26 Measuring Recollection: Strategic versus Automatic Influences of Associative Context

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ABSTRACT There has been much recent interest in the finding of dissociations between performance on indirect and direct tests of memory. Indirect tests (e.g., word-stem completion) are said to primarily reflect automatic or unconscious uses of memory, whereas direct tests (e.g., cued recall) primarily reflect strategic or consciously controlled uses of memory. Rather than identifying processes with tasks, as is done by use of the contrast between indirect and direct tests, I (e.g., Jacoby 1991) have used a "process-dissociation procedure" to separate the within-task contributions of consciously controlled and automatic uses of memory. I describe advantages of the process-dissociation procedure over standard direct tests as a means of measuring recollection. Because of its failure to distinguish between automatic and strategic uses of memory, reliance on standard, direct tests is shown to produce serious errors in conclusions that are drawn. I propose a distinction between strategic and automatic influences of associative context, and report two new experiments to show the utility of that distinction. As will be discussed, the strategic/automatic distinction is important for answering questions about the effectiveness of providing environmental support to aid the performance of memory-impaired individuals.

26.1 INTRODUCTION

How should one measure an amnesiac's ability to recollect memory for a prior event? An obvious means of measuring recollection would be to question the person directly about memory for the event; for example, a test of cued recall might be used. However, there are problems for measuring recollection in that way. To illustrate, consider difficulties for interpreting an amnesiac's performance on a test of recall cued by presentation of word stems. Suppose that amnesiacs were presented with a long list of words that they were told to remember, and then memory was tested by providing word stems that were to be used as cues for recall of the words presented earlier (e.g., mot___ as a cue for recall of *motel*). To measure memory, the probability of completing stems with old words is compared with the base rate probability of completing those stems. A measure of base rate is gained by presenting stems that can be completed only with words not presented earlier.

Experiments using these sorts of procedures have shown that amnesiacs' recall performance is sometimes nearly as good as that of subjects with normal functioning memory (Graf, Squire, and Mandler 1984; Warrington and Weiskrantz 1974). Consequently, it might be concluded that given word stems as cues, amnesiacs preserve an almost normal ability to recollect memory for

a prior experience (Warrington and Weiskrantz 1974). However, amnesiacs might achieve their high level of cued recall performance by a means other than recollection. They may complete word stems with the first word that comes to mind without being aware that their completions are the words that they were instructed to recall. Indeed, amnesiacs' cued recall performance sometimes does not differ greatly from what would be observed if they were given an indirect test of memory.

For an indirect test, people are not asked to report on memory for an event as they would be for a direct test, such as a test of recognition memory or recall. Rather, they engage in some task that can indirectly reflect memory for the occurrence of that event. Word stem and fragment completion tasks are among the most popular indirect tests of memory (Warrington and Weiskrantz 1974; Tulving, Schacter, and Stark 1982; Graf and Mandler 1984). Dissociations between performance on direct and indirect tests supply examples of effects of the past in the absence of remembering (Richardson-Klavehn and Bjork 1988; Hintzman 1990). Some of the most striking examples of dissociations come from the performance of patients suffering a neurological deficit. Korsakoff amnesiacs, for example, show near-normal effects of memory in their performance of a stem completion task, although their performance on direct tests of memory is severely impaired (for reviews, see Ostergaard and Jernigan, n.d.; Shimamura 1986; Moscovitch, chap. 25, this volume).

The problem for gaining an accurate measure of recollection (a strategic, consciously controlled use of memory) is that performance of a direct test may be contaminated by automatic influences of the sort reflected by performance on indirect tests of memory. Automatic influences of memory increase the probability of correct guessing. This informed guessing inflates estimates of recollection and may be largely responsible for accurate memory reports produced by amnesiacs (Gabrieli et al. 1990). Guessing could be discouraged by instructions, but it is unlikely that it could be fully eliminated. Rather than attempting to eliminate guessing, it would be better to measure its effects.

How should one correct for informed guessing on a direct test so as to gain an accurate measure of recollection? One answer to that question is to measure recollection as the difference between performance on a direct test and that on an indirect test of memory. For example, stem-completion performance might be subtracted from recall cued with word stems to gain a measure of recollection. However, that solution is unlikely to be satisfactory. Performance on indirect tests is sometimes contaminated by strategic uses of memory and so cannot be treated as a pure measure of automatic influences of memory (Richardson-Klavehn and Bjork 1988). Another problem for measuring recollection and automatic influences with different tasks is that processes may be qualitatively different across tasks. The issue here is something like the commonplace belief that people express what they "truly believe" when drunk. It is possible that what people believe when drunk is qualitatively different from what they believe when sober. Similarly, the automatic influences revealed by an indirect test may be different from those that are in play on a direct test of memory.

