 X 2 X 2 (Target X Age X Condition) repeated measures ANOVA was completed on JOL judged items. JOL means are reported in Table 4. There was a significant interaction of target and age where  $F(1, 116) = 11.12 (0.09)$  (Figure 8). Younger adults' JOLs were higher for text-picture pairs than text-sound pairs, whereas older adults' JOLs did not show the same differentiation. In summary, younger adult participants believed that their memory for text-picture pairs would be more accurate than their memory for text-sound pairs.

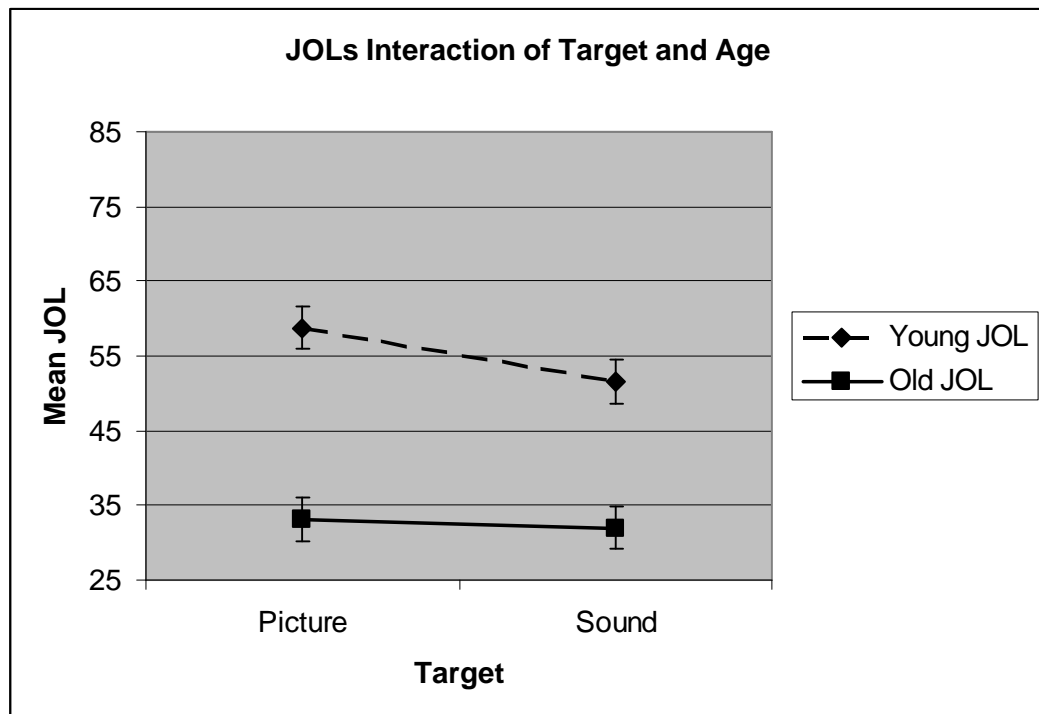


Figure 8 Significant interaction of age and target type for mean JOLs

### Mean JOSLs

The second analysis centered on JOSLs as the dependent variable. JOSL means are reported in Table 4. A 2 X 2 (Target X Age) repeated measures ANOVA revealed significant main effects of target and age. The within-subject effect of target where  $F(1, 58) = 13.36 (0.19)$ , indicated that participants predicted source recall of picture targets would be better than that of sound targets ( $M_{\text{picture}} = 53.54, \text{s.e.} = 2.74, M_{\text{sound}} = 47.47, \text{s.e.} = 2.80$ ). The between-subject effect of age, where  $F(1, 58) = 5.32 (0.08)$ , indicated that younger adults reported higher confidence in their future recall than older adults ( $M_{\text{young}} = 56.59, \text{s.e.} = 3.73, M_{\text{old}} = 44.41, \text{s.e.} = 3.73$ ). Overall participants believed they would remember more picture targets than sound targets, and younger adults' confidence in their target source recall was significantly greater than older adults' confidence in their future source memory.

Table 4 Aggregate Means and Gammas

<b>YOUNG ADULTS</b>				
	Mean (s.e.)		Gamma (s.e.)	
CONDITION	JOL Only	JOL/JOSL	JOL Only	JOL/JOSL
JOL – Picture	58.3 (4.09)	59.3 (4.23)		
JOL – Sound	53.5 (4.09)	49.23 (4.23)		
JOSL – Picture		61.1 (3.94)		
JOSL – Sound		52.1 (4.05)		
Associative Recognition				
ARJOL – Picture	0.92 (0.03)	0.92 (0.03)	0.52 (0.14)	0.34 (0.15)
ARJOL – Sound	0.90 (0.03)	0.92 (0.03)	0.50 (0.13)	0.53 (0.14)
ARJOSL – Picture		0.92 (0.03)		0.51 (0.14)
ARJOSL – Sound		0.91 (0.03)		0.55 (0.17)
CJ – JOL Picture	89.4 (4.26)	87.7 (4.26)	0.41 (0.15)	0.69 (0.17)
CJ – JOL Sound	85.7 (4.42)	85.0 (4.42)	0.73 (0.12)	0.62 (0.14)
CJ – JOSL Picture		89.4 (3.60)		0.53 (0.17)
CJ – JOSL Sound		84.8 (3.82)		0.69 (0.12)
Source Recall				
SRJOL – Picture	0.75 (0.02)	0.74 (0.02)	0.08 (0.09)	0.09 (0.09)
SRJOL – Sound	0.68 (0.03)	0.63 (0.03)	-0.03 (0.08)	-0.06 (0.08)
SRJOSL – Picture	0.75 (0.03)			0.17 (0.11)

Table 4 continued

SRJOSL – Sound	0.67 (0.04)		0.04 (0.09)	
CJ – JOL Picture	89.8 (3.92)	88.2 (3.92)	0.69 (0.10)	0.64 (0.10)
CJ – JOL Sound	83.7 (4.20)	80.4 (4.21)	-0.39 (0.10)	-0.26 (0.10)
CJ – JOSL Picture	87.5 (3.58)		0.46 (0.13)	
CJ – JOSL Sound	79.3 (3.56)		-0.22 (0.09)	
<b>OLDER ADULTS</b>				
CONDITION	JOL Only	JOL/JOSL	JOL Only	JOL/JOSL
JOL – Picture	28.6 (4.09)	36.7 (4.16)		
JOL – Sound	27.9 (4.09)	35.2 (4.16)		
JOSL – Picture		44.8 (3.87)		
JOSL – Sound		41.5 (3.98)		
Associative Recognition				
ARJOL – Picture	0.74 (0.03)	0.76 (0.03)	0.12 (0.11)	0.21 (0.11)
ARJOL – Sound	0.72 (0.03)	0.70 (0.03)	0.39 (0.10)	0.33 (0.10)
ARJOSL – Picture		0.72 (0.03)		0.34 (0.10)
ARJOSL – Sound		0.72 (0.03)		0.23 (0.12)
CJ – JOL Picture	60.0 (4.26)	71.2 (4.26)	0.33 (0.11)	0.25 (0.12)
CJ – JOL Sound	55.6 (4.42)	67.8 (4.42)	0.42 (0.09)	0.34 (0.10)
CJ – JOSL Picture		70.1 (3.60)		0.40 (0.11)
CJ – JOSL Sound		67.7 (3.82)		0.37 (0.08)

