Chapter 6

Metacognitive Aspects of Implicit/Explicit Memory

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A widely held belief in the area of implicit/explicit memory research is that implicit memory is revealed when previous experiences facilitate performance on a task that does not require conscious or intentional or deliberate remembrance of those experiences, whereas explicit memory is revealed when performance on a task requires conscious, intentional, or deliberate remembrance of previous experiences (cf. Schacter, 1987). Thus formulated, a key distinction between implicit and explicit memory tasks hinges on whatever is meant by the conscious, intentional, or deliberate remembrance.

Wilson (1994) wrote, "Researchers in the tradition of metamemory and metacognition (e.g., Flavell, 1979; Nelson & Narens, 1990) were among the first to draw attention to the necessity of understanding the way in which meta-beliefs monitor and control nonconscious processing." Accordingly, it might be fruitful to inquire about the applicability of metacognition to the domain of implicit/explicit memory. For instance, *Do the metacognitive components that we and others have been investigating play some useful role in explaining the distinction between implicit and explicit memory?* We present a case here that they do. Because these components use only a portion of the properties of consciousness and awareness, it is natural to ask, *Are these metacognitive components sufficient for explicating the implicit/explicit distinction?* To the extent that they are not, *What other aspects of consciousness or awareness are needed?* For example, these metacognitive components do not utilize qualia—a concept of considerable importance in the philosophical analysis of consciousness. *Do researchers of implicit/explicit memory consider qualia to play an important role in their theories?* If additional components are needed for explanation of the implicit/explicit distinction, then we believe it is likely that such components would also likely be useful in expanding theories of metacognition. Another question of interest is, *What metacognitive components might be involved in both implicit and explicit memory tasks?* Whatever those metacognitive components are, they seem important to highlight just in case their role varies across implicit and explicit memory tasks.

This chapter begins with a brief overview of the metacognitive components that we and others have been investigating, and we show how the theoretical framework that we developed for organizing them can be expanded to accommodate theoretical concepts that others consider important for implicit/explicit memory, for example, the concept of "meta-awareness" from Dulany (1994). We then utilize metacognitive components derived from the framework to analyze a word-fragment completion task in terms of the implicit/explicit distinction. Next, two new experiments are reported that probe connections between metacognitive judgments and implicit/explicit memory during word-fragment completion. The chapter closes with some observations about how metamemory and implicit/explicit memory may be more fruitfully integrated.

A FRAMEWORK FOR METAMEMORY

Nelson and Narens (1990, 1994) introduced the framework in Fig. 6.1 to organize theoretical ideas inherent in their metamemory research and to integrate empirical findings from the literature that bear on metacognitive aspects of memory. Note that the monitoring processes at the top of the figure and the control processes at the bottom (for elaboration, see Nelson & Narens, 1990, 1994) are neither arcane nor artificial, but are directly analogous to the kinds of judgments and control processes that occur routinely in naturalistic learning situations, such as a student studying for and taking exams.

Figure 6.2 provides a theoretical perspective used by Nelson and Narens (1990, 1994) to integrate monitoring and control processes into systems for active learning. This perspective is based on a distinction between the *metalevel* and the *object level* and the flow of information between these levels that gives rise to *monitoring* and *control.* Nelson and Narens (1990) summarized this informational flow:

> The basic notion underlying control—analogous to speaking into a telephone handset—is that the metalevel *modifies* the object level, but not vice versa. In particular, the information flowing from the metalevel to the object level either changes the state of the object-level process or changes the object-level process itself. This produces some kind of action at the object level, which could be: (a) to initiate an action; (b) to continue an action

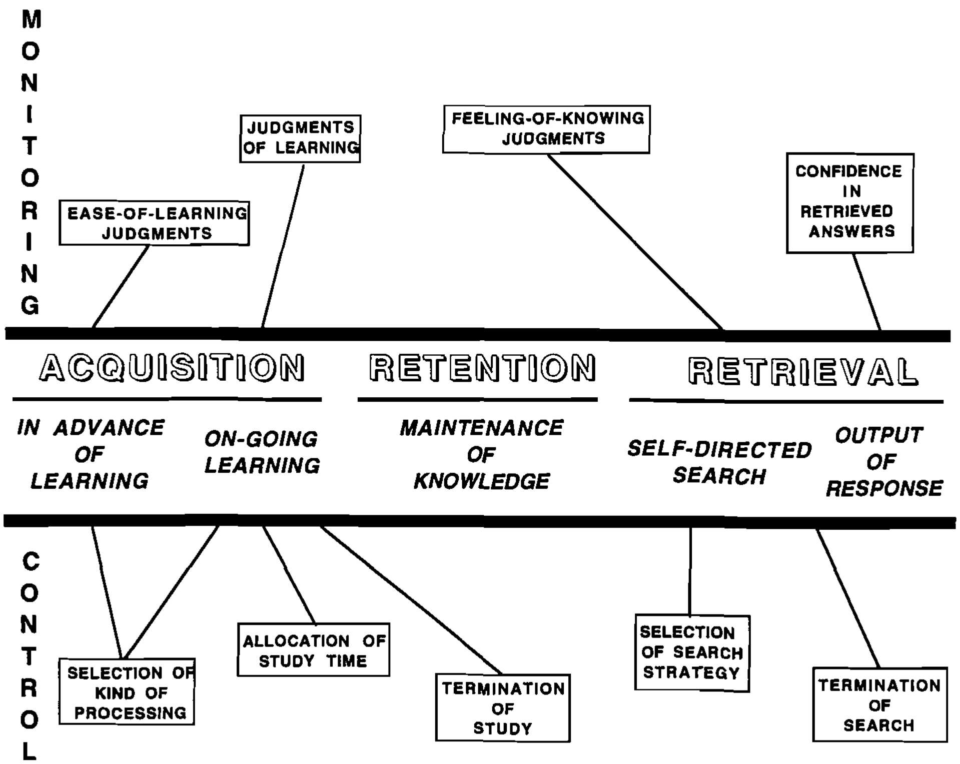

FIG. 6.1. Metacognitive framework. (For elaboration, see Nelson & Narens, 1990, 1994.)

> (not necessarily the same as what had been occurring because time has passed and the total progress has changed, e.g., a game player missing an easy shot as the pressure increases after a long series of successful shots); or (c) to terminate an action. However, because control per se does not yield any information from the object level, a monitoring component is needed that is logically (even if not psychologically) independent of the control component. The basic notion underlying monitoring—analogous to listening to the telephone handset—is that the metalevel *is informed by* the object level. (p. 127)

Nelson and Narens (1994) extended this perspective to more than two levels while keeping intact the key distinction between the meta- and object levels. The extended perspective appears to be applicable to some issues in implicit/explicit memory. For example, Dulany (1994) stated, "Implicit memory is no more 'remembering without awareness' than it is 'awareness without remembering'; it is evocative remembering and nonpropositional awareness without deliberative remembering." To better expound this and related ideas, Dulany developed a concept he called *meta-awareness*:

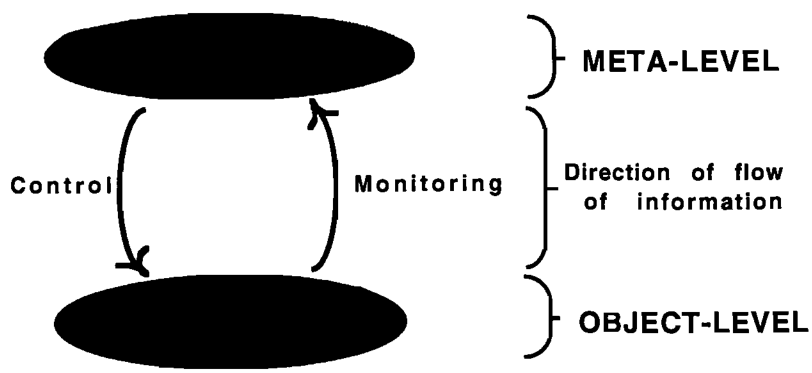

FIG. 6.2. A two-level system with monitoring and control. Adapted from Nelson and Narens (1990). © 1990 by Academic Press. Adapted with permission.

> Within a remembering episode, we may be aware of prior modes and contents of awareness [where S_{i1} is conscious state i at time 1]:
>
> $$\text{Aware}_2(\text{Aware}_1[S_{i1}]).$$
>
> By a nonconscious remembering operation, those prior conscious states, like any other natural event, may become objects of symbolic awareness. This amounts to a remembrance theory of second order (reflective) awareness.

In terms of our framework, a perspective similar to Dulany's is obtained by replacing awareness with monitoring and using a chain of three levels (see Fig. 6.3), resulting in a perspective that we call *metamonitoring*. This raises the following interesting question: What, if anything, of *scientific* (as opposed to *philosophical*) importance would be lost if Dulany's analysis is redone using metamonitoring instead of meta-awareness? Also notice that our three-level chain (or an extension of it) is bounded, not infinite (i.e., there is no problem of infinite regress).

Part of our approach to metamemory consists of using monitored object-level and other metalevel information as inputs to a decision rule R whose outputs are control processes. Awareness when attached to a monitoring process M will add nothing to this unless the attached awareness is being monitored by a higher metalevel which has a control process that also has an input into the decision rule R. We can imagine situations where the monitoring of M (i.e., metamonitoring) might be useful in the scientific analysis of memory—as in the situation described earlier by Dulany—and we are very interested in other aspects of awareness and consciousness that might also be involved in metalevel decision rules, but we have not yet found specific examples of the utility of such aspects for metamemory research.