Rather than identify processes with tasks, as is done by use of the contrast between indirect and direct tests, I have used a "process-dissociation procedure" to separate the within-task contributions of consciously controlled and automatic uses of memory (Jacoby, 1991). Elsewhere we (e.g., Jacoby and Kelley 1991; Jacoby et al. 1992) have written much about the advantages of the process-dissociation procedure over indirect tests as a means of investigating automatic influences of memory. Here, I change focus by describing the advantages of the process-dissociation procedure over the use of direct tests as a means of measuring recollection.

Reliance on direct tests of memory to measure recollection fails to separate strategic and automatic influences of memory and, consequently, can lead to erroneous conclusions. Failure to distinguish between automatic and strategic influences might account for the disarray in the literature concerning the effects of some variables on performance of direct tests. I present evidence to illustrate problems for interpreting performance on direct tests of memory. After describing advantages of the process-dissociation procedure, I propose a distinction between strategic and automatic influences of associative context and report new experiments to show the utility of that distinction.

26.2 MEASURING RECOLLECTION

The problem of correcting measures of recollection for guessing is as important for measuring normal memory as for measuring the memory performance of amnesiacs. It is classic test theory that motivates the common practice of correcting for guessing by subtracting the probability of false recall from the probability of correct recall or, for measuring recognition memory performance, subtracting false alarms from hits (see Kintsch 1970 for a discussion of high-threshold models). Similar to classic test theory, we assume that guessing is independent of true remembering (recollection). Unlike classic test theory, we assume that memory influences guessing. That is, guessing is informed by automatic influences of memory.

When Recollection is Zero

The first case that I consider is one in which the process-dissociation procedure shows recollection to be zero, and the absence of recollection could not be detected by use of either classic test theory or signal detection theory. After describing an example to show the use of those standard means of correcting for guessing, I describe the process-dissociation procedure.

In an experiment done by Jacoby, Toth, and Yonelinas (experiment 1b, 1993), people studied a set of words under conditions of full or divided attention and were later given the first three letters of the words as cues for recall. Subjects in a full-attention condition were told to read the words aloud and remember them for a later test of memory. Subjects in a divided-attention condition read aloud the same list of words while simultaneously engaging in a listening task. For the listening task, a long series of numbers was presented,

and subjects were to indicate when they heard a sequence of three odd numbers in a row (e.g., 3 9 7). Subjects were told that the task of reading words aloud was designed to interfere with performance on the listening task; no mention was made of the fact that subjects' memory for the read words would later be tested. By confounding attention condition with the deletion of instructions to remember, we hoped to eliminate the possibility of later recollection in the divided-attention condition so as to mimic results one would expect to be produced by amnesia (Craik 1982).

For an inclusion test (later contrasted with an exclusion test), a list of word stems was presented, and subjects were instructed to use each stem as a cue for recall of an earlier-presented word that could be used to complete the stem. If their attempt at recall was unsuccessful, they were to complete the stem with the first word that came to mind. That inclusion test is the same as a standard test of cued recall with instructions to guess when recollection fails. Within the test list were some stems that could be completed only with a new word. Completion of those stems served as a measure of base rate or "false recall." A standard means of correcting cued recall performance for guessing is to subtract the probability of false recall from that of correct recall (Weldon, Roediger, and Challis 1989).

Results showed that cued recall performance in the divided-attention condition was poorer than that in the full-attention condition (.62 versus .46). However, in the divided-attention condition, the probability of completing a stem with an old word was well above base rate (.46 versus .35). Should it be concluded that dividing attention did not fully eliminate the possibility of later recollection, or does the above-base-rate level of performance in the divided-attention condition only reflect guessing informed by automatic influences of memory? Neither classic test theory nor signal detection theory (Swets, Tanner, and Birdsall 1961) helps to answer that question because neither distinguishes between recollection and automatic influences of memory.

