CHAPTER NINE

Dissociating Automatic and Consciously Controlled Processes: Implications for Diagnosis and Rehabilitation of Memory Deficits

Larry L. Jacoby
Janine M. Jennings
Janine F. Hay
McMaster University

Sometimes we think and then act; other times we act and then make our excuses. The difference in intentionality described by this contrast has important practical consequences. Within our legal system, lawyers invest time and effort trying to convince a jury that their client did not intend to commit an illegal act or was unaware of what he or she was doing when the act occurred. Intentionality weighs heavily in the final verdict; the penalty for a criminal act is more severe when an act is judged to be intentional.

Reason (1993) discussed a criminal case involving an absent-minded elderly man that illustrates the importance of distinguishing intentionality in responding. In this case, the accused was charged with two counts of shoplifting because he had failed to pay for some of his items. When the accused was stopped and questioned, he claimed that he had overlooked the items and forgotten to pay. The defense argued that the elderly man did not deliberately intend to steal. Based on circumstantial evidence, including a prior history of "forgetting to pay" and poor performance on a cognitive failure questionnaire (which measures the frequency of self-reported action slips), the case was dismissed. For this man, intentionality made the difference between an oversight versus being charged with a criminal act.

Was justice served in this trial? Perhaps, but there is reason to question the outcome. First, was the gentleman's prior history really one of action slips (forgetting to pay) or one of deliberate shoplifting? Almost certainly, a different conclusion would have been drawn had the accused been a teenager rather than an elderly gentleman. Second, how valid are self-report

measures of action slips? Such questionnaires measure failures in cognitive control through the frequency of these errors. However, the correlation between responses on a cognitive failures questionnaire and memory measured in the laboratory is very low. Correlations have typically been found in the .20 to .30 range (Herrmann, 1982), which is sufficiently weak to question the validity of questionnaires.

What is needed is a more objective means of measuring cognitive control. Development of such a diagnostic tool is an important applied goal for experimental psychologists. As our population continues to age, questions of whether an act resulted from an action slip or was carried out with intent will arise more often. Questions about cognitive control are important in domains other than aging. As an obvious example, a major consequence of both frontal lobe injury (e.g., Stuss, 1991) and schizophrenia (e.g., Frith, 1987) is a deficit in cognitive control.

To adequately measure cognitive control, automatic influences of memory must be separated from consciously controlled use of memory. For example, consider a case in which an elderly executive performs quite adequately in his professional role. He is present at appointments, shows memory of prior discussions of a topic when that topic is later discussed, politely questions colleagues about the well-being of their families, and refers to their family members by name. Shortly after retiring and moving to another city, he shows symptoms of a severe deficit in cognitive control. Indeed, this retired executive could become the elderly gentleman accused of shoplifting in the previous example. The question is: Did his deficit in cognitive control have a sudden onset that coincided with his retirement, or was the cognitive deficit present prior to his retirement, but masked by automatic influences of memory (habit) supported by the structure of the preretirement environment? Answering these questions clearly requires some means of separating automatic influences from cognitive control.

Judges and juries sometimes arrive at verdicts on the basis of their ability to distinguish between intentional acts and acts that result from automatic influences. Even for a decision that has life or death consequences, these laypeople are willing to judge intentionality with the decision treated as beyond reasonable doubt. How well have experimental psychologists done in their attempts to measure intentionality? Much of the research aimed at measuring intentionality has focused on the *distinction* between automatic (unconscious) and consciously controlled processes. Little effort has been directed toward measuring the *contribution* of cognitive control to performance of a task, with the measure corrected for automatic or unconscious influences. Controversy has surrounded the validity of this distinction, and for its acceptance researchers have demanded that evidence of its validity be beyond doubt—reasonable or otherwise. For academicians, however, nothing can be proven beyond doubt. Their scepticism has swung between

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questioning the existence of cognitive control, as evidenced by the behaviorists (Skinner, 1971), to questioning the existence of unconscious influences, which some cognitivists deny (Brewer, 1974). While Rome burns, academicians debate whether it is justifiable to call the cause "arson" with its implication of intent.