Table 4 continued

Source Recall				
SRJOL – Picture	0.75 (0.02)	0.75 (0.02)	0.07 (0.09)	0.07 (0.10)
SRJOL – Sound	0.49 (0.03)	0.48 (0.03)	-0.08 (0.08)	0.04 (0.09)
SRJOSL – Picture		0.74 (0.03)		0.04 (0.11)
SRJOSL – Sound		0.50 (0.04)		-0.23 (0.10)
CJ – JOL Picture	66.0 (3.92)	74.6 (3.92)	0.59 (0.10)	0.44 (0.11)
CJ – JOL Sound	60.3 (4.21)	66.4 (4.20)	-0.37 (0.09)	-0.45 (0.11)
CJ – JOSL Picture		74.8 (3.58)		0.46 (0.13)
CJ – JOSL Sound		67.8 (3.56)		-0.48 (0.09)

#### Distinction between levels of JOLs and JOSLs

To investigate whether there were differences between levels of JOLs and JOSLs, a 2 X 2 X 2 (Age X Judgment X Target) repeated measures ANOVA was conducted, with mean JOLs and mean JOSLs as the dependent variables. There were 2 significant interactions revealed. First there was a significant interaction of judgment type and age where  $F(1, 58) = 4.41 (0.07)$  (Figure 9).

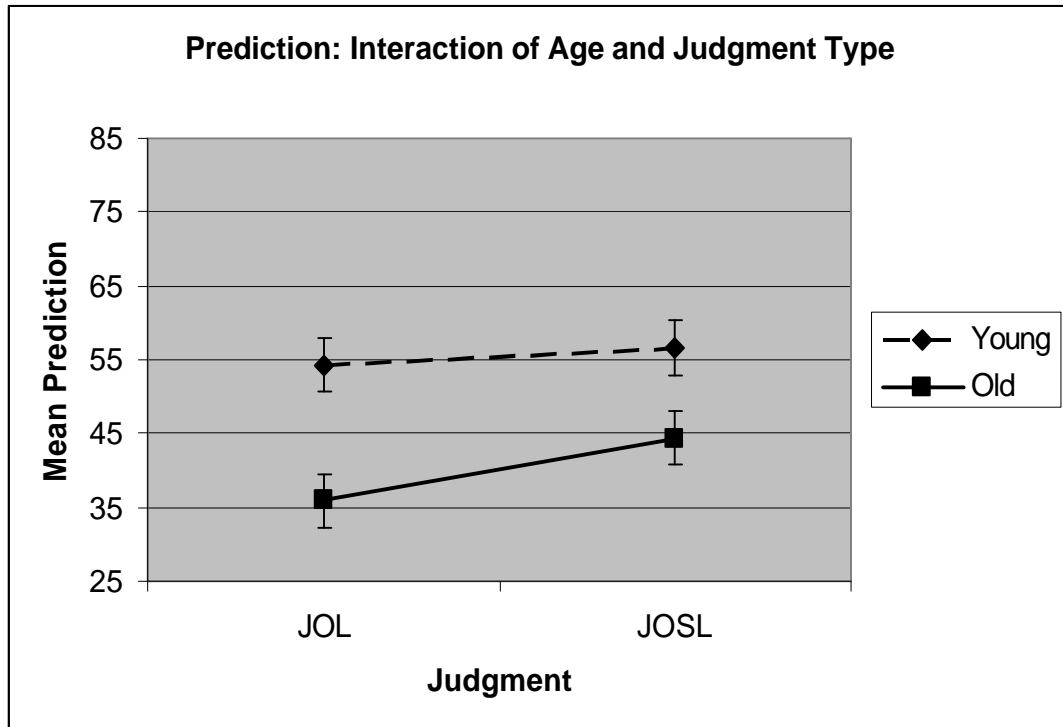


Figure 9 Significant interaction of age and judgment type for level of prediction

Older adults predicted higher target source recall than paired-associate memory, whereas younger adults' level of each type of judgment was equivalent. Secondly, there was a significant interaction of target and age, where  $F(1, 58) = 9.29 (0.14)$  (Figure 10).

Younger adults predicted higher target source memory performance for picture targets, whereas older adults did not make a distinction between target types.

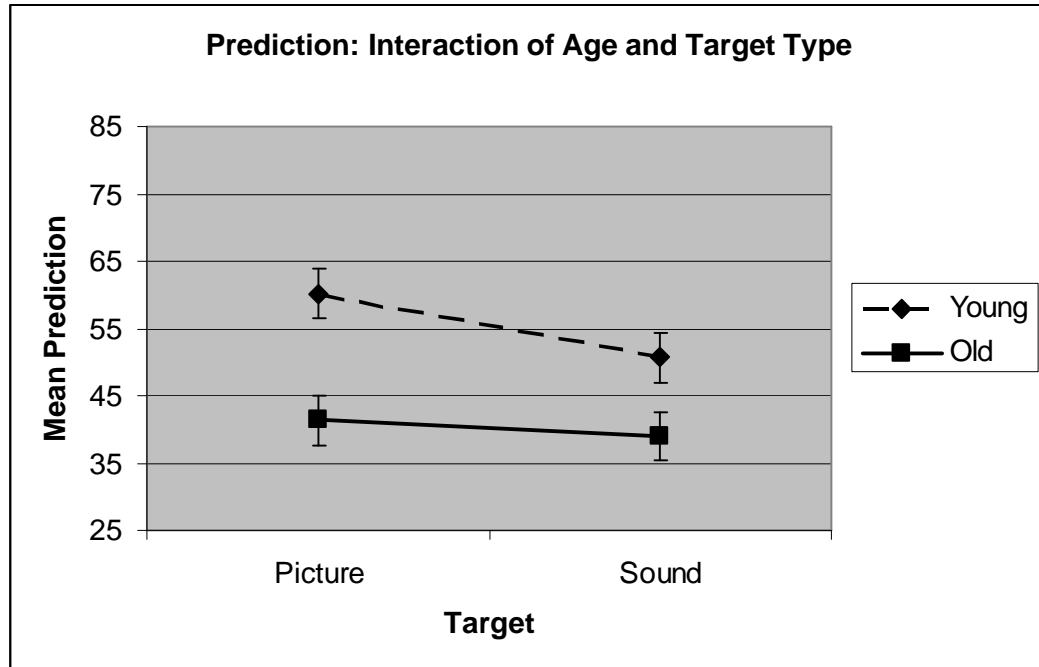


Figure 10: Significant interaction of target and age for level of prediction

## Memory Performance

### Associative Recognition

To measure associative-recognition (AR) accuracy, the proportion of the sum of correct match/mismatch judgments divided by the total number of item pairs for each participant was the computed accuracy measure. This value for each participant was used as a measure of memory performance for paired-associates. The aggregate means are reported in Table 4 for JOL judged items (ARJOL), and JOSL judged items (ARJOSL). A 2 X 2 X 2 (Target X Condition X Age) repeated measures ANOVA was conducted using mean ARJOL accuracy as the dependent variable and revealed several effects. As hypothesized, there was a significant between-subject effect of age where younger adults performed better than older adults on associative recognition,  $F(1, 116) = 44.32 (0.27)$