The process-dissociation procedure can be used to show that dividing attention during study reduced later recollection to zero and left only automatic influences of memory. An important difference between recollection and automatic influences of memory is that recollection affords a level of strategic, conscious control over responding that is not afforded by automatic influences. Suppose that for an exclusion test, subjects were instructed to complete stems with words that were not presented earlier. For that test, recollection would serve to exclude earlier-presented words as completions for word stems, an effect opposite to that for the inclusion test. To the extent that subjects recollected earlier-presented words, they should be more likely to complete stems with those old words when trying to (inclusion test) than when trying not to (exclusion test) respond with old words. That is, recollection can be measured as the difference between performance in the inclusion and exclusion test conditions, a measure of control. In contrast to recollection, automatic influences of memory are assumed not to support such selective

responding. Automatic influences of memory act to increase the probability of completing stems with old words regardless of whether an exclusion or an inclusion test is given.

Subjects in the experiment described were given an exclusion test as well as an inclusion test. For the exclusion test, they were instructed to use the stems as cues for recall of words presented earlier but not to give a recalled word as a completion for a stem. That is, for the exclusion test, subjects were told to complete stems with words that were not presented earlier. Results from the inclusion and exclusion test conditions are shown in the left half of table 26.1. Looking at results for the exclusion test, subjects in the divided-attention condition were less able to use recollection to exclude old words than were subjects in the full-attention condition. Indeed, after divided attention, the probability of completing a stem with an old word for the exclusion test was identical to that for the inclusion test. That identity in performance provides evidence that dividing attention during the study presentation of words reduced later recollection to zero. It can be concluded that responding with an old word did not result from a strategic, consciously controlled use of memory, because such responding was as likely when subjects were trying not to as when they were trying to respond with an old word. After divided attention to study, all that remained were automatic influences of memory.

Performance in the divided-attention condition provides clear evidence of automatic influences. Although the probability of responding with an old word was equal for the inclusion and exclusion tests, that probability was above the base rate gained from stems that could only be completed with new words (.46 versus .35). When recollection can be shown to be zero, subtracting base rate or false recall from correct recall gives a measure of automatic influences.

How can automatic influences be measured when recollection is greater than zero, as in the full-attention condition? Translating the above arguments into a set of simple equations that describe performance in the inclusion and exclusion test conditions provides a means of estimating the separate contributions of automatic and strategic processes. Stated formally, the probability of responding with a studied word in the inclusion test condition is the probability of recollection (R) plus the probability of the word's automatically coming to mind when there is a failure of recollection, A ($1 - R$):

$$\text{Inclusion} = R + A(1 - R). \tag{1}$$

Table 26.1 Probabilities of Responding with an Old Word and Estimates of Recollection (R) and Automatic Influences (A)

	Probabilities Test		Estimates	
Attention	Inclusion	Exclusion	R	A
Full	.61	.36	.25	.47
Divided	.46	.46	0	.46

Note: Base rate = .35.

For the exclusion test, a studied word will be produced only when a word automatically comes to mind and there is a failure to recollect that it was on the list, or more formally:

$$\text{Exclusion} = A(1 - R). \tag{2}$$

In the inclusion test, automatic and intentional influences act in concert. Performance in that condition clearly overestimates recollection and does not provide unambiguous evidence even for its existence. The exclusion test places recollection and automatic influences in opposition. If the probability of completing stems with studied words in that condition is higher than base rate, then one can be sure that automatic influences exist. However, if the probability of recollection is above zero, performance in the exclusion condition underestimates the magnitude of automatic influences.

The probability of recollection (R) can be estimated as the probability of responding with a studied word in the inclusion condition minus the probability of responding with a studied word in the exclusion condition:

$$\text{R} = \text{Inclusion} - \text{exclusion}. \tag{3}$$

Once an estimate of conscious recollection has been obtained, unconscious or automatic influences can be estimated by simple algebra:

$$\text{A} = \text{Exclusion}/(1 - R). \tag{4}$$

We call this the process-dissociation procedure because what we are looking for are factors that produce dissociations in their effects on the estimates of the different types of processes. Equations 1–4 can be applied to the data in table 26.1 to separate recollection and automatic influences. Doing so (right half of table 26.1) shows that dividing attention produced a process dissociation. Although dividing attention reduced the probability of recollection to zero, the estimated contribution of automatic influences was near identical for the full- and divided-attention conditions.

It is important to be able to find such process dissociations. One of the strongest assumptions underlying the procedure is that automatic and strategic uses of memory are independent. If this assumption is valid, we should be able to identify factors that have large influences on one process but leave the other process unchanged. The strategy is analogous to that used by proponents of signal detection theory to justify the assumed independence of discriminability and bias. For signal detection theory, if discriminability and bias are independent, it should be possible to vary bias and leave d' (the estimate of discriminability) unchanged (Snodgrass and Corwin 1988) or vice versa. For our approach, the process dissociation produced by dividing attention during study provides support for the assumption of independence of recollection and automatic influences. Jacoby, Toth, and Yonelinas (1993) further describe the assumptions underlying the process-dissociation procedure and review data that provide support for those assumptions. Process dissociations such as those produced by dividing attention during study have been found in several other experiments.