Measuring Automaticity

Although laypeople seem satisfied with their ability to separate intentional from automatic acts, psychologists have had difficulty doing so. For some psychologists, acts committed without intention are thought to be guided by automatic influences. By the standard definition, automaticity provides a basis for rapid responding, does not require attentional capacity or awareness for the response, and does not require intent (e.g., Hasher & Zacks, 1979; Posner & Snyder, 1975). This definition has been used to construct experimental conditions and select special populations so as to investigate automaticity in memory performance. Variables that have been used include depression, the effects of drugs and alcohol, and the effects of aging and amnesia. Experimental conditions attempt to meet the goal of providing a pure measure of automatic influences by eliminating intent through a manipulation of instructions (Hasher & Zacks, 1979) or by the use of conditions (dividing attention, etc.) that do not give intent an opportunity to operate. It is assumed that one is responding on the basis of automaticity when one experiences any of the conditions or mental states cited earlier.

The manipulation of instructions to eliminate the effects of intent and, thereby, to allow automatic or unconscious influences of memory to be investigated has received a great deal of attention. Automatic influences of memory have been described as "implicit memory," which has been investigated using indirect tests for its measurement. For these tests, people are not directly asked to remember a prior event but rather to engage in a task that indirectly reflects the occurrence of that event. *Implicit memory*, as indexed by these tasks, has been defined as unintentional, the same criteria used to define *automaticity*, and thus the two terms can be considered synonymous (e.g., Jacoby, 1991). In contrast, a direct test such as recognition or recall instructs subjects to remember earlier events, and provides a measure of conscious, intentional memory.

Dissociations between performance on direct and indirect memory tests supply striking examples of effects of the past in the absence of remembering and perceptual analysis in the absence of seeing. For example, although amnesics cannot remember the earlier presentation of a word when given a test of recognition memory or recall (a direct test), they show evidence of memory by using the word more often as a completion for a stem or fragment (an indirect test) than they would had the word not been presented

earlier (for reviews, see Moscovitch, Vriezen, & Gottstein, 1993; Shimamura, 1989). Similar memory dissociations are evident in people with normal functioning memory (for a review, see Roediger & McDermott, 1993). The form of dissociation found for memory is comparable to dissociations taken as evidence for unconscious perception. For example, Marcel (1983) flashed words for durations so brief that subjects could not "see" them, but could show effects of those words on a lexical decision task used as an indirect test of perception. Similarly, "blindsight" patients make visual discriminative responses without the subjective experience of seeing (Weiskrantz, 1986).

Empirical advances derived from the direct versus indirect test distinction have significantly increased our understanding of conscious and unconscious (automatic) influences (e.g., Jacoby & Dallas, 1981; Roediger, 1990; Schacter, 1987). Much of this research, however, has proceeded without confronting many of the methodological and conceptual issues that plagued earlier investigations of unconscious processes. Those issues are now resurfacing. The major difficulty for drawing a distinction between conscious versus unconscious processes is that of defining each type of process. Essential here is the relation of processes to tasks (Dunn & Kirsner, 1989). Typically, unconscious processes are equated with performance on indirect or implicit tests and conscious processes with performance on direct or explicit tests. However, this form of definition is problematic because conscious processes may contaminate performance on indirect tests (e.g., Holender, 1986; Reingold & Merikle, 1990; Toth, Reingold, & Jacoby, 1994) and, less obviously, unconscious processes might contaminate performance on direct tests (Jacoby, Toth, & Yonelinas, 1993). In addition, mapping processes onto test performance overlooks an essential aspect of any adequate definition of conscious and unconscious processes, which is that automatic and consciously controlled processes seldom operate in isolation. Further, automatic processes acting in isolation may be qualitatively different from those operating in the context of consciously controlled processes, and vice versa.

Consider the commonplace claim that in order to learn what somebody really believes, you should get him or her drunk. Drunkenness is treated as a pure measure of automaticity or true belief. The "contamination" problem is to question how drunk people have to be before their responses are no longer contaminated by consciously controlled processing. Even if one could achieve an uncontaminated test, the more serious "qualitative difference" problem is whether the test reveals people's "true" beliefs or only what they believe when drunk. It seems likely that some people's beliefs when drunk are qualitatively different from their beliefs when sober. Automatic influences in the context of consciously controlled processes, like true beliefs when sober, are of great interest. Because the indirect versus direct test distinction identifies processes with tasks, it provides no means of measuring automaticity in the presence of consciously controlled processing.

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What is needed is some means of separating the contributions of cognitive control and automatic influences to behavior in a particular situation. How does the layperson do this when deciding that an act is intentional?