( $M_{\text{young}} = 0.92$ ,  $s.e. = 0.02$ ,  $M_{\text{old}} = 0.73$ ,  $s.e. = 0.02$ ). A significant Target X Condition X Age three-way interaction (Figure 11) where  $F(1, 116) = 4.40$  ( $0.04$ ) was also found.

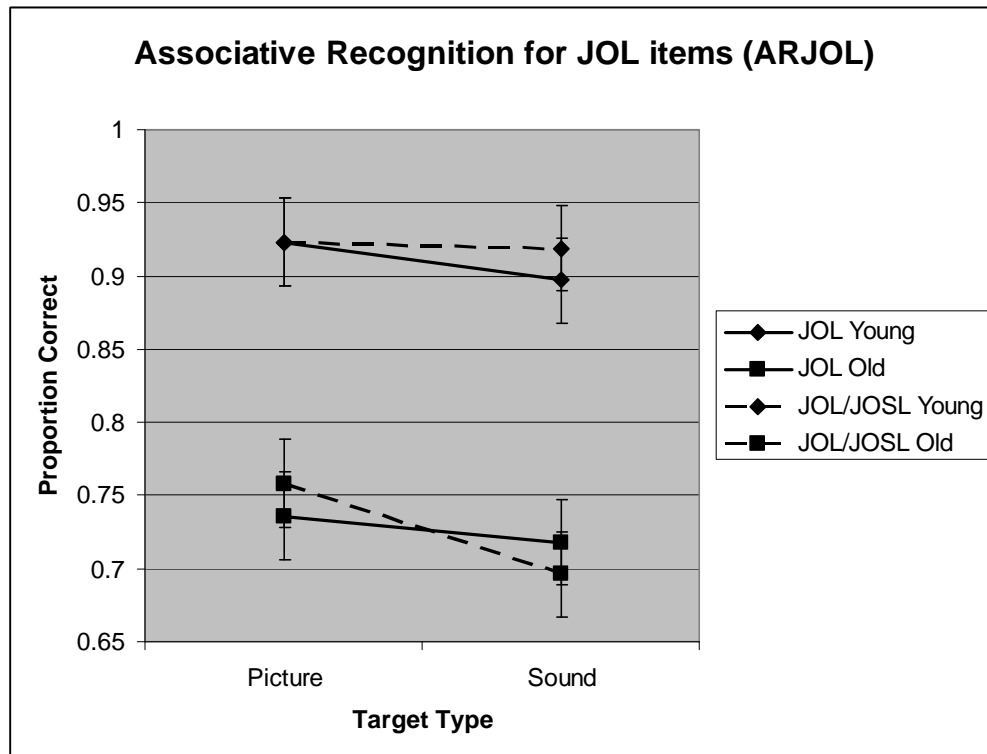


Figure 11 Significant three-way interaction of target, condition, and age for associative recognition on JOL judged items

One way to interpret this effect is to say that even though older adults in both conditions performed better on text-picture items; older adults in the JOL/JOSL condition had a larger difference between memory for text-picture pairs and text-sound pairs than older adults in the JOL only condition. The effect worked in the opposite direction for younger adults, i.e., younger adults' ARJOL in the JOL only condition for text-picture pairs was

significantly better than memory for text-sound pairs, whereas younger adults in the JOL/JOSL condition did not show this differentiation.

Analysis of the ARJOSL data by conducting a 2 X 2 (Age X Target) repeated measures ANOVA revealed a significant main effect of age only, where  $F(1, 58) = 27.01 (0.32)$  ( $M_{\text{young}} = 0.91$ , s.e. = 0.03,  $M_{\text{old}} = 0.72$ , s.e. = 0.03). Younger adults had better associative recognition memory for the JOSL judged pairs than older adults. Unlike the JOL judged items, there were no target effects present in the ARJOSL data. A 2 X 2 X 2 (Judgment X Target X Age) repeated measures ANOVA on the AR data from the JOL/JOSL mixed condition was conducted to establish whether a reactive effect of making JOSLs might be the explanation of the appearance of target effects for ARJOL items and not ARJOSL items. Judgment type yielded no significant effects,  $F(1,58) = 0.462 (0.01)$  ( $M_{\text{JOL}} = 0.82$ , s.e. = 0.02,  $M_{\text{JOSL}} = 0.82$ , s.e. = 0.02), so there is no support for the idea that making JOSLs influences AR (Figure 12).

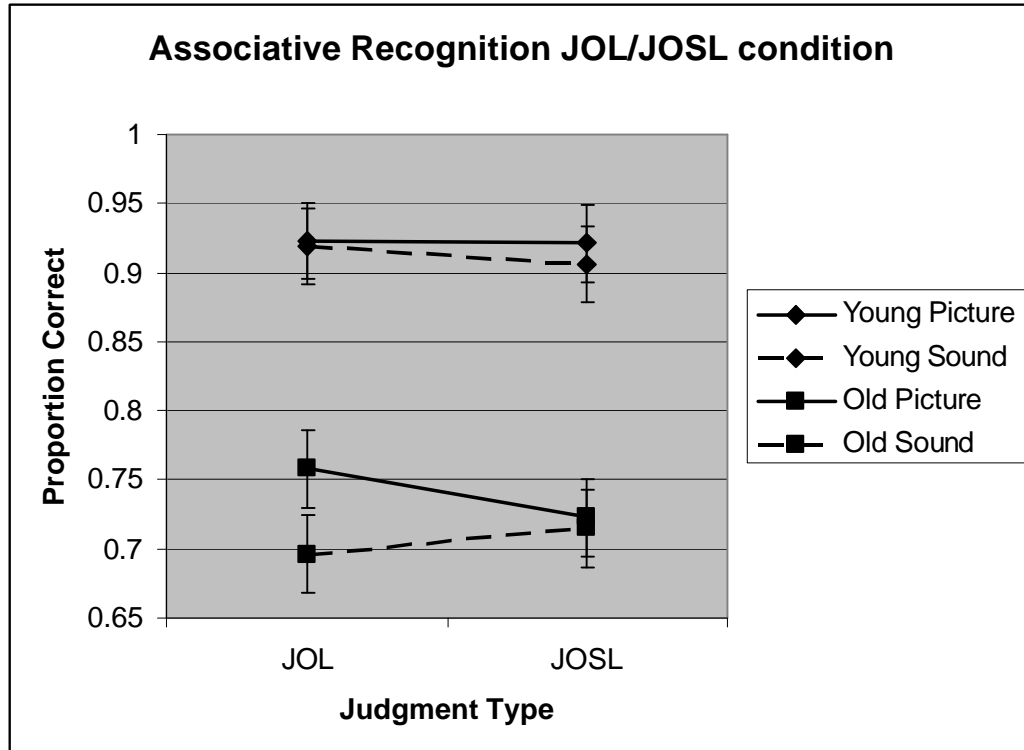


Figure 12 Non-significant effects of judgment type on associative recognition, but significant within-subject effects of target type and between-subject effect of age

Chance Responding and Response Bias in Associative Recognition.