Even when giving a correct memory response, amnesiacs often deny having the subjective experience of remembering and claim to be only guessing (Moscovitch, Winocur, and McLachlan 1986). For amnesiacs, the probability of recollection is likely very low and, so the probability of completing a stem with an old word should be nearly the same in inclusion and exclusion test conditions. Results consistent with that prediction have been obtained recently (Cermak et al. 1992). The process-dissociation procedure holds an important advantage over other means of measuring memory in that it allows one to separate recollection, an ability that is largely lost by amnesiacs, and, when attention is divided, from automatic or unconscious influences, a use of memory that is preserved by amnesiacs and when attention is divided.

Offsetting Effects of Recollection and Automatic Influences

The above example shows that reliance on standard means of correcting for guessing can overestimate recollection. The next case I consider shows an even more serious error in conclusions that can result from reliance on such standard procedures. A manipulation can have effects on strategic uses of memory that are fully offset by its opposite effects on automatic uses of memory. Given such offsetting effects, reliance on standard procedures for measuring memory leads to the mistaken conclusion that the manipulation had no effect.

Among the effects most intensely investigated using direct tests of memory is the finding that words generated in response to a question are later better remembered than are words that were simply read (Slamecka and Graf 1978; Jacoby 1978; for a review, see Hintzman 1990). Jacoby, Toth, and Yonelinas (experiment 3, 1993) examined this generation effect in recall cued with word stems. In their experiment, words were presented as anagrams to be solved or in their normal form to be read, and then word stems were presented as cues for recall. The test of cued recall took the same form as the inclusion test described in the preceding section. A generation effect would be shown by recall of words presented as anagrams being superior to that of words that were read. The results failed to show an effect of that sort. Instead, the probability of correctly recalling words that had been presented as anagrams was identical to that of recalling words that had been read.

If we had relied on cued recall performance, we would have concluded that the read/generate manipulation had no effect. However, by use of the process-dissociation procedure, we were able to show that the manipulation produced opposite and perfectly offsetting effects on recollection and automatic influences of memory. The experiment made use of both an exclusion and an inclusion test condition, just as did the experiment described in the preceding section. Although the read/generate manipulation had no effect on performance when an inclusion test was given, there was a large effect on performance when an exclusion test was given (left half of table 26.2). For the

Table 26.2 Probabilities of Responding with an Old Word and Estimates of Recollection (R) and Automatic Influences (A)

	Probabilities Test		Estimates	
Study	Inclusion	Exclusion	R	A
Read	.82	.49	.33	.73
Anagram	.82	.25	.57	.59

Note: Base rate = .56.

exclusion test, subjects were much more successful at avoiding responding with an old word when the word had earlier been produced as a solution for an anagram rather than simply read.

Equations 1–4 can be used to separate the contributions of recollection and automatic influences. Doing so allows one to see the differential effects of the read/anagram manipulation (right half of table 26.2). By use of the process-dissociation procedure, one sees that generating a word as a solution for an anagram produced an advantage in recollection that was perfectly offset by a disadvantage in automatic influences of memory.

The pattern of results found using the process-dissociation procedure parallels dissociations found between performance on indirect and on direct tests of memory. For example, Jacoby (1983) showed that words generated as an antonym of a presented word were later better recognized as old but were less likely to be perceptually identified as compared to words that were read earlier. Jacoby interpreted those results as showing that perceptual identification primarily relies on prior data-driven processing, whereas recognition memory primarily relies on prior conceptually driven processing. Roediger (1990) has extended that argument to account for a variety of dissociations between performance on indirect and direct tests.

Results of the above experiment show that a dissociation of the form found between tasks can also be found between processes within a task. The read/generate effect found for automatic influences in stem-completion performance is the same as found using indirect tests and the effect in recollection is the same as found using direct tests. Consequently, one might conclude that automaticity reflects data- or stimulus-driven processing (Posner and Snyder 1975) and that only recollection is enhanced by prior conceptually driven processing of the sort required to solve anagrams. However, it is important to note that for automatic processes in recognition memory, the read/generate effect is the opposite of that found for automatic processes in stem completion (Jacoby 1991). Because of differences in cues provided for retrieval and differences in task demands, automatic influences on stem-completion performance are more reliant on perceptual characteristics than are automatic influences on recognition-memory performance. I have used differences of that sort to argue for the task dependency of automaticity. Jacoby, Ste-Marie, and Toth (1993) provide a discussion of the relativity of automaticity that draws on theorizing done by Neumann (1984).