Celibacy Doesn't Count if You Can't Get a Date

The criterion used by psychologists to define automaticity are also used by the layperson to judge whether an act was intentional. For example, psychologists' concern with attentional variables, such as divided attention and the effects of drugs, is mirrored by legal reference to "diminished resources" when establishing in a court of law that an act was unintentional. However, the layperson does not just use information about characteristics of a static state or situation but, rather, relies most heavily on contrasting behavior across different situations to judge whether an act is intentional. For example, one is more impressed by abstinence from alcohol in a recovering alcoholic, who has previously been seen drunk at numerous parties, than in an individual who has never been seen having a drink. Clearly, the recovering alcoholic demonstrates greater evidence of intention and control. Similarly, to be given full credit for having been religiously "saved" one has to have been a blatant sinner first. Remember, it was the prodigal son who received the feast. Other examples, one of which was used as the heading for this section, are easily found.

The layperson begins by accepting the validity of the distinction between consciously controlled and automatic acts and then compares behavior in one situation with that in another to decide whether an act was intentional. Our process dissociation procedure (e.g., Jacoby, 1991; Jacoby, Toth, & Yonelinas, 1993) is a refinement of the strategy used by the layperson. We also begin by accepting the distinction between automatic and consciously controlled bases for responding, and make that distinction fundamental to our procedure. Our refinement is in the design of situations in which behavior is to be compared so as to separate the contributions of automatic influences and cognitive control.

The Process Dissociation Procedure

The process dissociation procedure measures cognitive control by combining results from a condition for which automatic and consciously controlled processes act in opposition, as in the case of action slips, with results from a condition for which the two types of process act in concert, as in the case of the well-functioning, elderly executive. The measure is the very commonsensical one of the difference between performance when one is *trying to*, as compared with *trying not to*, engage in some act or be influenced by information from some source. The difference between performance in those two cases reveals the degree of cognitive control. We later describe results

to show that this objective measure of cognitive control correlates with self-report measures of recollection and of frequency of action slips.

In order to avoid the equating of processes with tasks, the process dissociation procedure separates the contributions of conscious and automatic processes to performance of a single task. The procedure builds on previous findings of task dissociations but extends the analysis to situations for which it is acknowledged that both cognitive control and automatic influences contribute to performance. Such an analytic technique seems especially important given that both types of processes are operating concurrently in most real-world tasks, and given the likely possibility that automatic (unconscious) influences are context specific and sensitive to current intentions (Jacoby, Ste-Marie, & Toth, 1993; Wegner, 1994). As illustrated by the earlier "drunk" example, it is necessary to separate processes within a task to gain a true measure of their contributions.

The strategy for the process dissociation procedure is to start with the assumption that consciously controlled and automatic influences independently contribute to performance and then design conditions aimed at meeting that assumption as well as other necessary assumptions (Jacoby, Toth, & Yonelinas, 1993). There are a number of different ways that automatic and consciously controlled influences can combine but, fortunately, each of the ways has its own earmarks (Jacoby, Yonelinas, & Jennings, in press). How can one be certain of having attained the goal of independence? One source of evidence comes from results showing that variables traditionally associated with reduced cognitive control have an effect on our estimates of consciously controlled processing (e.g., recollection) but leave automatic influences unchanged. Jacoby et al. (in press) summarized the results of 20 experiments to show that subject variables such as aging, as well as processing variables, such as divided attention and fast responding, produce that pattern of results. Averaged across those 20 experiments, the effect of factors traditionally associated with reduced cognitive control on estimates of controlled responding was .24, whereas that on estimates of automatic influences was .002. Manipulations other than those associated with cognitive control produce different patterns of results, often affecting estimates of automaticity.

However, as noted earlier, the empirical gains made possible by the procedure are bought at the expense of confronting conceptual and methodological issues that troubled, and often undermined, previous research on automatic influences. Our approach has drawn critics that question its underlying assumptions, particularly our assumption that conscious and unconscious processes *independently* contribute to performance (Curran & Hintzman, in press; Graf & Komatsu, 1994). We can convincingly counter arguments made by critics (Jacoby, Begg, & Toth, in press; Toth, Reingold, & Jacoby, 1995). For example, Curran and Hintzman (in press) argued that correlations, at the level of items, between automatic and controlled proc-

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esses invalidate the independence assumption and estimates of processes. Their argument was the very reasonable one that some items are both more familiar and better recollected, and, consequently, one cannot assume that the two bases for judgments or responding are independent. Jacoby, Begg, and Toth (in press) showed that even if there is a high correlation at the item level, the bias in estimates of automatic influences would be very minor (a .01 difference) and not differential across conditions that were very different in the estimated controlled use of memory. That is, even if Curran and Hintzman were correct, the effects produced by correlations at the item level are trivial. What is often made clear by comments of critics is that the word *independence* has many meanings, only some of which are relevant to our purposes. Correlation does not mean lack of independence (see Jacoby, Begg, & Toth, in press, for this argument).