Each of the stages in Fig. 6.1 can be refined (Nelson & Narens, 1990). A refinement of the "termination of study" occurs in Fig. 6.4. A major question

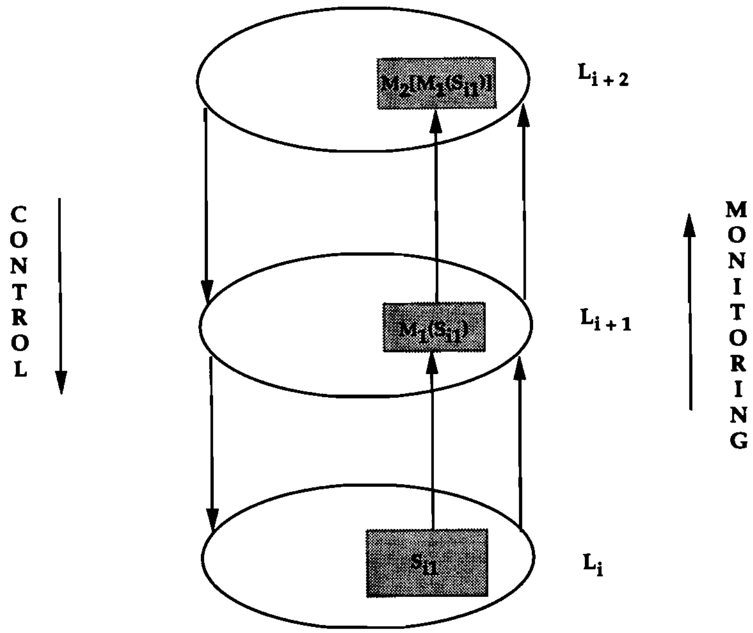

FIG. 6.3. A three-level metacognitive system, analogous to Dulany's (1994) notion of meta-awareness. Note that in representing Dulany's equation, level L_{i+1} is both a metalevel that receives monitored information about level L_i and simultaneously is an object level to L_{i+2}. For instance, L_{i+1} contains the monitored information about episode S_{i1} that occurs at L_i and itself is monitored during an explicit memory task occurring at L_{i+2}.

investigated in this chapter concerns components of this refinement; in particular, the accuracies of JOLs (Judgments of Learning) and FOK (Feeling of Knowing) for monitoring information that eventually is assessed by either an implicit or explicit memory task during word-fragment completion. Two experiments that bear on this and related issues are presented in the following.

WORD-FRAGMENT COMPLETION

Metacognitive Aspects of Retrieval

Metacognitive decisions are required for *explicit retrieval* during word-fragment completion, when the subject is attempting to retrieve a word from a recent study episode (e.g., Roediger, Weldon, Stadler, & Riegler, 1992). Figure 6.5, which for the purposes of this chapter may be considered as one kind of refinement of the "termination of search" stage in Fig. 6.1, portrays theoretical relationships among several of the metacognitive components

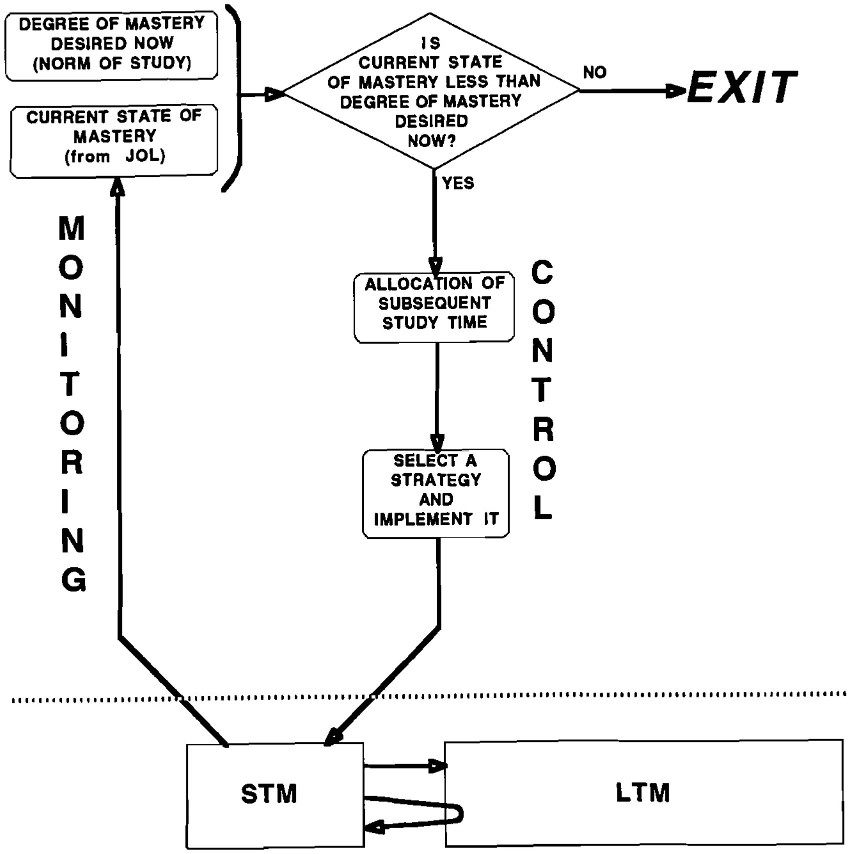

FIG. 6.4. An instantiation of a two-level metacognitive system for acquisition of information into memory. Adapted from Nelson and Narens (1990). © 1990 by Academic Press. Adapted with permission.

that can be activated during the retrieval portion of a word-fragment completion task for implicit/explicit memory. (A related figure providing a more complete analysis of retrieval of general information from long-term memory is available in Barnes, Nelson, Dunlosky, Mazzoni, & Narens, 1995.) In Fig. 6.5, presentation of the word fragment generates a mental image. This mental image may be an image of the presented word fragment, a word that completes the fragment, or some other extension of the word fragment. It is produced implicitly. A metacognitive confidence judgment occurs to evaluate whether the mental image is a possible answer, and if it is deemed a possible answer, then another metacognitive confidence judgment is made about whether it was an answer presented during study, and if it is so deemed, the possible answer is produced as an output. If the mental image is judged

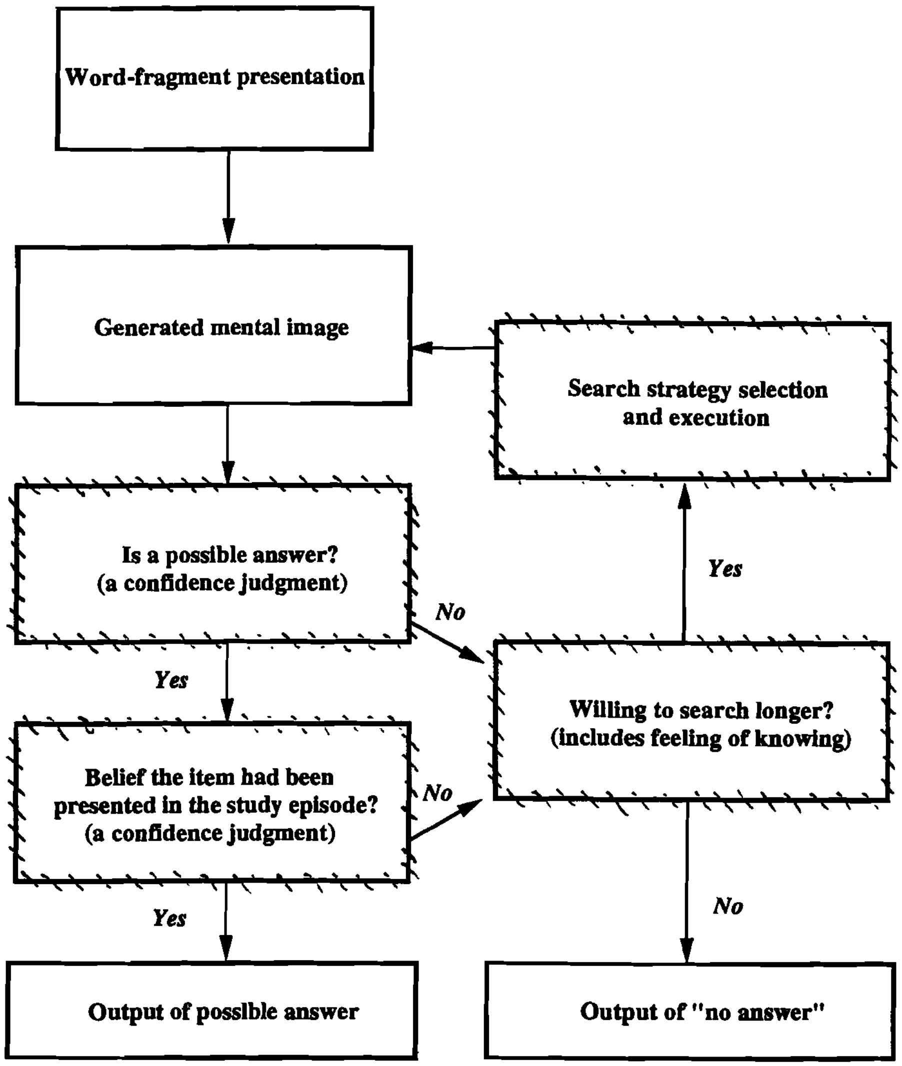

FIG. 6.5. A dynamic generation-recognition model containing metacognitive components (indicated by boxes with hatched borders) that is designed as a partial theoretical analysis of explicit retrieval during word-fragment completion. The primary modification needed for implicit retrieval during word-fragment completion is that the metacognitive belief that the item had been presented in the study episode is not utilized, and the search strategy (and its execution) may produce different cues to initiate the search.

to not be a possible answer, or if the possible answer is judged to not have been presented during prior study, then a metacognitive decision about whether to continue searching for the answer is made. In part, this metacognitive decision is based on the feeling of knowing. If it is negative, then a "no answer" response is produced. If it is positive, then a search strategy is selected and initiated. When initiated, this search generates a new mental image, and another cycle begins (see Fig. 6.5).

In *implicit retrieval* the subject attempts to retrieve a word that completes the fragment, without regard for whether the word occurred during a recent study episode (e.g., Roediger et al., 1992). We propose that the metacognitive decisions for implicit retrieval are qualitatively the same as for explicit retrieval except that (a) the stage of "did the possible answer occur during study" is eliminated, and (b) those subcomponents of the stage of "selecting and executing search strategies" that use aspects of the study episode are eliminated.