Reliance on stems that can be completed only with new words to measure false recall forces one to use the same base rate to "correct" recall of read words and recall of anagrams. Doing so requires the contradictory assumptions that R_n for new words is equal to R_o for anagrams and R_o for read words but that R_o is different for the two classes of words. What is needed is separate measures of false recall for read and anagram words.

The exclusion condition used in the process-dissociation procedure provides separate measures of false recall for different classes of studied words. The equations for the process-dissociation procedure (equations 1 and 2) are identical to equations 5 and 6, except for the change from two parameters (R_o and R_n) to one parameter (R) to represent recollection. For the process-dissociation procedure, we assume that the recollection used for inclusion is the same as that used for exclusion. Although the validity of that assumption might sometimes be arguable, it is much more tenable than the standard assumption that R_o equals R_n. Our use of the exclusion test condition allowed us to see that recollection was different for anagram and read words. That difference would not have been revealed had we relied on a test of cued recall (the inclusion test condition) and corrected for guessing by subtracting base rate from correct recall of anagram and read words.

Another difference between the process-dissociation approach and classic test theory is that unlike classic test theory, we assume that memory influences guessing. Without separating the different influences of memory, the memory preserved by amnesiacs and after divided attention might be mistaken for recollection rather than correctly being seen as an automatic influence of memory. Also, a failure to distinguish between different influences of memory can lead to the false conclusion that a factor had no effect when, in actuality, there were two offsetting effects.

26.3 STRATEGIC AND AUTOMATIC INFLUENCES OF ASSOCIATIVE CONTEXT

The effectiveness of a recall cue depends on the relation between the cue and the study encoding of the item that is to be recalled. For example, presentation of an associate of a studied word as a cue for its recall is much more effective if the associate and the to-be-remembered word were studied together (Tulving and Thomson 1973). Such "encoding-specificity effects" might be interpreted as showing the importance for recollection of the compatibility of the retrieval cue and the study encoding of the target word. However, encoding-specificity effects might also originate from automatic influences of memory. In line with that possibility, Shimamura and Squire (1984) found that amnesiacs show "associative priming" effects. They presented word pairs, such as *table-chair*, to amnesiacs and control subjects. After presentation, subjects were shown the first word of each pair and were asked to say the first word that came to mind. The likelihood of subjects' responding with the second member of the pair was found to be almost three times above baseline level for amnesiacs as well as for control subjects (For a review of similar results

from other experiments, see Moscovitch, chap. 25, this volume; Shimamura 1986.)

How should recall cued with associates be corrected for guessing? The problem is the same as described for recall cued with word stems. The standard procedure of subtracting a baseline level obtained using new items from correct recall does not take automatic influences into account and, consequently, can overestimate the probability of recollection. Further, manipulations of the compatibility of retrieval cues and study encoding likely affect both recollection and automatic influences of memory. To measure effects on recollection accurately, one needs to separate effects on recollection from those on automatic influences.

Experiment 1: Placing Strategic and Automatic Influences in Opposition

A first experiment was done to demonstrate that associative context affects both recollection and automatic influences of memory. In phase 1 of that experiment, associatively related words were presented in pairs (e.g., *talk-chat*; *eat-drink*) or were repaired and presented as pairs of unrelated words (e.g., *turtle-cider*; *apple-shell*). Subjects judged whether words in each pair were related or unrelated. Subjects in one condition devoted full attention to making those judgments, whereas subjects in a second condition engaged in a listening task while simultaneously judging whether words were related. For an exclusion test, the first member of each studied pair was presented as a cue along with the initial letter of the associatively related target word (e.g., *eat-d*). Subjects were instructed to produce a word that was associatively related to the cue and began with the presented letter but had not been presented earlier (acceptable responses would be *dine* or *devour*, for example).

Recollection that a word was presented earlier allowed subjects to avoid giving that word as a response. Automatic influences, in contrast, would have the opposite effect by acting to increase the probability of responding with an old word. Only when words were presented in related pairs did the cues provided at test reinstate the associative context of studied words. Consequently, words presented in related pairs were expected to produce both better recollection and larger automatic influences of memory as compared to words presented in unrelated pairs. Based on results of the sort described earlier, dividing attention during the study presentation of pairs was expected to reduce later recollection but leave automatic influences of memory unchanged. Because of the effect on recollection, the probability of mistakenly responding with an old word was expected to be higher in the divided- than in the full-attention condition. The obtained pattern of results was such as to allow one to be certain that associative context affected both automatic and strategic influences of memory.