To evaluate response biases in the associative recognition task, participants' response data on the associative recognition task were analyzed by performing a probit transformation and then computing and analyzing  $d'$  and  $C$ , a criterion measure of bias (see Snodgrass & Corwin, 1988) (see Table 5 for means). For  $d'$ , values close to 0 indicated chance responding while values of  $C$  significantly different from 0 in either direction indicated response bias. For ARJOL items,  $d'$  was significantly above 0 for both age groups  $F(3, 119) = 19.87 (0.34)$  ( $M_{\text{young}} = 3.55, s.e. = 0.19, M_{\text{old}} = 1.55, s.e. =$

0.19), and a significant effect of age  $F(1, 116) = 57.87 (0.33)$ , where younger adults had better recognition sensitivity than older adults.

Table 5 Sensitivity and Bias:  $d'$  and  $C$

Measure	$d'$ (s.e.)		$C$ (s.e.)	
	JOL Only	JOL/JOSL	JOL Only	JOL/JOSL
<b>Young Adults</b>				
Associative Recognition				
JOL	3.39 (0.26)	3.72 (0.26)	0.29 (0.10)	-0.01 (0.10)
JOSL		3.48 (0.25)		0.14 (0.14)
Source Recall				
JOL	1.24 (0.12)	1.06 (0.12)	0.18 (0.20)	0.33 (0.20)
JOSL		1.25 (0.14)		0.20 (0.22)
<b>Older Adults</b>				
Associative Recognition				
JOL	1.53 (0.26)	1.57 (0.26)	0.08 (0.10)	0.35 (0.10)
JOSL		1.51 (0.25)		0.08 (0.14)
Source Recall				
JOL	0.67 (0.12)	0.75 (0.12)	0.82 (0.20)	1.10 (0.20)
JOSL		0.76 (0.14)		0.86 (0.22)

These results indicated that overall participant responding was not ‘at chance’, even when participants were at 50% memory performance on text-sound pairs. The bias criterion measure  $C$  was significantly different from 0 for the entire sample,  $F(1, 119) = 2.76 (0.07)$ , indicating a slight response bias to say MATCH. Analysis revealed a significant (Age X Condition) interaction  $F(1, 116) = 7.70 (0.06)$  (Figure 13). The bias to respond MATCH was higher for older adults in the JOL/JOSL condition than in the JOL alone condition, but this finding was actually reversed with younger adults in the JOL alone condition being more biased to say MATCH in the JOL alone condition. It appears that for younger adults, being in the JOL/JOSL condition made for significantly more neutral

responding, while for older adults, being in the JOL/JOSL condition made for more bias to say MATCH.

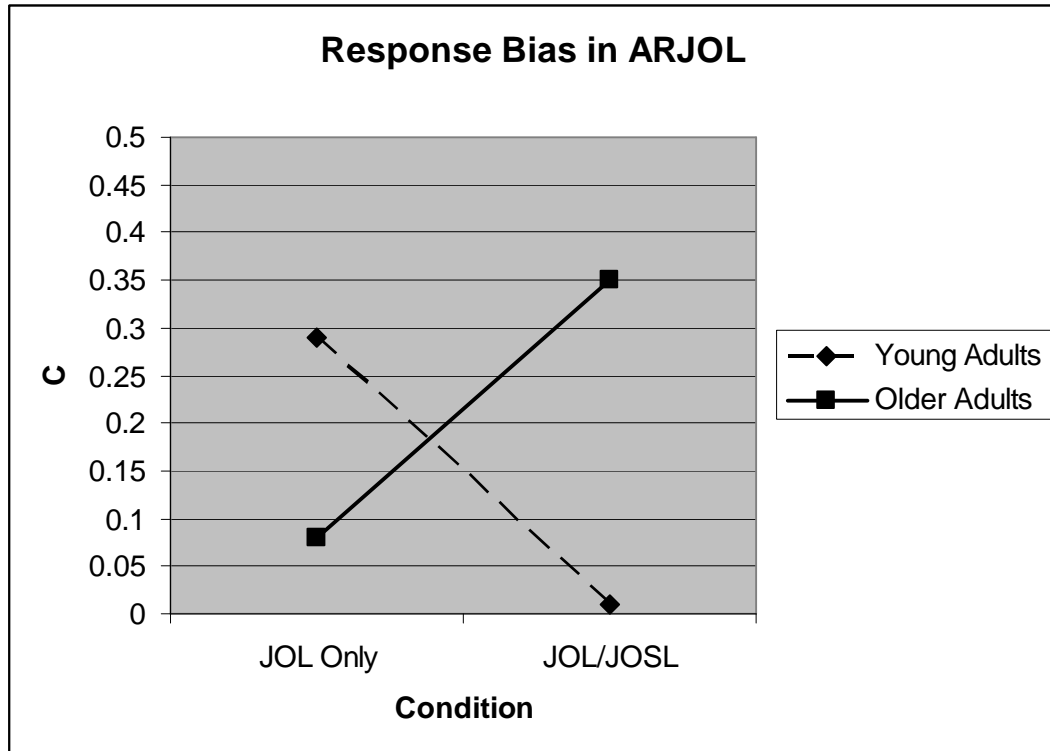


Figure 13 Significant interaction of age and condition for bias measure C

For ARJOSL items,  $d'$  was significantly greater than 0  $F(1, 59) = 30.16 (0.34)$ , and a significant age effect  $F(1, 58) = 30.16 (0.34)$  ( $M_{\text{young}} = 3.48$ ,  $s.e. = 0.25$ ,  $M_{\text{old}} = 1.50$ ,  $s.e. = 0.25$ ), which was consistent with the effect found for ARJOL items described in the preceding paragraph where younger adults were further from chance responding than older adults (see Table 5 for means). Analysis of C for these items, revealed that the bias measure was no different than 0,  $F(1, 59) < 1$  ( $M = 0.11$ ,  $s.e. = 0.18$ ), and there were also no significant age effects  $F(1, 59) < 1$  ( $M_{\text{young}} = 0.14$   $s.e. = 0.14$ ,  $M_{\text{old}} = 0.08$ ,  $s.e. = 0.14$ ).