The metacognitive component in Fig. 6.5 of deciding whether a possible answer occurred during study is generally acknowledged by researchers of implicit/explicit memory as being an important distinguishing factor between implicit and explicit memory, with its presence indicating explicit memory. Thus in designing implicit memory tests, researchers often go to great lengths to avoid this decision, such as by instructing the subject to output the first completion that comes to mind—a strategy that in essence eliminates the stage of "did the possible answer occur during study." However, there is another component in Fig. 6.5 where a nonimplicit form of memory may be used to advantage. This is the stage of "selecting and executing search strategies." In that stage, the metacognitive subcomponents include strategies that use aspects of the study episode as cues for producing a mental image of the answer or part of the answer. Such subcomponents of nonimplicit memory are rarely discussed in the literature. We believe them to be of importance, because it is plausible that the utilization of the information contained in them may result in different processes/products of generating candidate words during retrieval; for instance, the "generation" component of Jacoby and Hollingshead's (1990) generation-recognition model may occur differently during implicit retrieval than during explicit retrieval.[1]

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[1]Research by Anderson and Pichert (1978), Bower and Mann (1992), and Gardiner, Craik, and Birtwhistle (1972) show that in other memory situations subjects can at the time of retrieval effectively use retrieved aspects of the study episode to help direct their memory search. Jameson, Narens, Goldfarb, and Nelson (1990) presented research in which subthreshold primes increase recall performance. However, due to the subthreshold nature of the primes, there are no aspects of the priming episode that could help in directed search. Interestingly enough, even though there is an increase in recall performance for primed items, there was no corresponding increase in metacognitive ratings for primed items.

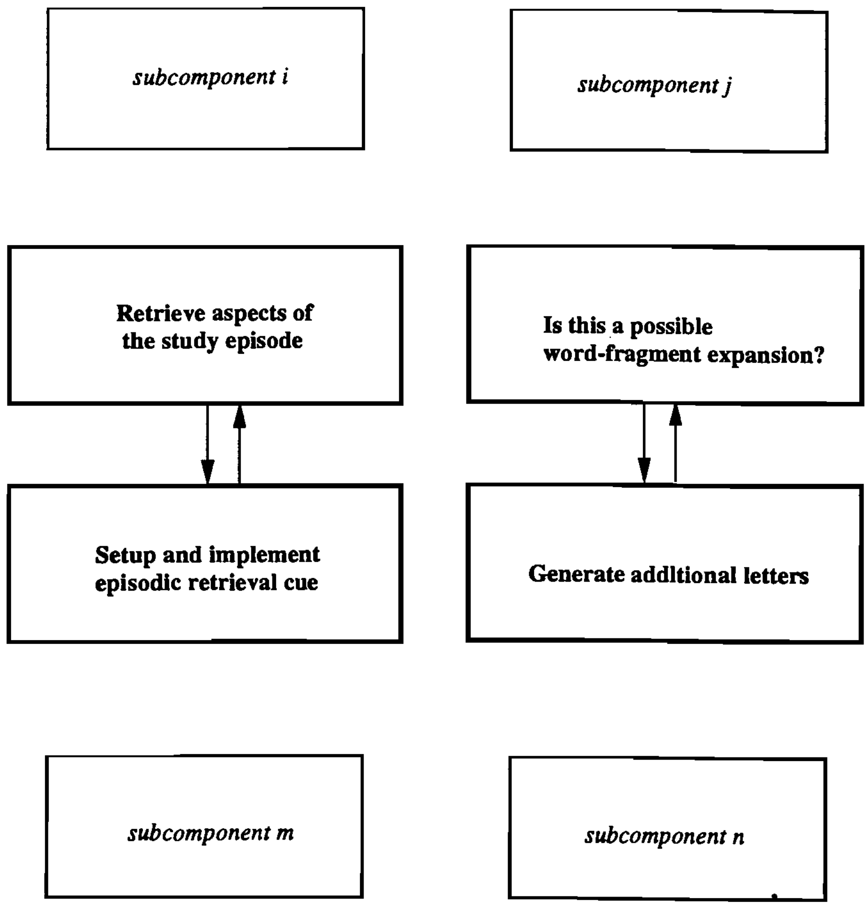

FIG. 6.6. Some potential subcomponents of the "search strategy selection and execution" stage of Fig. 6.5.

Figure 6.5 is our version of a generation-recognition model that stresses multiple cycles of generation. In it, the "generation" aspect comes from two sources: the word-fragment stimulus and the metacognitive component that selects and executes retrieval strategies. The latter component is refined in Fig. 6.6. The stages in Fig. 6.6 represent some metacognitive components that select or execute search strategies. Only four of these are described, and arrows representing flows of information between components other than these four are not included in the figure. The four described components divide into two kinds of metacognitive strategies for generation—a generation strategy that uses aspects of the study episode, and a generation strategy that does not use such aspects.

The issue of whether implicit and explicit retrieval instructions differentially affect the implicit metacognitive components discussed earlier is a sticky one. It appears to us that most researchers of implicit/explicit *assume* that they are not so affected. However, the issue needs empirical investigation. In general, we believe that any complete analysis of implicit/explicit retrieval during word-fragment completion will require empirical investigations of the aforementioned or similar metacognitive components.[2]

EXPERIMENTS

According to Vallone, Griffin, Lin, and Ross (1990):

> In self-prediction . . . people will be prone to make errors to the extent that they have incorrectly inferred details about the objective situations to be faced. . . . They also will be prone to show overconfidence to the extent that they express levels of confidence that make insufficient allowance for the possibility of erroneous inference or misconstrual. (p. 583)

Therefore, one hypothesis about explicit memory is the following: If subjects when making JOLs (in terms of predicting their subsequent retention performance on the recently studied item) are incorrectly inferring the nature of the retention test more for an upcoming implicit-memory test than for an upcoming explicit-memory test, then (a) the accuracy of their JOLs for predicting performance on one item relative to another should be lower in the case of an eventual implicit-memory test than an eventual explicit-memory test, and (b) their JOLs might display more overconfidence in the case of the implicit-memory test than in the case of the explicit-memory test. A similar prediction about the degree of JOL accuracy for one item relative to another (as quantified by the Goodman and Kruskal gamma correlation) can be derived from Patrick, Harbluk, and Lupker (1988), who suggested that metacognitive monitoring such as the feeling of knowing:

> May be based on partial conceptual or elaborative information about the unrecalled items (which is supposed to be the information tapped by explicit tests), instead of perceptual or data driven information (which is supposed to be the information tapped by implicit tests). If so, one would expect that

[2]As an example, consider an amnesic patient who displays impaired explicit memory but normal implicit memory. This may be due to either deficiencies in retrieving aspects of the study episode or deficiencies making accurate confidence judgments about whether the retrieved word appeared in the study episode or both.

the gamma correlations in the explicit condition should be higher than in the implicit conditions. (p. 5)

By contrast, another hypothesis, which can be derived from our metacognitive-aspects-of-retrieval model (Fig. 6.5), is that JOLs should be equally accurate for predicting upcoming implicit memory as for predicting upcoming explicit memory, unless the difference between the instructions for implicit versus explicit retrieval affects which of the studied items are retrieved. These and other hypotheses concerning implicit/explicit memory were examined in our two new experiments.

In accord with past research on implicit versus explicit memory, a word-fragment completion task was used in our experiments.[3] A prerequisite for assuming that the instructions at the time of the retention test are adequate for concluding that the investigation was of implicit versus explicit memory is that the earlier encoding of the items by semantic versus graphemic processing should not affect implicit memory but should affect explicit memory (i.e., the retrieval intentionality criterion in Schacter, Bowers, & Booker, 1989). Therefore we also included in our experimental design the independent variable of semantic versus graphemic processing during encoding of the items in the acquisition phase. Our experiments are modeled after the procedure in Roediger et al. (1992), and we thank Roddy Roediger for his helpful advice.

EXPERIMENT 1

Method

Subjects, Design, and Items. The subjects were 180 University of Washington undergraduates who participated for course credit. The design had one between-subjects variable with three groups (implicit, explicit-withhold, and explicit-guess during the retention test) and one within-subjects variable (half of the items were studied under semantic encoding instructions and the remaining half were studied under graphemic encoding conditions). The 136 items (68 being studied and 68 being nonstudied) were taken verbatim from the words and their corresponding fragments (71% of which had unique solutions in terms of the words they could give rise to) from Roediger et al. (1992, Appendix C). Items were randomly assigned anew for

[3]We used word-fragment instead of word-stem completion, because our design ideally required unique correct answers, and word-fragment completion yielded more cases with such answer patterns. Having unique correct answers eliminates the possibility that the JOL accuracy for items from an implicit test could be artifactually lowered by the subject producing a word that is a correct completion but did not occur in the study session.

each subject to study versus nonstudy and to semantic versus graphemic encoding.

Procedure. Subjects were run individually on Macintosh LC II computers, with the exception of the filler tasks (described later). The four distinct phases were: (a) semantic (or graphemic) encoding of words intermingled with JOLs, (b) graphemic (or semantic) encoding of words intermingled with JOLs, (c) filler tasks, and (d) fragment-cued recall. The presentation of semantic and graphemic encoding was counterbalanced for order; half of the subjects studied first under semantic encoding conditions and then under graphemic encoding conditions, and vice versa for the remaining subjects. The verbatim instructions for all phases of the experiment appear in the Appendix at the end of this chapter.

Semantic Encoding. Subjects saw each of 34 words singly at a 7-second rate and were instructed to think of the corresponding referent as each word appeared and to enter a pleasantness rating on a scale from 0 (*extremely unpleasant*) to 7 (*extremely pleasant*). Subjects were told to study each word so that they would be able to remember it later, but were not informed of the upcoming memory test.

Graphemic Encoding. Subjects saw each of 34 words singly at a 7-second rate and were instructed to count the total number of ascenders (e.g., b, d, f, h, k, l, and t) and descenders (e.g., g, j, p, q, and y) in each word and to enter an answer between 0 (no ascenders and no descenders) and 7. Subjects were told to study each word so that they would be able to remember it later, but were not informed of the upcoming memory test.

JOLs. Immediately after the offset of each study word, subjects made a JOL on the following scale: "How confident are you that you will be able to remember the word you just saw? (0 = definitely will recall, 20 = 20% sure, 40 . . . , 60 . . . , 80 . . . , 100 = definitely will recall)." All JOLs were self-paced. Subjects made JOLs alternately with rating the words by making the JOL for a given word immediately after the offset of that word and just before the onset of the next word.