Subjects Subjects were volunteers from a first-year introductory psychology course at McMaster University who participated in the experiment for course credit. Eighteen subjects were randomly assigned to each of two

experimental conditions created by a manipulation of full versus divided attention at study.

Materials and Design A pool of 220 related word pairs was selected from *The Connecticut Free Associational Norms* (Bousfield et al. 1961), *The University of South Florida Associative Meaning Norms* (McEvoy et al., n.d.), and the *Norms of Word Association* (Postman and Keppel 1970). The associated words were chosen from a range of association frequencies, with the majority being from the medium range. The highest-frequency associates were not selected, and an additional criterion was that there must be at least one other associate beginning with the same letter as the selected associate (e.g., *burial—coffin, casket, ceremony, crypt*). From the selected pairs, three sets of forty pairs each were formed, and those sets were used to represent the three presentation conditions: presented in related pair, presented in unrelated pair, and new at test. Unrelated pairs were formed by repairing words in related pairs. Each set was balanced with regard to the probability of the selected associates being given as a response when new. Across formats, the sets were rotated through experimental conditions. Remaining pairs were used as fillers for the study list or for the test list.

The study list contained 120 pairs, with the first 20 pairs and the last 20 pairs in the list serving as fillers. Of those fillers, half were related and the other half were unrelated pairs. The order of items in the study list was random, with the restriction that not more than 3 pairs of the same condition could appear in a row. The test list contained 200 pairs, 80 of them fillers. The first 40 pairs in the test list were fillers (20 pairs of which had been presented during study). The fillers at the beginning of the list were used to allow subjects to become acquainted with the task before data were collected. The remaining 40 fillers were words from new pairs and were spread through the list so as to make the number of cues that would only allow responding with a new word equal to the number of cues that would allow responding with an old word.

Procedure In the study phase, the word pairs were presented on a monitor for 2 sec each with a 1/2-sec delay, during which the screen was blank, between the presentation of pairs. For each pair, subjects pressed one key to indicate that the pair of words was related or another key to indicate that they were unrelated. Subjects in the divided-attention condition engaged in a listening task while simultaneously judging whether words were related. The listening task was one previously used by Craik (1982). Subjects monitored a tape-recorded list of digits to detect target sequences of three odd numbers in a row (e.g., 9 3 7). Digits were recorded at a 1.5-sec rate. Subjects signaled their detection of a target sequence by saying "now."

For the test, the first word from each pair was presented followed by two spaces and then the first letter of its selected associate. The cue remained on the screen until the subject gave a response or until 15 sec elapsed; then the next test item was presented. Subjects were told that they were to produce a

word that was associatively related to the cue and began with the provided first letter but had not been presented earlier. They were told that if they were able to recall a previously presented, related word, even if the word had not been paired with the cue word, they were not to use that old word as a response.

The significance level for all tests was set at $p < .05$.

Results The probability of mistakenly responding with an old word is shown in table 26.3 for words presented in related and unrelated pairs along with the baseline probability of responding with those words when they were new. Analysis of those probabilities revealed a significant interaction between prior presentation and full versus divided attention ($F(2,68) = 11.62$, $MS_e = .005$).

Results from the full-attention condition provide evidence that reinstating associative context improved recollection. After full attention to judging pairs, words presented in related pairs were given as a response less frequently than were new words and were also less likely to be mistakenly given as a response than were words presented in unrelated pairs. That pattern of results shows that recollection of words presented in related pairs was often sufficiently good to allow subjects to exclude those words as permissible responses. In contrast, results from the divided-attention condition provide evidence of automatic influences of memory. After divided attention, old words from related pairs were more likely to be given as a response than were new words. This increased probability must have resulted from an automatic influence of memory, because an intentional use of memory (recollection) would have produced an opposite effect. Weak evidence of an effect of associative context on automatic influences is provided by the finding that after divided attention, words from related pairs were slightly more likely to be mistakenly given as a response than were words from unrelated pairs.

Experiment 2: Separating Strategic and Automatic Influences

The results of experiment 1 provide evidence that reinstating associative context affects both recollection and automatic influences of memory. However, the design of that experiment was not sufficient to allow one to separate effects of associative context fully on the two types of processes. To accomplish that goal, experiment 2 made use of the process-dissociation procedure.