These results indicated that there was no significant response bias for items judged with JOSLs.

### Source recall

Source recall (SR) accuracy was computed as the proportion of correct picture/sound discriminations divided by the total number of items. The aggregate means for JOL judged items (SRJOL) and JOSL judged items (SRJOSL) are reported in Table 4.

The hypothesis that younger adults' SR would be better than older adults' SR was not fully supported by the results. For SRJOL items, a 2 X 2 X 2 (Target X Condition X Age) repeated measures ANOVA revealed a significant interaction of target and age where  $F(1, 116) = 12.67 (0.10)$  (Figure 14). SR for picture targets was better than SR for sound targets, and equivalent for young and old; however, older adults did significantly worse on source discriminations for sound targets than younger adults.

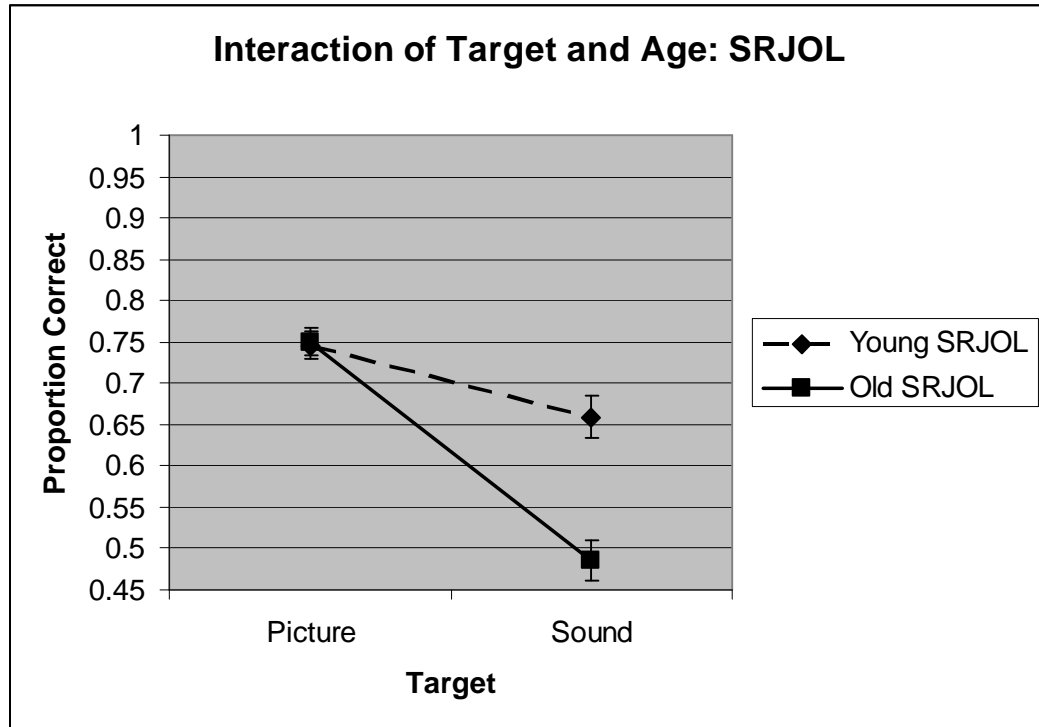


Figure 14 Significant interaction of target and age for source recall of JOL judged items

Analysis of SRJOSL items by running a 2 X 2 (Age X Target) repeated measures ANOVA revealed main effects of target and age. The within-subject effect of target where  $F(1, 58) = 13.86 (0.19)$  ( $M_{\text{picture}} = 0.74$ , s.e. = 0.02,  $M_{\text{sound}} = 0.59$ , s.e. = 0.03), indicated that SR for picture targets was better than SR for sound targets. The between-subject effect of age where  $F(1, 58) = 10.45 (0.15)$  ( $M_{\text{young}} = 0.71$ , s.e. = 0.02,  $M_{\text{old}} = 0.62$ , s.e. = 0.02), showed that younger adults did better on SR than older adults. Because picture recall was equivalent for both age groups for JOL judged items but not for JOSL items, further analysis was carried out to look specifically at SR in the JOL/JOSL mixed group. A 2 X 2 X 2 (Age X Judgment X Target) repeated measures ANOVA with SR as the dependent variable showed no significant judgment effects, indicating no difference

in SR between JOL and JOSL items [ $F(1, 58) = 0.242 (0.02)$   $M_{JOLrecall} = 0.65$ , s.e. = 0.013,  $M_{JOSLrecall} = 0.67$ , s.e. = 0.14].

### Chance Responding and Response Bias in Source Recall

Even though this task was described as ‘source recall’, chance responding and response bias analyses were conducted on the SR data because there were only two forced response options, much like a recognition task. A probit transformation was performed and  $d'$  and  $C$  were computed and analyzed.

Chance responding was ruled out because the analysis of  $d'$  showed that for SRJOL items,  $d'$  was significantly greater than 0 where  $F(3, 119) = 5.18 (0.12)$  (see Table 5 for means). There was a significant effect of age where  $F(1, 116) = 14.13 (0.11)$  ( $M_{young} = 1.15$ , s.e. = 0.08,  $M_{old} = 0.71$ , s.e. = 0.08), indicating that although discrimination was low in both groups, it was reliably higher for younger adults. The analysis of  $C$  indicated that  $C$  was significantly different from 0,  $F(3, 119) = 4.52 (0.10)$ , indicating a response bias to say PICTURE. There was a significant age effect,  $F(1, 116) = 12.31 (0.10)$  ( $M_{young} = 0.25$ , s.e. = 0.14,  $M_{old} = 0.96$ , s.e. = 0.14), signifying that older adults were more biased to say PICTURE than younger adults.

For SRJOSL items, the results followed the same pattern of results obtained for SRJOL items (means reported in Table 5). Sensitivity was significantly greater than 0 and younger adults had better recall sensitivity than older adults, where the age effect was significant,  $F(1, 59) = 6.20 (0.10)$  ( $M_{young} = 1.25$ , s.e. = 0.14,  $M_{old} = 0.76$ , s.e. = 0.14).  $C$  was significantly different than 0 overall, and the bias to answer PICTURE was carried by the older adult data, indicated by a significant age effect  $F(1, 59) = 5.53 (0.07)$  ( $M_{young}$

= 0.20, s.e. = 0.22,  $M_{old} = 0.93$ , s.e. = 0.22). The results suggest that younger adults had better sensitivity and less bias in responding than older adults.