Filler Task. For the 10-minute filler task, the subjects recalled as many U.S. states and capitals as they could for 6 minutes and then tried to solve some box problems for 3 minutes (with one minute for instructions and distribution of materials).

Fragment-Cued Recall. All 136 fragments were included in this phase. Of these fragments, half were portions (identical to those in Roediger et al., 1992) of words that had been studied and the other half were portions of nonstudied words. For each item, the corresponding fragment was displayed on the screen, and subjects were to fill it in with a word that completed the fragment. Subjects had 15 seconds to make a response. In the implicit group, subjects were told that they were going to solve a series of word fragment puzzles. They were instructed to type in the first word they could think of that turned the fragment into a word. In the explicit groups, subjects were told that they were taking a memory test for words seen earlier. They were also told that some of the words they would be tested on had not appeared during study. They were instructed to use the fragments as clues to help them remember the words they had seen during the rating phase. In the explicit-withhold group (modeled after Roediger et al., 1992), subjects were instructed to enter an answer only when certain it had actually appeared at study; if unsure about whether it had appeared at study, subjects were to omit the item. The instructions for subjects in the explicit-guess group (aka "inclusion group" in Jacoby's research) were identical to the explicit-withhold group, except that subjects were encouraged to enter a response even if they could not remember having seen the item at study.

Old/New Recognition and Confidence Judgments. During this phase, subjects saw 136 words (of which 68 were old words that had been studied, and the remaining 68 were new) from the items that completed the fragments from the fragment-cued recall test. The self-paced judgments consisted of a word followed by the prompt, "is this word old or new? ("O" = Old, "N" = New), followed by the prompt, "How sure are you that this word is old/new? (50% = it is equally likely that the word is either old or new, 60 = 60% chance word is old/new, 70 . . . , 80 . . . , 90 . . . , 100 = the word is definitely old/new)" so that the subjects could make confidence judgments about their old/new decisions. Subjects were informed just prior to this phase that half of the words they would judge had appeared during study, whereas the other half of the words had not, and they should therefore expect any given word to be either old or new with a likelihood of 50%.

Results and Discussion

Effect of Group on Baseline Completion (Nonstudied Words). The mean proportion of word-fragment completions on nonstudied items for the implicit, explicit-withhold, and explicit-guess groups was .29 (SEM = .01), .12 (SEM = .01), and .27 (SEM = .01), respectively. The groups were significantly different $F(2, 117) = 53.7$, $p < .01$. Paired comparisons revealed significant differences between the implicit and explicit-withhold groups $t(177) = 9.42$, $p < .01$ and between the explicit-withhold and explicit-guess groups $t(177) = 8.45$, $p < .01$, but not between the implicit and explicit-guess groups, $t(177) = .97$, $p = .33$. This pattern confirms that the instructions were effective, because subjects in the explicit-withhold group should withhold some percentage of the nonstudied items that they mistakenly believed may have been studied.

Effect of Semantic Versus Graphemic Processing. In the implicit group, the mean proportion of correct word-fragment completions was .54 (SEM = .02) for the semantically encoded items and .52 (SEM = .02) for the graphemically encoded items. This difference was not significant by a paired t-test $t(59) = 1.24$, $p = .22$. The mean word-fragment-completion performance in the explicit-withhold group was .54 (SEM = .02) for the semantically encoded items and .48 (SEM = .02) for the graphemically encoded items, respectively, which yielded a significant difference, $t(59) = 3.82$, $p < .01$. The mean word-fragment-completion performance for the explicit-guess group was .55 (SEM = .02) for the semantically encoded items and .50 (SEM = .02) for the graphemically encoded items, which yielded a significant difference, $t(59) = 2.74$, $p < .01$. Thus the retrieval intentionality criterion's prerequisite of a nonsignificant effect on implicit memory and a significant effect on explicit memory was satisfied.

Relative Accuracy of Item-by-Item JOLs. The mean levels of JOL accuracy for predicting subsequent memory performance on one item relative to another item (in terms of the Goodman–Kruskal gamma correlation; see Nelson, 1984, for rationale) for the implicit, explicit-withhold, and explicit-guess groups were .16 (SEM = .03), .23 (SEM = .03), and .17 (SEM = .03). These three means were not significantly different by a one-way ANOVA, $F(2, 176) = 1.40$, $p = .25$.

Absolute Accuracy of Item-by-Item JOLs. In contrast to the aspect of relative (i.e., one item relative to another) accuracy, we also analyzed absolute accuracy (i.e., cardinal aspect, aka calibration of overall predicted recall). Figure 6.7 shows the calibration for each group in terms of the mean percentage of correct word-fragment performance as a function of the predicted likelihood of being correct. Perfect predictive accuracy would yield a curve that is atop the main diagonal, and overconfidence is indicated by a curve that is below the main diagonal. As can be seen in both panels, there was no difference between the three groups in terms of calibration being systematically better for one group than another group, and there was no greater overconfidence in the implicit-memory group than in the two explicit-memory groups.

Old/New Recognition of Studied Versus Nonstudied Items. People's accuracy at judging whether the items had been studied versus nonstudied is shown for each of the three groups in Fig. 6.8. Notice that although people's recognition was substantial for discriminating studied items from nonstudied

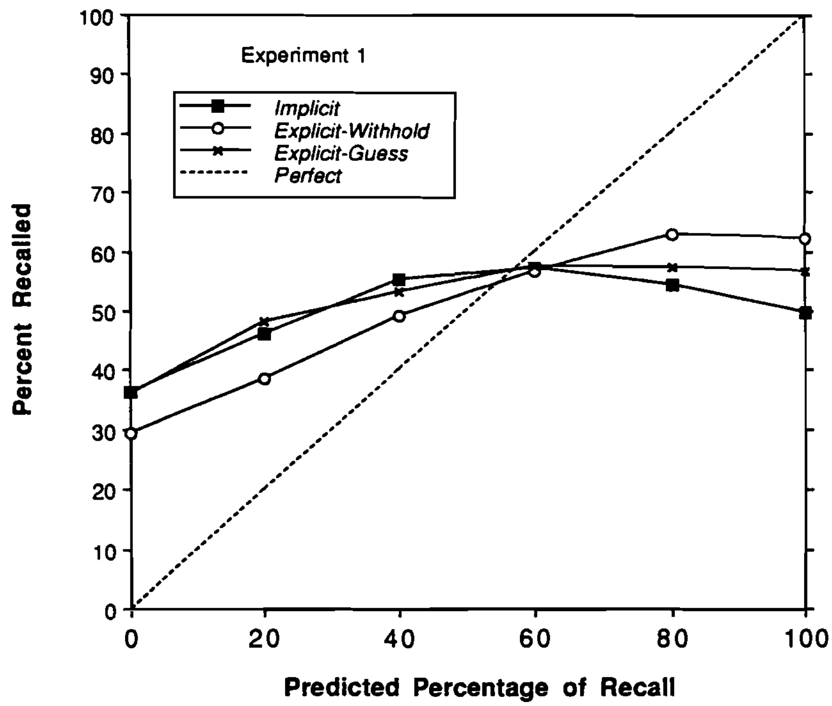

FIG. 6.7. Calibration curves for Experiment 1 showing the mean percent recalled as a function of the predicted percentage recall (from people's JOLs) for the implicit, explicit-withhold, and explicit-guess groups. The main diagonal is a reference line for perfect calibration.

items, their recognition was far from perfect. The probability of saying "studied" to items that had been studied (aka hit rate) was less than 1.0, but even more striking in terms of imperfect recognition, the probability of saying "studied" to items that had not been studied (aka false alarm rate) was substantially above zero. For instance, the explicit-withhold group believed that approximately 20% of the nonstudied items had been in the study episode. This indicates that the corresponding metacognitive component (see Fig. 6.5) contains a degree of inaccuracy for which theories of implicit/explicit memory somehow have to account.

Output of Items by the Explicit-Withhold Group During Word-Fragment Completion. If people in the explicit-withhold group do withhold all of the nonstudied items, then the probability of their completing a word fragment with a nonstudied word would be zero, regardless of whether they believe the item was studied or nonstudied. By contrast, if the decision to withhold is instead based entirely on the person's belief that the item was nonstudied (as suggested in Fig. 6.5), then the probability of outputting an item be-

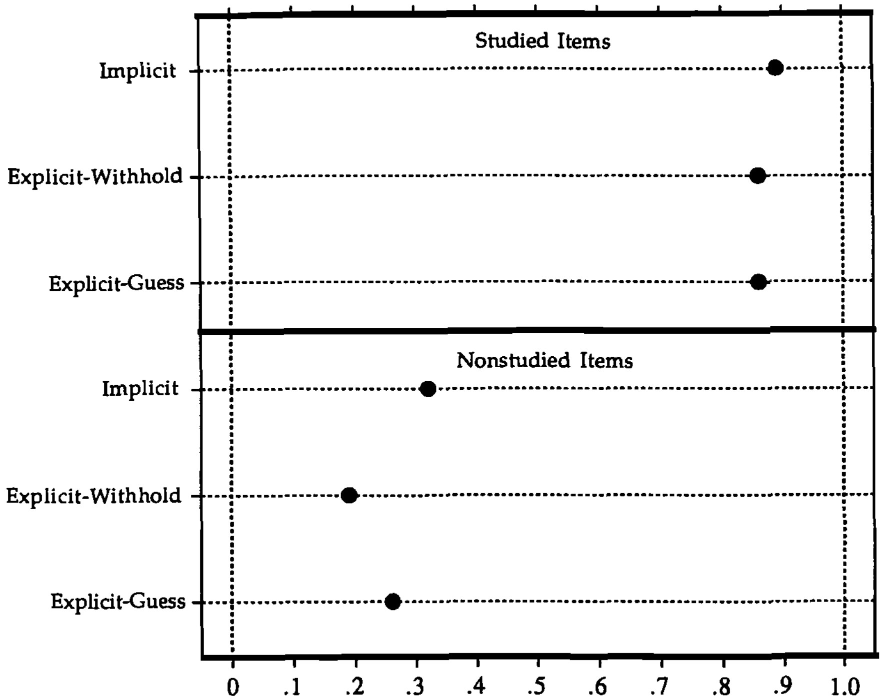

FIG. 6.8. A dot chart for Experiment 1 showing the mean probability that subjects said a given word had been studied (i.e., the mean probability that subjects believed they had seen the item during the study episode) for items that had been studied versus nonstudied by each group.

lieved to be nonstudied should be zero regardless of whether the item had/had not been in the study episode. The mean probability that people in the explicit-withhold group completed a word fragment is shown in Table 6.1 as a joint function of the state of the item during the acquisition episode (i.e., studied versus nonstudied) and of the person's belief that the item had been studied versus nonstudied (as assessed by the old/new recognition test described in the previous paragraph). None of the joint probabilities is exactly zero, and this disconfirms the simple decision rules shown earlier. However, as is also obvious in Table 6.1, the likelihood of an item being output (rather than withheld) depends not so much on whether the item had/had not been studied but rather is dominated by *the person's belief* about whether the item had/had not been studied; the need for postulating such a metacognitive component is particularly obvious from a comparison of the two cells on the main diagonal in Table 6.1. This is analogous to people's feeling of knowing being based less on the frequency of their previous recalls than on people's beliefs about the frequency of their previous recalls (see Nelson & Narens, 1990, Table 2).