Table 26.3 Probabilities of Responding with an "Old" Word on an Exclusion Test

	Pair Type		
Attention	Related	Unrelated	New
Full	.21	.30	.29
Divided	.36	.33	.27

Note: New pairs provide a measure of base rate.

Materials and Procedure The materials and procedure for experiment 2 were the same as those for experiment 1, except an inclusion test condition was added. Inclusion and exclusion test items were randomly intermixed, with the color of test items (green or red) signaling their type. For green test items, subjects were instructed to use the presented cue word and first letter to recall an earlier-presented word that was associatively related to the cue word and began with the provided first letter. If subjects were unable to recall a suitable old word, they were told to respond with the first word that came to mind that fit the restrictions. For red stems, in contrast, subjects were instructed not to respond with old words. The instructions for that exclusion test were the same as for experiment 1.

The procedure of randomly intermixing inclusion and exclusion test items was used to equate the interval between prior presentation of an item and type of test. The addition of the inclusion test condition reduced by half the number of words representing each combination of experimental conditions as compared to experiment 1. The only other difference between the two experiments is that pairs were presented for 1.5 sec in phase 1 for subjects to judge whether words were related in experiment 2 but for 2 sec in experiment 1.

Results The baseline probability of producing the selected associates when new did not differ significantly across type of test (inclusion versus exclusion) or attention condition (full versus divided attention), and averaged .29. For words presented in related or unrelated pairs, an analysis of the probability of responding with an old word revealed a significant interaction among type of pair (related versus unrelated), type of test, and attention condition ($F(1,34) = 16.57$, $MS_e = .008$). The results in the left half of table 26.4 show that effects for the exclusion test were similar to those of experiment 1 in that dividing attention increased the probability of subjects' mistakenly responding with words from related pairs. For the inclusion test condition, in contrast, dividing attention decreased the probability of subjects' correctly responding with words from related pairs. That pattern of results is what would be expected if dividing attention reduced the probability of recollection.

Table 26.4 Probabilities of Responding with an Old Word and Estimates of Recollection (R) and Automatic Influences (A)

Pair Type	Probabilities Test		Estimates	
Attention	Inclusion	Exclusion	R	A
Related				
Full	.60	.24	.36	.37
Divided	.48	.36	.12	.40
Unrelated				
Full	.37	.30	.07	.32
Divided	.37	.29	.08	.31

Note: Base rate = .29.

So as to better examine differential effects of dividing attention and associative context, the equations presented earlier were used to estimate the separate contributions of automatic and strategic uses of memory (right half of table 26.4). The estimates of recollection reveal that words from related pairs were more likely to be recollected than were words from unrelated pairs. Dividing attention reduced recollection of words from related pairs but did not affect recollection of words from unrelated pairs, perhaps because recollection of words from unrelated pairs was near zero even in the full-attention condition. Thus, the results provided strong evidence that dividing attention reduced recollection, whereas reinstating associative context improved recollection.

An analysis of the estimated automatic influences showed that dividing attention did not produce a significant main effect or a significant interaction with type of pair. This result agrees with those from earlier experiments in showing that although dividing attention radically reduces later recollection, automatic influences of memory are left unchanged. More interesting, reinstating associative context increased automatic influences of memory. Estimated automatic influences for words presented in related pairs were larger than for words presented in unrelated pairs ($F(1,34) = 10.99, MS_e = .008$). The estimated automatic influence for words presented in unrelated pairs was not significantly larger than baseline. That is, the results provided no evidence that presenting words in unrelated pairs had the automatic influence of increasing the likelihood of those words being given as a response. Data-driven processing required to read the words earlier was not enough to produce such automatic influences of memory. Rather, to produce automatic influences, it was necessary that words be presented in related pairs so that the associative relation dealt with during study was the same as that used at test.

Effects of Providing Environmental Support

The estimates of recollection gained by use of the process-dissociation procedure differ from estimates that would result if false recall (baseline) was subtracted from correct recall, as is standard. For the full-attention condition, the standard measure of recollection underestimates recollection of words from related pairs (.60 − .29 = .31 versus .36), whereas for the divided-attention condition, the standard measure overestimates recollection (.48 − .29 = .19 versus .12). In part, this difference results because the standard measure rests on the contradictory assumptions that the probability of recollecting that an item was not earlier presented (R_n) is the same for the full- and divided-attention conditions and equal to the probability of recollecting that an item is old (R_o), which is assumed to differ for the two attention conditions. In contrast, the process-dissociation procedure provides different baselines (measures of exclusion) for the full- and divided-attention conditions and takes effects of automatic influences of memory on guessing into account.