## **Confidence Judgments**

### Associative Recognition Confidence

Analysis of the confidence measure was conducted by running a 2 X 2 X 2 (Age X Condition X Target) repeated measures ANOVA with mean confidence judgments (CJs) as the dependent variable. For ARJOL items (means in Table 4) a significant between-subject effect of age  $F(1, 116) = 30.29 (0.21)$ , and a significant within-subject effect of target type  $F(1, 116) = 20.30 (0.15)$  were found. Older adults were less confident in their memory for the word pairs than younger adults ( $M_{young} = 86.96$ , s.e. = 3.03,  $M_{old} = 63.40$ , s.e. = 3.03), and participants were more confident in their memory for text-picture pairs than text-sound pairs ( $M_{picture} = 76.83$ , s.e. = 2.13,  $M_{sound} = 73.54$ , s.e. = 2.21). For ARJOSL items (means in Table 4), a 2 X 2 (Age X Target) repeated measures ANOVA showed significant main effects for age  $F(1, 58) = 12.47 (0.18)$ , and target type  $F(1, 58) = 13.22 (0.19)$ . Once again, older adults were less confident in their target source memory ( $M_{old} = 68.89$ , s.e. = 3.65,  $M_{young} = 87.11$ , s.e. = 3.65), and confidence for pictures overall was higher than confidence for sounds ( $M_{picture} = 79.77$ , s.e. = 2.55,  $M_{sound} = 76.23$ , s.e. = 2.70).

Level of confidence was not affected by whether an item was judged with a JOL or JOSL. A 2 X 2 X 2 (Target X Judgment X Age) repeated measures ANOVA revealed no significant effects of judgment type,  $F(1, 58) = 0.006 (0.00)$  ( $M_{JOL} = 77.94$ , s.e. = 2.66,  $M_{JOSL} = 78.00$ , s.e. = 2.58).

### Source Recall Confidence

A 2 X 2 X 2 (Age X Condition X Target) repeated measures ANOVA with CJ on SRJOL items (see Table 4 for means) as the dependent variable indicated that confidence in SR of picture targets was significantly greater than recall confidence of sound targets,  $F(1, 116) = 65.23 (0.36)$  ( $M_{\text{picture}} = 79.65$ , s.e. = 1.96,  $M_{\text{sound}} = 72.71$ , s.e. = 2.10). A significant between-subject effect of age  $F(1, 116) = 22.29 (0.16)$  indicated that younger adults were more confident in their SR performance than older adults ( $M_{\text{young}} = 85.56$ , s.e. = 2.81,  $M_{\text{old}} = 66.81$ , s.e. = 2.81). These effects were also seen in CJs for SRJOSL (means reported in Table 4). There was a significant effect of age  $F(1, 58) = 6.25, (0.10)$ , and a significant effect of target type  $F(1, 58) = 30.33 (0.34)$ . Older adults were less confident than younger adults in their performance on SR ( $M_{\text{young}} = 83.43$ , s.e. = 3.44,  $M_{\text{old}} = 71.28$ , s.e. = 3.44), and both ages were more confident in SR for picture items than sounds ( $M_{\text{picture}} = 81.16$ , s.e. = 2.53,  $M_{\text{sound}} = 73.56$ , s.e. = 2.52).

Level of confidence in source recall was not affected by which type of judgment was originally made at study. A 2 X 2 X 2 (Target X Judgment X Age) repeated measures ANOVA showed that confidence for JOL judged items and JOSL judged items was not differentiated,  $F(1, 58) = 0.003 (0.00)$  ( $M_{\text{JOL}} = 77.40$ , s.e. = 2.49,  $M_{\text{JOSL}} = 77.36$ , s.e. = 2.43).

### **Prediction**

#### JOLs

To investigate if participants' judgments predicted which items they were more likely to recognize later gamma correlations between JOLs and memory performance on both memory tasks were computed as measures of resolution. For JOL judged items, a 2

2 X 2 (Target X Age X Condition) repeated measures ANOVA on both gammas for associative recognition and source recall (means in Table 4) was conducted. For the AR gamma, there was a significant main effect of age where younger adults had significantly higher resolution than older adults,  $F(1, 65) = 5.17 (0.07)$  ( $M_{\text{young}} = 0.47$ ,  $s.e. = 0.07$ ,  $M_{\text{old}} = 0.26$ ,  $s.e. = 0.06$ ). This finding is inconsistent with previous research which found no age effects of resolution. JOLs were not predictive of target SR and even though there was a significant effect of target type,  $F(1, 101) = 4.22 (0.04)$ , the effect is essentially non-interpretable since the gammas correlations are so close to 0 ( $M_{\text{picture}} = 0.08$ ,  $s.e. = 0.04$ ,  $M_{\text{sound}} = -0.03$ ,  $s.e. = 0.04$ ). As hypothesized, JOLs were significantly correlated with associative recognition performance and not predictive of target source recall. Younger adults were better able to predict which items they would recognize at test than older adults.

### JOSLs

The main research question of this study was whether the JOSL would be a predictive metacognitive judgment for source memory. For JOSL judged items, 2 X 2 (Target X Age) repeated measures ANOVAs on gammas correlations between JOSLs and SR, as well as JOSLs and AR (means in Table 4) was performed. Astonishingly, JOSLs did not significantly predict SR, but predicted AR. In SR, the mean gamma for the young was 0.10,  $s.e. = 0.07$ , and for the older adult data the mean was -0.10,  $s.e. = 0.07$ . The mean resolution for JOSLs and AR ranged between 0.53 for the young and 0.28 for the old. Hence, both JOLs and JOSLs predicted AR, but not SR. The levels of prediction were about the same magnitude for both AR and SR.

## **Confidence Judgment Gammas**

Participants were asked to rate how confident they were that the answer they provided for each item in AR and SR was indeed correct. I correlated these confidence judgments (CJs) and their actual recognition or recall, once again using gamma. The gamma correlations between CJs and AR performance are reported in Table 4. The gammas for SR are reported in Table 4 as well.

## Associative Recognition

The gamma correlations between CJs and AR for JOL judged items were analyzed using a 2 X 2 X 2 (Target X Age X Condition) repeated measures ANOVA. There was a significant effect of age where younger adults had better CJ resolution than older adults  $F(1, 72) = 7.29 (0.09)$  ( $M_{\text{young}} = 0.61$ ,  $s.e. = 0.08$ ,  $M_{\text{old}} = 0.34$ ,  $s.e. = 0.06$ ). The 2X2 (Age X Target) repeated measures ANOVA on the CJs and AR for JOSL judged items uncovered no significant effects of either age or target type. Although there seemed to be a large difference in the means ( $M_{\text{young}} = 0.61$ ,  $s.e. = 0.11$ ,  $M_{\text{old}} = 0.38$ ,  $s.e. = 0.07$ ), this difference was not significant,  $F(1, 31) = 2.851 (0.08)$  probably due to the large number of non-computable gammas (because of ceiling AR) in this sample that caused the total N of 60 to drop down to nearly half (33;  $n_{\text{young}} = 10$ ,  $n_{\text{old}} = 23$ ).