TABLE 6.1
Probability of Outputting an Item in the Explicit-Withhold Group as a Joint Function of State of the Item (Studied/Nonstudied) and Belief About State of the Item (Experiment 1)

Belief About State of the Item	*State of Item During Acquisition Episode*	
	Studied	*Nonstudied*
"Studied"	.62	**.46**
"Nonstudied"	**.15**	.09

Note: SEM was less than or equal to .03 for every cell.

The likelihood of outputting (versus withholding) items was also examined as a function of people's confidence about their beliefs of whether the items had been studied/nonstudied. For every pair of items in which one item was believed to have been studied (hereafter, "studied") and the other item was believed to have been nonstudied (hereafter, "nonstudied") and in which one of the two items was output whereas the other item had not been output, we computed the probability that the item that was judged to be the "studied" item was also the item that was output. The mean probability, designated P(output more likely for Item J than Item K | belief of being in study episode is greater for Item J than Item K), is shown in Fig. 6.9 as a function of people's confidence in those beliefs. (Note: Only those pairs wherein the degree of confidence was equal for the two items—i.e., confidence that Item J had been studied and confidence that Item K had not been studied—are included in the analysis.) Several findings are noteworthy. First, the implementation in the explicit-withhold group of a metacognitive rule for outputting all "studied" items and withholding all nonstudied items is not all-or-none (see the earlier discussion of Table 6.1), but rather now can be seen to depend greatly on people's degree of confidence in their beliefs that the items were/were not in the study episode. The likelihood of outputting the "studied" item rather than the "nonstudied" item increased as people's confidence in those beliefs also increased; put another way, the likelihood of outputting "nonstudied" items increased as people's confidence in their beliefs about study/nonstudy decreased toward 50%. Second, relative to the two other groups (whose curves are included in Fig. 6.9 for purposes of comparison), the explicit-withhold group made greater utilization of their confidence, such that the curve is steeper for the explicit-withhold group than for either of the other two groups. Third, when people's confidence in their beliefs about particular items was 100%, the explicit-withhold group's performance was quite close to what would be expected if they were using the simple rule of always outputting the items they believed were more likely to have been studied. Thus the evidence confirms the notion that meta-

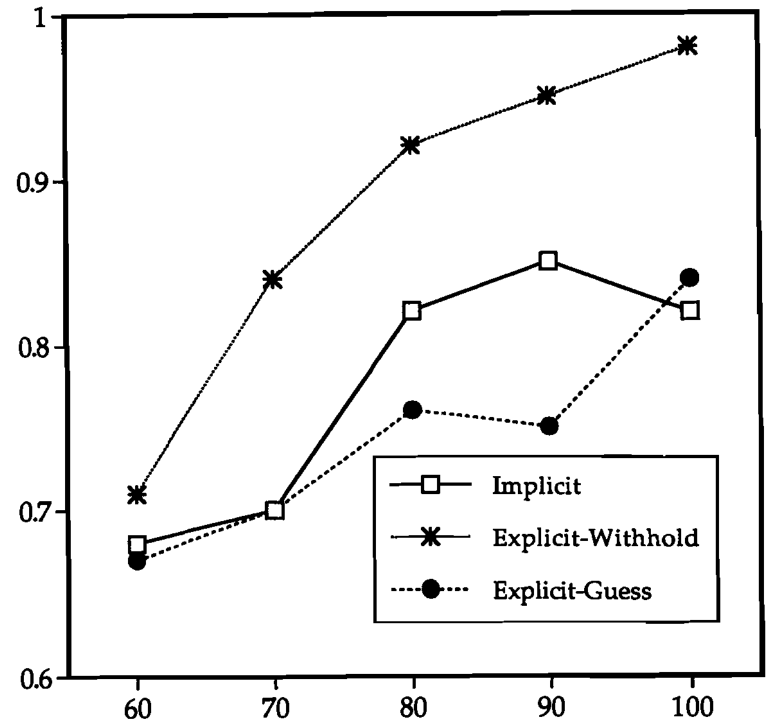

FIG. 6.9. Mean P(output more likely for Item J than Item K | belief of being in study episode is greater for Item J than Item K) as a function of people's confidence in their beliefs about whether the items had been studied/nonstudied for each group in Experiment 1. See text for elaboration.

cognitive confidence is a component that is useful in the theoretical framework depicted in Fig. 6.5.

EXPERIMENT 2

A recent innovation in metamemory that produces large effects on metacognitive monitoring accuracy is to delay the JOL for at least 30 seconds after study of the item (Nelson & Dunlosky, 1991). Although the psychological mechanisms are not yet known for this delayed-JOL effect (in terms of the advantage in JOL accuracy for delayed JOLs over immediate JOLs), we wanted to see if the delayed-JOL effect might interact with the test conditions of implicit versus explicit memory. However, delayed JOLs require a cue so that the person will know which prior item is being judged, and if the cue is the entire item (i.e., stimulus and response), then the delayed-JOL effect is reduced or eliminated (Dunlosky & Nelson, 1992). Therefore, we used the word fragment itself as the cue for the JOLs. As in Experiment 1, the instructions at the time of the retention test were manipulated so that the retention test was either implicit or explicit memory.

Method

The method was identical to that for Experiment 1 except for the following changes:

1. Delayed JOLs were included, and the kind of JOL (Immediate or Delayed) was blocked as a within-subjects variable. Half of the subjects made immediate JOLs on half of the items prior to making delayed JOLs on the remaining items, and vice versa for the other subjects. Thus 17 items were randomly allocated anew for each subject into each of the following four categories: (a) semantic study with immediate JOLs, (b) graphemic study with immediate JOLs, (c) semantic study with delayed JOLs, and (d) graphemic study with delayed JOLs.

When making immediate JOLs, subjects studied words in the first two aforementioned categories. Following the presentation of each item, subjects made an immediate JOL (i.e., JOLs were intermingled with study, and a JOL was made for each item). After the subjects studied and made JOLs for those items, they studied and made delayed JOLs for the remaining items. When making delayed JOLs, subjects studied words in the third and fourth categories, followed by a delayed JOL on each of those items. Delayed JOLs were made such that there were always at least five intervening items (either words being studied or other JOLs) between the study of an item and its delayed JOL.

The inclusion of the kind of JOL as a blocked variable necessitated a more complex counterbalancing scheme. As in Experiment 1, semantic versus graphemic encoding during study was blocked. The two variables (kind of JOL and kind of encoding) were simultaneously counterbalanced for order. A given subject studied and made JOLs in one of the following eight sets (with each row corresponding to one ordering of conditions), where "S" indicates words semantically encoded, "G" indicates words graphemically encoded, an "(I)" indicates immediate JOLs, and a "(D)" indicates delayed JOLs:

(I) S,G (D) G,S
(I) G,S (D) S,G
(I) S,G (D) S,G
(I) G,S (D) G,S
(D) S,G (I) G,S
(D) G,S (I) S,G

(D) S,G (I) S,G
(D) G,S (I) G,S

Thus, a subject in the first set of conditions (i.e., the first of these eight rows) would study words under semantic instructions and make immediate JOLs, and then study words under graphemic instructions and make immediate JOLs; then the person would study words under graphemic instructions, make delayed JOLs on those words, study words under semantic instructions, and make delayed JOLs on those words. Each of these eight sets constituted a separate subgroup of subjects, and this was crossed with the between-subjects independent variable (kind of retention test). Thus, the counterbalancing scheme required a total of 8 sets * 3 kinds of test = 24 subgroups. Three subjects were run in each subgroup, for a total of 24 * 3 = 72 subjects. Subjects were assigned to subgroups by a block randomization design in which the $i + 1$th subject in a given group was not run until the ith replication was complete (i.e., each run of 24 subjects constituted one replication).

2. The JOLs were made differently in Experiment 2 than in Experiment 1. Experiment 2 used the fragment cue as the cue for the JOL (whereas in Experiment 1 the cue for the JOL was the offset of the just-studied word). For each JOL, the subject was presented with the fragment corresponding to the word seen at study, along with the query, "How likely are you to recall the word you saw at study so as to complete this fragment into that word (0 = definitely will recall, 20 = 20% sure, 40 . . . , 60 . . . , 80 . . . , 100 = definitely will recall)."

Results and Discussion

Effect of Group on Baseline Completion. The mean proportion of word-fragment completions for nonstudied words was .31 (SEM = .02), .14 (SEM = .02), and .31 (SEM = .02) for the implicit, explicit-withhold, and explicit-guess groups, respectively. These three means are significantly different; $F(2, 69) = 18.31$, $p < .01$. Paired comparisons showed that the implicit and explicit-guess groups did not significantly differ, $t(69) = 0$, but the implicit group differed significantly from the explicit-withhold group, $t(69) = 5.24$, $p < .01$, but the explicit-guess group differed significantly from the explicit-withhold group, $t(69) = 5.24$, $p < .01$. Thus, participants in the implicit and explicit-guess groups had higher baseline completion than participants in the explicit-withhold group, thereby confirming that the instructions were effective, as in Experiment 1.