The results of the experiments provide clear evidence for the utility of a distinction between strategic and automatic influences of associative context.

Reinstating associative context has the separate effects of improving recollection and increasing the probability that an old item will be given as a guess. The two effects work in concert to improve performance on direct tests of memory such as a test of cued recall. Because they work in concert for those tests, it is impossible to separate the two effects of associative context or even to see that there are separate effects. Much of the disarray in results from experiments using direct tests might be produced by the two effects of associative context being mistakenly treated as if they originate from a single source. The contradictory results from experiments examining the memory effects of providing environmental support serve as an example.

Craik (1983, 1986) proposed an environmental support hypothesis to account for variation across situations in the severity of the memory deficit suffered by the elderly. The primary assumptions of that hypothesis are that age-related deficits are at least partially due to deficiencies in self-initiated processing and information present in the environment (environmental support) can have effects that compensate for deficient self-initiated processing. A prediction of the environmental support hypothesis is that age differences in performance on direct tests of memory should decrease as environmental support is increased. Craik and Jennings (1992) reviewed the relevant literature and concluded that the results of some experiments agree with the environmental support hypothesis, whereas results of other studies conflict with that hypothesis by showing that age differences are constant across different levels of environmental support or even larger when greater enviromental support is provided. That is, all possible patterns of results have been obtained.

Such mixed results are easily explained if providing environmental support has separate effects on recollection and automatic influences of memory. The aged may suffer a deficit in self-initiated processing and, consequently, show smaller effects of enviromental support (e.g., associative context) on recollection. Indeed, reinstating associative context may affect only automatic uses of memory for the aged but both automatic and strategic uses of memory for younger subjects. The overall effect of providing environmental support would then depend on whether automatic or strategic uses of memory were given the heavier weight by the particular test situation. To examine this possibility, effects on strategic and automatic uses of memory must be separated, as is done by the process-dissociation procedure.

26.4 CONCLUSIONS

Findings of dissociations between performance on direct and indirect tests of memory have been cause for a great deal of excitement and have resulted in renewed interest in automatic or unconscious influences of memory. A widely recognized problem for interpreting performance on indirect tests comes from the possibility that performance on indirect tests is contaminated by intentional uses of memory. Much less attention has been given to the possibility

that performance on direct tests of memory is contaminated by automatic influences of memory.

Rather than identify processes with tasks, I have used the process-dissociation procedure to separate the contributions of strategic and automatic influences within a task. The results reported here weigh on theorizing about automatic influences of memory. For example, the experiments examining the effects of associative context on automatic influences could have been described as showing the advantage of the process-dissociation procedure over the use of indirect tests as a means of measuring effects of conceptually driven processing. Elsewhere (Jacoby et al. 1992; Toth, Reingold, and Jacoby, n.d.) we provide discussions of that sort and argue that the process-dissociation procedure holds important advantages over indirect tests as a means of investigating automatic influences of memory. Jacoby, Toth, and Yonelinas (1993) discuss the relation between the "direct retrieval" assumptions that underlie the equations presented here and the "generate/recognize" assumptions (Jacoby and Hollingshead 1990) that are often used to describe cued recall performance. They argue that the invariance in automatic influences across manipulations of attention cannot be predicted by a generate/recognize model of cued recall performance.

The process-dissociation procedure can be applied in a wide range of situations. Debner and Jacoby (n.d.) have extended the procedure to separate conscious and unconscious effects of perception. The arguments for "seeing" are the same as for recollection in the case of separating conscious and unconscious influences of memory. Supposed demonstrations of unconscious perception that have relied on indirect tests have been dismissed by critics (Holender 1986) on the grounds that performance on the indirect test may have been contaminated by the effects of conscious perception. Here, too, we turn the tables by showing that performance on direct tests, which is usually taken at face value as measuring conscious perception, is sometimes badly contaminated by the effects of unconscious perception.

The implications of the distinction between strategic and automatic uses of memory are, in some ways, even more important for direct than for indirect tests of memory. It is performance on direct tests of memory such as tests of cued recall that has been the traditional focus of investigations of memory. The measures of memory gained using those standard, direct tests do not distinguish between recollection and automatic influences of memory. The results described here show that by failing to distinguish between those two effects of memory, one risks serious errors in conclusions that are drawn.

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