## Source Recall

Gamma correlations between CJs and SR were analyzed using a 2 X 2 X 2 (Target X Age X Condition) repeated measures ANOVA for JOL judged items. There was a significant target effect where resolution for picture items ranged from 0.51 ( $s.e. = 0.07$ ) to 0.66 ( $s.e. = 0.07$ ) for old and young, respectively, and resolution for sound items was reliably negative with values ranging from -0.33 ( $s.e. = 0.07$ ) to -0.41 ( $s.e. = 0.07$ )

for young and old respectively. For JOSL judged items, a 2 X 2 (Target X Age) repeated measures ANOVA showed a significant age effect,  $F(1, 49) = 42.29 (0.46)$ , where gammas for picture items ranged from 0.46 (s.e. = 0.12) to 0.52 (s.e. = 0.13) (young and old respectively), and for sound items confidence gammas ranged from -0.22 (s.e. = 0.09) to -0.46 (s.e. = 0.09) (young and old respectively). CJ resolution was higher for picture items and CJ gammas for sound items were reliably negative.

### **Strategy Reports**

The strategy report data from the computer task were analyzed using a 3 X 2 X 2 (Strategy X Age X Condition) repeated measures ANOVA with AR as the dependent variable and interactive imagery, sentence generation and rote repetition as the strategies of interest. There was no significant effect of strategy use on picture items,  $F(2, 176) = 2.98 (0.03)$ . This means that paired associate memory performance was not significantly affected by different strategy use. For sound items, there was a significant effect of strategy,  $F(2, 176) = 6.26 (0.07)$ , where recognition of text-sound pairs studied with rote repetition was worse than pairs studied with either interactive imagery or sentence generation.

SR and strategy were analyzed using a 3 X 2 X 2 (Strategy X Age X Condition) repeated measures ANOVA. For picture items, there was a significant interaction of strategy and age,  $F(1, 176) = 3.64 (0.04)$  (means and standard error reported in Table 6), where younger adults' source recall was better for items studied with sentence generation, and older adults' source recall was better for items studied with interactive imagery. For sound items, there were no significant effects of strategy use, indicating

that for sound targets, recall of sound targets was not differentiated by strategy use, within the respective age groups (Table 6).

Table 6 Strategy Report

	Interactive Imagery		Sentence Generation		Rote Repetition	
	Associative Recognition	Source Recall	Associative Recognition	Source Recall	Associative Recognition	Source Recall
<b>Young Adults</b>						
JOL Picture	0.96 (0.04)	0.75 (0.04)	0.94 (0.04)	0.80 (0.04)	0.89 (0.04)	0.78 (0.05)
JOL Sound	0.95 (0.04)	0.66 (0.05)	0.87 (0.04)	0.69 (0.05)	0.86 (0.04)	0.68 (0.06)
JOSL Picture	0.94 (0.04)	0.74 (0.04)	0.97 (0.04)	0.81 (0.04)	0.86 (0.04)	0.73 (0.05)
JOSL Sound	0.95 (0.04)	0.66 (0.05)	0.94 (0.04)	0.64 (0.05)	0.90 (0.04)	0.69 (0.06)
<b>Older Adults</b>						
JOL Picture	0.77 (0.04)	0.82 (0.04)	0.77 (0.04)	0.72 (0.04)	0.79 (0.05)	0.73 (0.05)
JOL Sound	0.78 (0.05)	0.37 (0.05)	0.78 (0.05)	0.49 (0.05)	0.65 (0.04)	0.51 (0.06)
JOSL Picture	0.68 (0.04)	0.79 (0.04)	0.72 (0.04)	0.70 (0.04)	0.67 (0.04)	0.72 (0.05)
JOSL Sound	0.70 (0.04)	0.52 (0.05)	0.72 (0.04)	0.51 (0.05)	0.64 (0.04)	0.57 (0.06)

Tallies from the JOSL post experiment questionnaire (JOSL-PEQ) were computed. Of the participants who filled out the questionnaire (n = 67), 95% reported use of some strategy to study the word pairs. Only 31% of participants reported using a strategy to study the source of the target word. Tallied responses to the first portions of questions 1 and 4 from the questionnaire (see Appendix A) are reported in Table 7.

Table 7 Was Strategy Used to Study Word Pairs/Source of 2<sup>nd</sup> Word?

	YES		NO	
	Word Pairs	Source	Word Pairs	Source
<b>Young Adults</b>	28	7	1	22
<b>Older Adults</b>	36	14	2	24
<b>Total</b>	64	21	3	46

## CHAPTER 4

### DISCUSSION

The results did not support the hypothesis that JOSLs are predictive of source recall. Instead, JOSLs, like JOLs, were predictive of associative recognition. The results did not show an age-related effect for JOSL resolution. Finally, the results did not support the hypothesis that making JOSLs would result in increased memory performance.

The finding that JOSLs were not predictive of future source recall is consistent with results from Carroll and colleagues (1999), and those reported in experiment 2 of the Lafferty manuscript (2001). One could argue from a cue-utilization perspective (Koriat, 1997) that participants were not effectively utilizing cues diagnostic to source recall in order to make their JOSLs. First, in the experiment, participants were given strategy instructions to study the word pairs, not source information. It is possible that participants in this study were biased to downgrade the importance of the source recall task and focus on associative memory as the primary task. A focus on associative recognition as the primary task might cause cues diagnostic of associative memory performance to be more accessible to participants overall. This is an issue in source tasks where item learning is a goal as well. Cook, Marsh, and Hicks (2006) found it was difficult to have above chance source discriminations for unrecalled targets in a cued learning task without specific encoding procedures. That is, without recollection of the target in cued-recall, source could not be specified unless familiarity was built up over multiple presentations of the items. Secondly, since all judgment prompts were cue alone, participants were possibly forced to engage in retrieval of the target on which to

base their JOSLs. ‘Noncriterial recollection’ refers to the recollection of details that are irrelevant to the task demands (see Parks, 2007; Toth & Parks, 2006; Yonelinas & Jacoby, 1996 for review). Participants may have contaminated their JOSLs by using information about item memory, that was ‘noncriterial’ or irrelevant to the JOSL part of the task. The finding that JOSLs were reliably predictive of associative recognition to the same degree as JOLs supports the reasoning that both judgments were based on the same kinds of cues. The cues, on which both judgments were based, were diagnostic of associative recognition as evidenced by the gammas.