Effect of Semantic Versus Graphemic Processing. In the implicit group, the mean probability of correct word-fragment-completion performance was .66 (SEM = .03) for the semantically encoded items and .63 (SEM = .02) for the graphemically encoded items. This difference was not significant by a paired t test, $t(23) = .90$, $p = .38$. The mean word-fragment-completion performance in the explicit-withhold group was .61 (SEM = .04) for the semantically encoded items and .51 (SEM = .04) for the graphemically encoded items, which was a significant difference, $t(23) = 2.76$, $p < .05$. The mean word-fragment-completion performance for the explicit-guess group was .64 (SEM = .02) for the semantically encoded items and .61 (SEM = .03) for the graphemically encoded items, which was not significant $t(23) = .97$, $p = .34$. These three pairwise comparisons yielded only partial confirmation of the retrieval intentionality criterion. The presence of the word-fragment cues for the JOLs may have partially attenuated the different effects of the encoding instructions on the various kinds of retention tests.

Relative Accuracy of Item-by-Item JOLs. The mean JOL accuracy (in terms of mean gamma) for the implicit, explicit-withhold, and explicit-guess groups were .62 (SEM = .04), .63 (SEM = .04) and .52 (SEM = .04). These three means were not significantly different by a one-way ANOVA $F(2, 67) = 2.27$, $p = .11$. Notice that the mean gammas were nearly identical for the implicit and explicit-withhold groups, even though other differences between those two groups satisfied the retrieval intentionality criterion.

A more fine-grained breakdown of JOL accuracy (in terms of mean gamma) for kind of JOL by kind of encoding is shown in Table 6.2. Four one-way ANOVAs were performed to determine the effect of group on each of the following dependent variables: (a) accuracy for immediate JOLs after semantic encoding, (b) accuracy for delayed JOLs after semantic encoding, (c) accuracy for immediate JOLs after graphemic encoding, and (d) accuracy for delayed JOLs after graphemic encoding. For the delayed JOLs on semantically encoded items, the effect of groups was significant, $F(2, 64) = 4.08$, $p < .05$. Pairwise comparisons showed that the only significant pairwise comparison was between the explicit-withhold group and the explicit-guess group, $t(64) = 2.84$, $p < .01$. The paired comparison between the implicit and explicit-withhold groups was not significant, $t(64) = 1.73$, $p > .08$, and the pairwise comparison between the implicit and explicit-guess groups was not significant, $t(64) = 1.19$, $p = .24$. Because the aforementioned pattern of significance for delayed JOLs on semantically encoded items would be impossible for population means and therefore probably represents a power problem in (at least) one of the comparisons, it will not be interpreted further but rather is left as a topic for future research. For the immediate JOLs on semantically encoded items, for the immediate JOLs on graphemically encoded items, and for the delayed JOLs on graphemically encoded items, the effect of group was not significant, $F < 1$. Thus, as in Experiment 1, there was no systematic disadvantage in JOL accuracy for memory predictions that were corroborated by implicit-memory tests as compared with explicit-memory tests.

TABLE 6.2
Mean JOL Accuracy as a Function of Kind of Encoding (Semantic Vs. Graphemic) and Kind of JOL (Immediate Vs. Delayed) Between JOLs and Word-Fragment Completion in Experiment 2

	Condition			
	Semantic		*Graphemic*	
	Immediate JOLs	*Delayed JOLs*	*Immediate JOLs*	*Delayed JOLs*
Group				
Implicit	.27 (.12)	.76 (.05)	.37 (.12)	.76 (.09)
Explicit-Withhold	.29 (.10)	.90 (.03)	.32 (.12)	.81 (.04)
Explicit-Guess	.34 (.07)	.68 (.06)	.37 (.09)	.75 (.04)

Note. SEM is in parentheses.

Absolute Accuracy of Item-by-Item JOLs. The calibration curves comparing absolute accuracy for three groups are shown in Fig. 6.10 (immediate JOLs) and Fig. 6.11 (delayed JOLs). As in Experiment 1, there was no systematic difference between the three groups in the absolute accuracy of their predictions (i.e., closeness to the main diagonal of perfect prediction), and there was no evidence of greater overconfidence in the implicit-memory group than in the explicit-memory groups.

Old/New Recognition of Studied Versus Nonstudied Items. People's accuracy at judging whether the items had been studied versus nonstudied is shown in Fig. 6.12 for each of the three groups. As in Experiment 1, although people's recognition was substantial for discriminating studied items from nonstudied items, their recognition was imperfect—for instance, the probability of saying "studied" to items that had not been studied (aka false alarm rate) was substantially above zero. This represents additional confirmation that the metacognitive confidence judgments postulated in Fig. 6.5 contain some inaccuracy, which should be taken into account by theories of implicit/explicit memory.

Output of Items by the Explicit-Withhold Group During Word-Fragment Completion. The mean probability that people in the explicit-withhold group completed a word fragment is shown in Table 6.3 as a joint function of the state of the item during the acquisition episode (i.e., studied versus nonstudied) and of the person's belief that the item had been studied versus nonstudied (as assessed by the old/new recognition test described in the previous paragraph). As in Experiment 1 (Table 6.1), the likelihood of an item being output depends not so much on whether the item had/had not been studied but rather is dominated by *the person's belief*

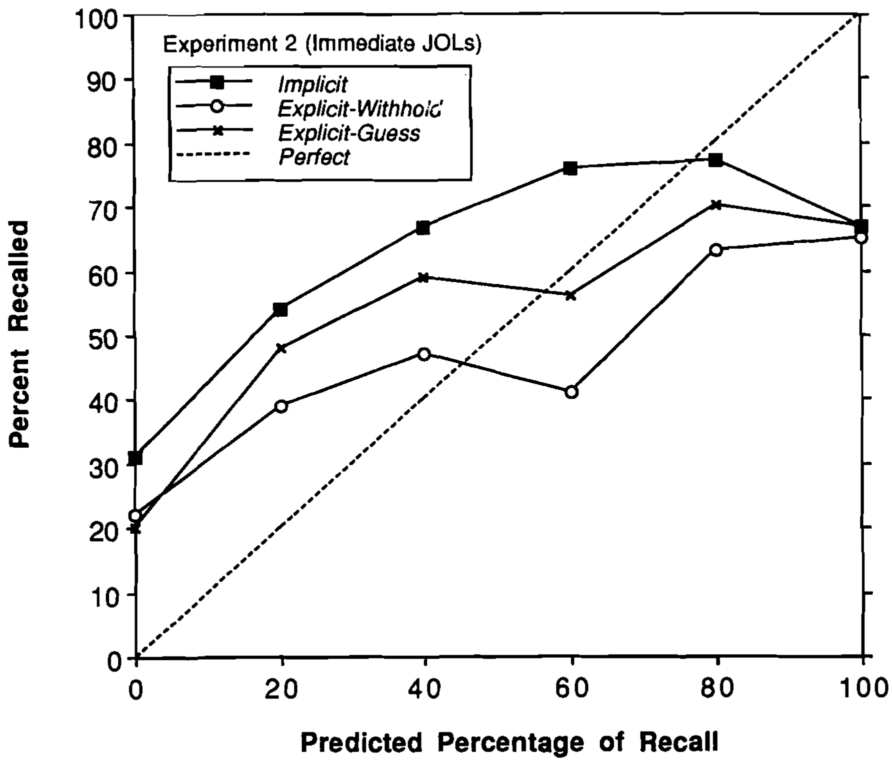

FIG. 6.10. Calibration curves for Experiment 2 showing the mean percent recalled as a function of the predicted percentage recall (from people's immediate JOLs) for the implicit, explicit-withhold, and explicit-guess groups.

about whether the item had/had not been studied. Note that these findings emerged in post hoc analyses that were conducted after the data were collected in both experiments; future research may want include an additional group in which the person's beliefs are assessed at the time of (and in place of) the word-fragment completion in the present groups.

The mean P(output more likely for Item J than Item K | belief of being in study episode is greater for Item J than Item K) is shown in Fig. 6.13 as a function of people's confidence in those beliefs. As in Experiment 1 (Fig. 6.9), the implementation of the explicit-withhold people's metacognitive rule for outputting all "studied" items and withholding all "nonstudied" items is not all-or-none, but instead increased as people's confidence in those beliefs increased. Also, the explicit-withhold group made greater utilization of their confidence than did the two other groups, although the difference between the groups was not as great as in Experiment 1 (e.g., one inversion occurs in Fig. 6.13). Finally, as in Experiment 1, when

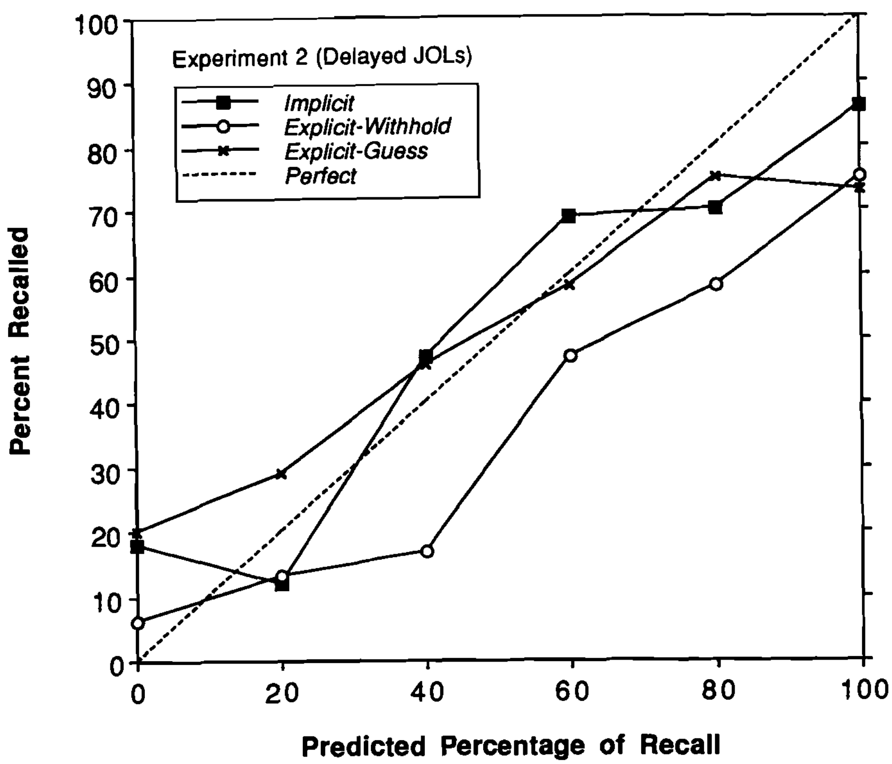

FIG. 6.11. Calibration curves for Experiment 2 showing the mean percent recalled as a function of the predicted percentage recall (from people's delayed JOLs) for the implicit, explicit-withhold, and explicit-guess groups.

people's confidence in their beliefs about particular items was 100%, the explicit-withhold group's performance was almost perfectly compatible with a simple rule of always outputting the items they believed were more likely to have been studied. Thus the evidence from both experiments confirms the important role of metacognitive confidence that was postulated in our theoretical framework (Fig. 6.5).