The best response to critics is to show the success of our approach. In the following section, we illustrate the process dissociation procedure by describing its use in several experiments done to analyze age-related deficits in memory. Although the focus is on effects of aging, we have found that manipulations such as dividing attention, speeded responding, and fast presentation rate mimic the elderly's pattern of performance. Then, in the final section, we address applied issues for which it is important to separate automatic and consciously controlled uses of memory. We return to examples there, such as our elderly shoplifter, to question the relation between subjective reports of awareness, and the objective measure of cognitive control supplied by our process dissociation procedure. We also describe the utility of our procedure for diagnosis and treatment of memory deficits. Designing effective, special environments that provide support to compensate for memory deficits, and designing programs aimed at rehabilitating memory, require that one separate the contributions of automatic and consciously controlled processes.

MEMORY EFFECTS OF AGING

Action Slips: Separating Habit and Recollection

The interplay between consciously controlled and automatic processes can be seen in daily life through the action slips that people commit. These errors in performance occur when automatic responding and current intention are opposed, leading to conflicting responses (e.g., Norman, 1981; Reason, 1979). Automaticity, in this case, is expressed in the form of a habit that overcomes our intended behavior. These errors can be illustrated with a story about an aging math professor at the University of Manitoba who went to a conference in Chicago and was unable to find his airline ticket

when he was ready to return home. After an extensive search for the ticket, he bought another and, upon arriving in Winnipeg, called his wife to pick him up at the airport. She responded that she would be unable to do so because they only had one car and he had driven it to Chicago!

The professor's action slip is useful to highlight the distinction between automatic and controlled influences of memory. It is likely that he typically flew to conferences, and his action slip was a result of habit gained from prior conferences dominating recollection for having recently driven. That is, his error reflects proactive interference from memory for earlier trips, and automatic influences served as the source of that interference.

Action Slips and Aging. Does aging increase the likelihood of action slips? Our story about the math professor suggests this is the case and, in fact, there is anecdotal evidence that the elderly are more likely to commit action slips than are younger subjects. We (Jacoby & Hay, 1993) addressed this question more directly by examining memory performance in a lab situation where habit and intention act in opposition.

The first phase of our action slip experiment was designed to create habits of a specific strength. Words were presented paired with a fragment of a related word, and subjects were to predict how these fragments would be completed. One of two possible completions for each fragment was shown, with a "dominant" completion being shown twice as often as the other. For example, 12 times out of 18 (67% of occurrences) when knee b_n_ was shown, the fragment was completed with the word *bone* (the dominant item) whereas for its other 6 presentations (33% of occurrences) it was completed with the word *bend* (the nondominant item). The habit of producing the dominant completion should be stronger than habit for the nondominant completion. Our intention was to build a habit or automatic response in a manner similar to having our math professor fly to two thirds of the conferences he attends.

The second phase of the experiment created a situation that was meant to resemble recollecting the mode of transportation to a current conference. In that second phase, people were presented with a list of nine word pairs, and then tested by presentation of the first member of each pair and a fragment of the second word (e.g., knee-b_n_). Subjects were to complete the fragment by recalling the word that was paired with the cue word in the short list they had just studied. Subjects studied and were tested in this manner for several lists. The trick, of course, is the completion word presented in the study list was not the word made dominant in Phase 1 (e.g., the study pair was *knee-bend*, rather than *knee-bone*). Consequently, relying on habits established in Phase 1 would produce an action slip of completing the fragment with the stronger habitual response in Phase 1, although the weaker response was appropriate.

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TABLE 9.1
Probability of Responding with a Dominant Item and Estimates of Recollection and Automatic Influences for Young and Elderly Adults

	Test Condition		*Estimates*	
	Facilitation	*Interference*	*Recollection*	*Automatic*
Young	.80	.35	.44	.63
Elderly	.73	.44	.29	.62

If the elderly are more susceptible to action slips, they should mistakenly give the dominant items from training more often than do younger adults. Those were the results that were obtained (see interference condition, Table 9.1). How should the greater probability of an action slip be understood? One interpretation is that the elderly are more susceptible to interference from prior learning. Indeed, there is a large amount of literature to show that the elderly are more vulnerable to proactive interference effects than are younger subjects (e.g., Winocur & Moscovitch, 1983), and several authors have argued that interference effects stem from the elderly's inability to inhibit irrelevant information (e.g., Hasher & Zacks, 1988). Our evidence thus far could suggest that the elderly are less able than the young to inhibit responding on the basis of habit and, therefore, may have deficient inhibitory mechanisms.