Another argument for why JOSLs were not predictive of source recall in this experiment comes from the reality monitoring perspective (Johnson & Raye, 1981). One could argue that participants were confusing the constructed details from the mediator used to study the word pair with the actual source of the target. Unfortunately, the results of this experiment can not weigh in directly on this issue. On one hand, older adults recalled less picture targets studied with sentence generation or rote repetition than picture targets studied with interactive imagery. This suggests that use of a normatively ‘incompatible’ strategy translated into more source misattributions for older adults. This finding may be indirect support that the accuracy of the JOSL could have been impacted by participants confusing the modality of the mediator with the actual source of the target. On the other hand, younger adults recalled more picture targets studied with sentence generation than those studied with interactive imagery or rote repetition. This result goes against the reality monitoring explanation. For younger adults, encoding pictures with sentence generation may have resulted in a dual coding situation. Paivio (1991) argued that, “...verbal and imaginal components contribute to distinctive

encoding and efficient retrieval of information from memory” (p. 261). It seems that, for younger adults, the use of a normatively ‘incompatible’ strategy benefited memory. It is difficult to apply a reality monitoring explanation given these mixed results and the result that, for sound items, source recall was not affected by which strategy participants utilized.

An age-related effect in JOSL resolution was not found for source recall. Interestingly, there was an age-related effect in JOL resolution. Although evidence of age-related differences in metamemory has been found in confidence resolution (Kelley & Sahakyan, 2003), FOK ratings correlated with study time allocation (Souchay & Insigrini, 2004), and JOL resolution for pre-studied related items, and when a discrete rating scale was used (Hertzog et al, 2002), this finding was not expected as the general consensus has been that monitoring skills remain relatively stable across the lifespan and age differences in JOL accuracy are not typically found (Hertzog & Hultsch, 2000). Hertzog and Hultsch based their argument on data from several studies where the memory task was a recall task (where recollection is essential). The results from this study could be inconsistent with Hertzog and Hultsch because the item memory task was associative recognition (both familiarity and recollection contribute to performance). A contributing factor to the age effect comes from the idea that older adults were relying more often on familiarity of the cue over memory of the association (actual recollection) to make their predictions. One could argue that since associative recognition requires specific recollection to a larger degree than familiarity (not the other way around), older adults may have been operating more on cue familiarity at the time of judgment which did not match the processes required at test. Consider the following example. During

judgment (which is cue alone), an older adult may give an item a low JOL because the cue is less familiar. During a cued recall task, that same unfamiliar cue is presented again, and the older adult answers incorrectly (as expected based on the low JOL). During the associative recognition task, the older adult bases her answer on recollection of whether the words in the pair were studied together (rather than familiarity) and answers correctly. Even though older adults may have lower performance than younger adults in cued recall, JOL resolution is still comparable because older adults give low JOLs to items they, in fact, do not recall. The problem with associative recognition is that older adults (relying on familiarity) will give low JOLs to items that they do recognize, which decreases JOL resolution.

The hypothesis that making JOSLs would improve memory accuracy was not supported. Participants in the JOL/JOSL condition did not show an increase in the accuracy of their JOLs, or their performance on associative recognition or the source recall task. Source recall was above chance and comparable across conditions, while recall for picture items was equivalent across age groups. These findings indicate that though attending to source information did not improve the accuracy of JOLs or associative recognition, it was utilized effectively in the source recall task.

Stimulus characteristics (that is, whether a target was picture or spoken) resulted in differential effects in the data. Participants rated their memory for picture items (predicted and actual) higher than sound items. Generally speaking, memory for text-picture pairs and targets presented as pictures was much better than memory for spoken targets in almost every respect.

There was a reliably negative correlation of confidence judgments with sound target recall. A possible reason for this result comes from the finding of a response bias to say 'PICTURE'. Participants were largely overconfident for incorrectly recalled sound targets, i.e., identifying a target as being previously studied as a picture, when it was actually presented as a sound. Given the within task history of picture items being recalled more quickly and more often, participants may have been biased to say 'PICTURE' to ambiguous items when they should have engaged in a deeper search. Secondly, because the sound stimuli were less distinctive (same voice used within list), participants might not have been able to discriminate between correctly recalled sound targets and incorrectly recalled sound targets. What cues participants were relying on to make the confidence judgments to sound items remains unclear and is not readily evaluated in these data.

The results from this study are consistent with the idea that when making source attributions, individuals use flexible criteria that are prone to error and disruption (Johnson et al, 1993). Several studies have explored ways to improve source monitoring and in turn improve memory performance (Dodson & Schacter, 2001; 2002a; 2002b). The JOSL investigated in this study is part of an initiative to explore source monitoring from a metacognitive perspective that was different from the approaches previously used in the literature. It was hoped that this line of research would prove valuable to the field of cognitive aging by providing yet another way to look at monitoring and how humans handle source information as they age. In this study, orienting participants to source information (that was assumed to provide an added level of information) by having them make JOSLs did not have any effects on performance. Source information alone was not

enough to influence judgments made before test, increase memory, or impact the judgments made after participants were tested. These findings may suggest that, in everyday life, specific recall of source information may be less important than recall of the actual information. The rare finding of an age-effect of JOL resolution, and the new finding of picture/sound target effects in source recall, indicates that the results from this study point to further research that must be conducted.

Given the argument that participants may not have utilized source information and cues in ways that would be diagnostic of future source recall, a follow up study is suggested. At this point, Johnson et al's (1993) opinion that source judgments are more often made heuristically rather than as the outcomes of evaluative processes seems correct. It seems that participants need specific instruction to attend to, and utilize specific source information in making predictions, source discriminations and confidence judgments. Perhaps asking participants to forecast their source discriminations is likely to be unsuccessful unless specific encoding procedures geared at encoding distinctive information are employed at study and drawn upon during the time JOSLs are made. The next step is to conduct a manipulation where distinctiveness heuristic instructions are implemented at encoding, judgment, and test. Reformatting the JOSL prompt to show the target only may also minimize the AR cues that might be contaminating the JOSL. Presumably, by instructing participants to utilize source information will result in bolstering use of appropriate cues to make JOSLs, making them a more discriminative measure, and making them predictive of source recall.

## APPENDIX A

### JOSL POST EXPERIMENT QUESTIONNAIRE

1. Did you use strategies to learn the word pairs? If so, did these strategies change as you saw more pairs from the list? How so? Did the type of strategy you used depend on the type of pair you were studying (text-picture, text-sound)? How so?
2. Let's say you gave a word pair a high rating (I'm 80% confident I will remember the 2<sup>nd</sup> word of this pair). What reasons would typically cause you to be that confident?
3. Let's say you gave a word pair a low rating (I'm 20% confident I will remember the 2<sup>nd</sup> word of this pair). What reasons would typically cause you to be that confident?
4. We also asked you to remember the source of the 2<sup>nd</sup> word of the pair (picture or sound). Did you use any strategies to remember the source information? How so? Did the type of strategy you used depend on the type of pair you were studying (text-picture, text-sound)? How so?
5. We're interested in the accuracy of your ratings -- in other words, whether you made high ratings for items you actually remembered. Do you think you were accurate in your ratings before your memory was tested for the word pairs? Why or why not?
6. Do you think your ratings were more accurate after your memory was tested for the word pairs? Why or why not?

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