Related Research Involving the Feeling of Knowing

Patrick et al. (1988) reported that feeling-of-knowing accuracy at predicting subsequent word-stem completion for previously nonrecalled words was equally accurate for word-stem completion following implicit retrieval instructions versus explicit retrieval instructions. This finding is also in accord with the idea that metacognitive monitoring is tapping information in memory whose retrieval may not differ substantially after implicit-memory versus explicit-memory instructions.

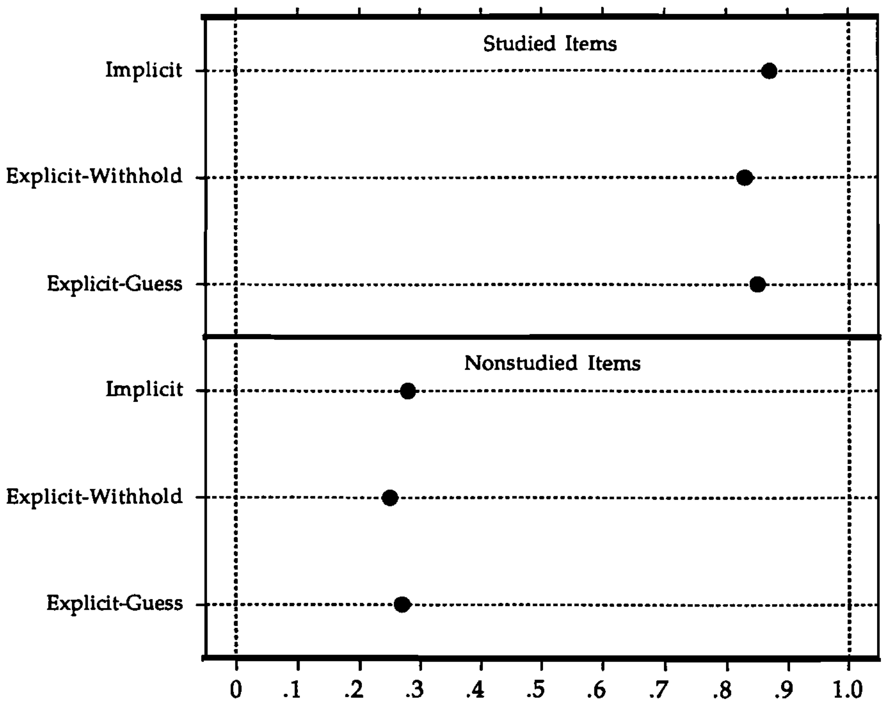

FIG. 6.12. A dot chart for Experiment 2 showing the mean probability that subjects said a given word had been studied (i.e., the mean probability that subjects believed they had seen the item during the study episode) for items that had been studied versus nonstudied by each group.

TABLE 6.3
Probability of Outputting an Item in the Explicit-Withhold Group as a Joint Function of State of the Item (Studied/Nonstudied) and Belief About State of the Item (Experiment 2)

Belief About State of the Item	*State of Item During Acquisition Episode*	
	Studied	*Nonstudied*
"Studied"	.73	**.55**
"Nonstudied"	**.17**	.11

Note. SEM was less than or equal to .06 for every cell.

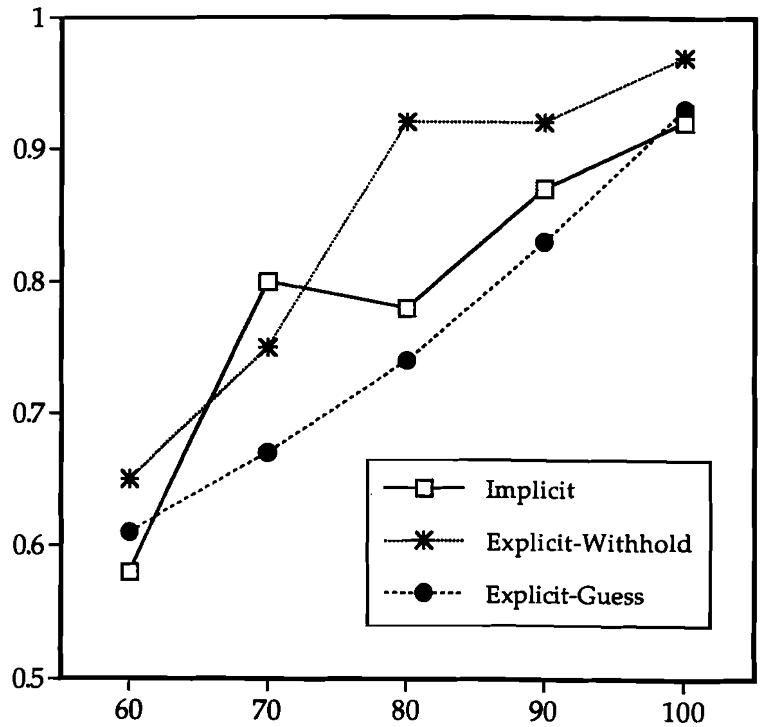

FIG. 6.13. Mean P(output more likely for Item J than Item K | belief of being in study episode is greater for Item J than Item K) as a function of people's confidence in their beliefs about whether the items had been studied/nonstudied for each group in Experiment 2. See text for elaboration.

A Methodological Consideration

Researchers of implicit/explicit memory need to deal with the possibility that in the explicit-withhold condition used by us and others (e.g., Roediger et al., 1992; also see Jacoby & Hollingshead, 1990), the withholding of responses arises not from simply one factor (e.g., "conscious awareness") but rather from several factors. In terms of our retrieval model, the following three factors involved in the decision about whether or not to output a retrieved response seem particularly relevant:

1. The subject's tacit assumptions about what is most important. For instance, in terms of payoffs, what is the cost of outputting a nonstudied word, and what is the cost of withholding a studied word? Or alternatively, what is the reward for withholding a nonstudied word and what is the reward for outputting a studied word? These payoffs can be systematically manipulated as is common in yes/no psychophysical experiments, where

the probability of withholding a retrieved word could then be computed. In contrast, most implicit/explicit memory paradigms have *assumed* the conditions of explicit guess (wherein penalty = 0) or explicit withhold. In the explicit-guess condition, the probability of withholding a retrieved word is assumed to be 0. We see no problem with this assumption. However, in the explicit-withhold condition, the probability of withholding, w, is sometimes assumed to be 1. Perhaps instead it should be assumed to be somewhere along almost the full range of the probability scale; namely, $0 < w \leq 1$.

2. The accuracy of recognizing that a retrieved word had previously appeared in the study episode (i.e., old words).

3. The accuracy of recognizing that a retrieved word had not previously appeared in the study episode (i.e., new words).

Notice that the second and third factors here need not be the same; for example, in our two experiments, the subjects were more accurate at recognizing that the studied words had been studied (with probability = .95) and less accurate at recognizing that the nonstudied words had not been studied (with probability = .70). This distinction is analogous to the distinction between the feeling of knowing and the feeling of not knowing in Nelson and Narens (1990).

Also notice that this formulation bears some similarities to the *general* model of signal detection (see Nelson, 1987) wherein there are (*i*) two distributions (corresponding here to a distribution of nonstudied words and a distribution of studied words) that vary in terms of the familiarity/probability of the word as having been in the study episode and (*ii*) the placement of the criterion for outputting a word as having been in the study episode (i.e., the placement of the criterion for the output decision in terms of the word being old). Accordingly, and analogous to the usual signal-detection view, failures to output studied items in the explicit-withhold condition can occur either because the distributions of studied and nonstudied words are not sufficiently separated (e.g., the average familiarity is too similar for the two distributions) or because although the distributions are widely separated the subject chooses to place his or her decision criterion for outputting too high (e.g., so as to withhold items that had not been studied).

Similar to the situation in psychophysics, researchers of implicit/explicit memory need to develop models of withholding the output of presumably nonstudied items (ideally without making arbitrary, untested assumptions about the form of the underlying distributions). We anticipate that several metacognitive components (e.g., placement of the decision criterion for outputting a response as shown in Fig. 6.5, which in turn may be based on a metacognitive evaluation of the payoffs that correspond to withholding studied versus nonstudied items) will play an important role in such models.

CONCLUSIONS

Both metacognitive and implicit/explicit theorists use higher level cognitive processes in the theoretical foundations of their respective subareas. In our own metacognitive theorizing, we have tried to avoid the temptation of using phenomenologically and philosophically rich concepts such as consciousness, awareness, intentionality, and reflexivity. Instead, we have tried to limit ourselves to using only what seem (at least to us) to be the relevant aspects of those richer concepts that are embodied in metacognitive monitoring and control. For example, where some theorists have invoked consciousness or awareness, perhaps instead (meta-) monitoring may suffice; where some theorists have invoked reflexivity, perhaps instead the idea that the metalevel contains an imperfect model of part of the object level may suffice, and so on. Such a limited reductionist approach to higher level cognitive processes may be advantageous for several reasons, not the least of which is that it can be applied to machines as well as to people, thereby potentially extending the reach of psychological theories, hopefully without sacrificing any aspect of consciousness that is scientifically necessary to account for the available data. The extension of scientifically sound psychological principles to machines seems to us to be a potential strength, not a weakness.