If this is the case, we should be able to demonstrate that the elderly perform as well as the young when recollection and automatic processing act in concert to produce the same response. That is, the elderly may do as well as, or even better than, the young if habit is a source of facilitation rather than interference. In that circumstance, a failure to inhibit effects of habit would be to one's advantage. Think back to the aging math professor. Had he flown to the conference in Chicago, as he usually did, habit would have helped him on his way home. In this case, habit and recollection work together to facilitate performance.

In the experiment just described, a facilitation condition was also used to compare performance of young and elderly adults. This time, the dominant items from the training phase appeared on the study list. At test, if subjects could recollect that the word was just presented, they would give the correct response. Alternatively, if they failed to recollect the item, they could produce the correct answer by relying on habit. Unlike the interference condition, subjects did not need to inhibit habitual responses; consequently, if the inhibition hypothesis is adopted, one must predict that age deficits will be eliminated.

The results did not support this prediction (Table 9.1). Older adults were *less* likely than the young to correctly recall an item in the facilitation condition.

This finding is difficult to understand if the source of memory deficits in the elderly stems from poor inhibition. Given that the elderly were less likely to correctly recall an item when habit was a source of facilitation, as well as a source of interference, some other explanation is required. However, we would not have recognized the inadequacy of the inhibition hypothesis if we had only examined the interference condition. To truly understand performance, responding in both the interference and facilitation conditions must be considered. To see that this is the case, think of our experiment as being analogous to an investigation of recognition memory. The role served by facilitation test items is analogous to that served by "old" words and the role served by interference test items is analogous to that served by "new" words on the recognition test. For recognition memory, of course, one has to compare performance on old and new items to separate correct responding that reflects memory from that due to guessing. Rather than memory and guessing, however, we want to separate the contributions of recollection and automatic influences. The situations are similar in that automatic influences can serve as the basis for guessing. We return to this point later.

Rather than inhibition, a better explanation of our results is that the elderly are deficient in their ability to consciously recollect an earlier event and, consequently, more vulnerable to misleading effects of habit. To investigate this possibility we need to separately examine automatic and consciously controlled influences on performance. Jacoby's process dissociation procedure (Jacoby, 1991) allows us to separate out and measure the contributions of habit and recollection within a given task, and determine the effects of aging on each process. We first illustrate this procedure in the context of our action-slip experiment.

Estimating Automatic and Consciously Controlled Influences

For the facilitation condition in the action slip experiment, subjects can give the correct answer at test either by recollecting (R) the item presented in the study list, or by relying on habit or automatic influences (A) when recollection fails ($1 - R$). We assume that these two bases for responding act independently; recollection can occur with or without responding on the basis of automatic influences and vice versa. Consequently, the probability of a correct response, which would be to respond with the "dominant" item, in the facilitation condition (Fac) is:

$$\text{Prob (dominant item)} = R + A\,(1 - R)$$

In contrast, for the interference condition, responding with the dominant item is an action slip. Such an action slip will occur only if subjects fail to recollect the nondominant response that appeared in the study list. If subjects

fail to recollect the nondominant response ($1 - R$), an action slip will occur with a probability that reflects automatic influences (A). The probability of an action slip in the interference condition (Int) is:

$$\text{Prob (dominant item)} = A\,(1 - R)$$

By using these two equations we can compute estimates of automatic influences and recollection. Subtracting the probability of an action slip on interference trials (Int) from the probability of a correct response on facilitation trials (Fac) provides an estimate of recollection:

$$R = \text{Fac} - \text{Int}$$

Given an estimate of recollection, an estimate of automaticity or habit can be computed by simple algebra, dividing the probability of an action slip in the interference condition (Int) by the estimated probability of a failure in recollection:

$$A = \text{Int}/(1 - R)$$

When we calculate these estimates, we find that the poor memory performance of the elderly was not because of a failure to inhibit automatic influences or habit. The estimated contributions of automatic influences were near identical for the elderly and the young (see Table 9.1). Furthermore, these estimates of automatic influences reflected the probability with which fragments were completed with dominant items during training. That is, there was a .67 probability that a dominant item would appear on any given trial during training, and the estimates of automatic influences obtained by using the process dissociation procedure were .63 for the young and .62 for the elderly.