We described a partial theoretical task analysis of the word-fragment-completion task, wherein metacognitive components from earlier theoretical formulations played a major role. In our theoretical analysis, the primary difference between implicit and explicit memory performance during word-fragment completion is attributed entirely to two distinct kinds of metacognitive components, one involving metacognitive monitoring (aka recognition of the source of the retrieved item) and its effect on the metacognitive decision to output an answer, and the other involving the metacognitive choice of cues (and metacognitive strategies using aspects of the study episode) to influence the generation of retrieved candidates for an answer in the word-fragment-completion task. We conducted two new experiments that combined standard implicit/explicit memory instructions with standard assessments of metacognitive monitoring and control. Those experiments yielded several findings that can be accounted for by theoretical mechanisms already available in recent theories of metacognitive monitoring and control but that might otherwise be puzzling for a nonmetacognitive theory of implicit/explicit memory. For instance, the output/withholding of answers in an explicit-withhold condition is only partially related to whether the items had/had not been included in the study episode; instead, it is more highly related to whether the person metacognitively believes that the items had/had not been studied, albeit still an imperfect relation. However, the relation between the output/withholding of answers and the person's metacognitive belief about whether the items had/had not been studied will become nearly perfect when the person's metacognitive confidence in that belief increases toward subjective certainty. We suggest that the aforementioned metacognitive components (or their equivalents) are necessary to account for those findings. It appears to us that performance in an implicit/explicit memory task is analogous to what chemists conceptualize as a compound (as opposed to a mixture). If this is so, there may be strong bonds between metacognitive and memory aspects of performance that would be of interest both to metacognitive and implicit/explicit memory researchers. We consider our analysis to be a first step in this direction.

ACKNOWLEDGMENTS

This research was supported by NIMH grant R01–MH32205, a career development award (K05–MH1075) from the NIMH, and an Alexander von Humboldt senior scientist award to the third author. Portions of the research were conducted while the third author was at the University of Washington. Send correspondence to Thomas O. Nelson, Psychology Department, University of Maryland, College Park, MD 20742–4411.

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APPENDIX: INSTRUCTIONS FOR EXPERIMENTS 1 AND 2

In this experiment, we are interested in collecting norms about the characteristics of words for future psycholinguistic research. You will be making ratings that will contribute to these norms in the various word rating tasks that follow.

Semantic Instructions: You are going to rate a series of words for pleasantness. As each word appears on the screen, think about the real world object it represents, and rate it for pleasantness on a scale of 0 (extremely unpleasant) to 7 (extremely pleasant). For example, if you see the word "platypus", you should think of a platypus and then decide whether a platypus is pleasant or not. If a platypus is extremely pleasant, you should assign a rating of 7. If you think a platypus is extremely unpleasant, you should assign a rating of 0. As you rate the words, you should study them carefully. For each word that appears, you will have 7 seconds to study it and make a rating. The word will always stay on the screen for 7 seconds, whether you type in an answer early or not. If you don't make a rating within 7 seconds, the word will disappear.

Graphemic Instructions: You are going to see a series of words for which you are going to count the number of ascending and descending letters. Ascending letters are letters that have lines or "parts" protruding upward from the letter (e.g., b,d,f,h,k,l,and t). Descending letters are letters that have lines or "parts" that protrude downward from the letter (e.g., g,j,p,q, and y). The word "platypus" has two ascenders (l and t) and three descenders (two p's and a y). This word therefore contains a total of five ascenders and descenders, and would therefore receive a rating of 5. The word "college" has 2 ascenders (two l's) and one descender (the g). It would therefore receive a rating of 3. The letters c, o, and e are neither ascenders nor descenders and therefore don't count toward the rating. You should always enter a rating between 0 and 7, since there will always be between 0 and 7 ascenders and descenders for any given word. As you rate the words, you should study them carefully. For each word that appears, you will have 7 seconds to study it and make a rating. The word will always stay on the screen for 7 seconds, whether you type in an answer early or not. If you don't type in an answer within 7 seconds, the word will disappear. As before, you will also be asked to make memory judgments about the words that you study. You should follow the same procedure here as before. Note: _After_ the subject finishes here, she is instructed to go across the hall to see the experimenter for further instructions.

JOLs: You will also be asked to make memory judgments about the words that you study. For example, if you study and make a rating for the word "platypus", you will be asked to make a judgment about whether you will be able to remember that the word "platypus" was on the list you are studying and rating. You will make these judgments on a percentage scale (0 = definitely will not recall, 20 = 20% sure, 40...,60...,80...,100 = definitely will recall). If you think you definitely will be able to the word "platypus", you should assign a rating of 100. If you think you definitely will not be able to remember the word "platypus", you should assign a rating of 0. There's no need to rush in making your judgments; you can take as much time as you need here. Type in your judgment, and then press the return key to continue. If you have any questions, please ask the experimenter now. Note: Prompt on screen will say: "How confident are you that you will be able to remember the word you just saw? (0 = definitely will not recall, 20 = 20% sure, 40...,60...,80...,100 = definitely will recall).

Implicit Test: You are going to see a series of word fragment puzzles. When you see the fragment, type in the first word you think of that turns the fragment into a word (e.g., if you saw "-ezza----", then you would be correct if you typed in the word "mezzanine"). It is important that you type in the FIRST WORD THAT COMES TO MIND. A given word that first comes to mind may or may not come from the list of words you studied earlier; just ignore that fact, because we don't care about whether or not it was on the list. All we care about is that you should BE SURE to enter the very first word you think of that completes the fragment. Don't think about the words you just studied; instead, think only about what word will complete the fragment and AS SOON AS YOU THINK OF an answer that will complete the fragment, type it into the computer. Thus your job is to type into the computer the first word you think of that will turn the fragment into a word. You will have 15 seconds to figure out each puzzle; after that time the fragment will disappear.

Explicit-Withhold Test: You are going to take a memory test for words seen earlier. The word fragments you will see on the screen are clues to help you remember the words you saw at study. Many of the fragments you will see do not refer to previously studied words; you should leave these fragments blank. DO NOT GUESS at a word that completes the fragment unless you are SURE that the word was on the list you recently studied. Enter a guess ONLY if you are certain it was on the list you just finished studying. For example, if you see the fragment "-ezza----", you should type in the word "mezzanine" if and ONLY IF you remember having seen the word during study. It is important that you enter a response ONLY when you are sure it was on the list you studied; if you are not sure, DON'T TYPE ANYTHING IN. You will have 15 seconds to enter each answer, after that time the fragment will disappear.

Inclusion (Explicit-Guess) Test: You are going to take a memory test for words seen earlier. The word fragments you will see on the screen are clues to help you remember the words you saw at study. Many of the fragments you will see do not refer to previously studied words; but even though you didn't see the item you should still try to complete the fragment whenever you can. Thinking back to the study list will often help you to complete a given fragment, but still feel free to take a guess at every item, whether it was on the study list or not. You should always try to guess; the computer will not penalize you for incorrect guesses, so if you have any guess at all, please type it in response to the fragment as long as it turns the fragment into a word. For example, if you see the fragment "-ezza----", you should type in the word "mezzanine" regardless of whether or not you remember having studied the word in the list you saw earlier. You will have 15 seconds to enter each answer, after that time the fragment will disappear.

Confidence Judgments: Half of the words you will see you have previously studied; the other half of the words will be entirely new. Note therefore that for any given word that you see, there is a 50% chance that the word is old, and a 50% chance that the word is new. For each word that you see, you should first determine whether the word is old or new. A word is considered old if you saw it during study, and new if you did not see it during study. Following this judgment, you will make a confidence rating on a percent scale to indicate how sure you are that the word is old or new. Note that a 50% rating would indicate that you think it is equally likely that the word is old or new, and a 100% rating would indicate that you are absolutely sure the word is old(new). You will make these judgments on the following scale: (50 = it is equally likely that the word is either old or new, 60 = 60% chance word is old/new, 70...,80...,90...,100 = the word is definitely old/new).

The instructions for Exp. 2 were the same except for the following changes.

1) Delayed judgments of learning were included in experiment 2. Thus, type of judgment (Immediate or Delayed) was added as a within-subjects independent variable. The two types of judgments were presented in blocks.

2) The JOLs in experiment 2 were made differently. Experiment 2 used a fragment cue in the prompt to the subject. For each JOL, the subject was presented with a word fragment corresponding to a word seen at study together with the following query: "How likely are you to recall the word you saw at study so as to complete this fragment into that word (0 = definitely will not recall, 20 = 20% sure, 40...,60...,80...,100 = definitely will recall)."

JOL instructions for immediate blocks: You will also be asked to make memory judgments about the words that you study. For this section of the experiment, you will make a memory judgment on each word IMMEDIATELY after studying that word. For example, if you study and make a rating for the word "platypus", you will immediately be asked to make a judgment about whether you will be able to recall the word you saw at study so as to complete the word fragment "pl-t-pu-". You will make these judgments on a percentage scale (0 = definitely will not recall; 20 = 20% sure, 40...,60...,80...,100 = definitely will recall). If you think you definitely will be able to complete the word fragment "pl-t-pu-" to make the word "platypus", you should assign a rating of 100. If you think you definitely will not be able to complete the word fragment "pl-t-pu-" to make the word "platypus", you should assign a rating of 0. There's no need to rush in making your judgments; you can take as much time as you need here. Type in your judgment, and then press the return key to continue. If you have any questions, please ask the experimenter now.

JOL instructions for delayed blocks: You will also be asked to make memory judgments about the words that you study. For this section of the experiment, you will make memory judgments AFTER you have studied all of the words. For example, if you study and make a rating for the word "platypus", you will later be asked to make a judgment about whether you will be able to recall the word you saw at study so as to complete the word fragment "pl-t-pu-". You will make these judgments on a percentage scale (0 = definitely will not recall, 20 = 20% sure, 40...,60...,80...,100 = definitely will recall). If you think you definitely will be able to complete the word fragment "pl-t-pu-" to make the word "platypus", you should assign a rating of 100. If you think you definitely will not be able to complete the word fragment "pl-t-pu-" to make the word "platypus", you should assign a rating of 0. There's no need to rush in making your judgments; you can take as much time as you need here. Type in your judgment, and then press the return key to continue. If you have any questions, please ask the experimenter now.