In contrast, estimates of recollection revealed pronounced age-related deficits; the elderly showed much poorer consciously controlled processing (.29) than did the young adults (.44). It is this deficit that was responsible for the larger number of action slips committed by the elderly in the interference condition, and for their poor performance when habit and recollection were acting in the same direction (in the facilitation condition). Factors other than aging also increase the likelihood that action slips will occur. We have found that forcing young adults to respond quickly at test or rapidly presenting information at study increases the probability of such errors (Jacoby & Hay, 1993). Similar to aging, the effects of speeded responding and rapid presentation serve to reduce recollection and leave automatic influences in place.

This invariance in estimates of automaticity does not reflect a general insensitivity of that measure. We have carried out other action-slip experi-

ments to show that varying the number of presentations of a pair during training (i.e., the "strength" of a habit) influences estimates of automaticity but leaves recollection unchanged (Jacoby & Hay, 1993). As discussed earlier, manipulations that affect one process while leaving the other intact provide evidence to support the assumption of independence between intentional and automatic responding. Those later experiments also revealed probability matching, as did the experiment described previously, which suggests that probability matching can be used as a measure of implicit learning (cf., Estes, 1976; Reber, 1989). It seems likely that the observed probability matching qualifies as implicit knowledge, because probability matching was found when conscious recollection of list structure would be nearly impossible (i.e., rapid responding). Probability matching, as a measure of implicit learning, holds important advantages over other procedures. Foremost, probability matching measures implicit learning in the context of intentional use of memory, and adoption of the process dissociation procedure eliminates concerns that the measure of implicit learning is contaminated.

Automatic and Intended Influences of Memory for a Prior Event

The distinction between behavior driven by habit versus behavior driven by recollection is really the difference between automatic and intended influences of memory for a prior event. In the case of habit, the automatic influence was built up by multiple presentations of a stimulus; however, automatic influences of memory also arise from a single presentation of an item. A series of "false fame" studies illustrates this effect (Dywan & Jacoby, 1990; Jacoby, Kelley, Brown, & Jasechko, 1989; Jacoby, Woloshyn, & Kelley, 1989).

In this paradigm, subjects read a list of nonfamous names and then performed a fame-judgment test consisting of old names, new nonfamous names, and famous names. Subjects were correctly informed that the study names were nonfamous, and if they recognized a name from that list they could be certain it was not famous. Because prior presentation of a name increased its familiarity, subjects could misattribute this familiarity as fame, by mistaking old names for famous ones (the false fame effect). However, if subjects could recollect the source of the name, any automatic influence of familiarity would be opposed, and subjects would correctly identify the name as nonfamous. This task is, in essence, an interference condition, similar to the one described earlier where habit and recollection were placed in conflict.

Elderly adults show the false fame effect (Dywan & Jacoby, 1990; Jennings & Jacoby, 1993a) as do amnesics (Cermak, Verfaellie, Butler, & Jacoby, 1993; Squire & McKee, 1992) and patients who have suffered a closed-head injury (Dywan, Segalowitz, Henderson, & Jacoby, 1993). Subjects in each of these

special populations were more likely to mistakenly respond "famous" to old names as compared to new, nonfamous names, whereas the opposite was true for younger subjects with normal functioning memory. This finding suggests that these populations suffered a lessened ability to engage in recollection; however, automatic influences of memory were preserved. Jennings and Jacoby (1993a) have used the process dissociation procedure to show that this is the case; automatic influences of memory (familiarity) on fame judgments were the same for elderly and young adults despite large age differences in recollection. In experiments to be described later, we used a misleading effect of familiarity, much like false fame, to diagnose deficits in recollection and design a training procedure to rehabilitate recollection.

Automatic influences based on a single presentation, such as those seen in the false fame effect, have typically been studied with indirect tests of memory. As discussed, however, it is better to separate the effects of automatic and consciously controlled influences within a task. In the action-slip experiment described earlier, we accomplished this by manipulating materials to construct facilitation and interference conditions. However, the same goal can be achieved by manipulating task instructions.

Measuring Recollection. Jacoby, Toth, and Yonelinas (1993) used a manipulation of inclusion versus exclusion instructions with a stem completion task to separate recollection from automatic influences of memory. Young adults first studied a list of words either under conditions of full or divided attention. In both conditions, subjects read study words aloud. However, subjects in the one condition were allowed to give full attention to their study of those words, and were warned of a later memory test. Subjects in the second condition were not warned about the later test, and were required to engage in a second task while reading the words aloud. They were told to give as little attention as possible to the reading task. Our goal was to show that reducing attention could produce memory results that were the same as found with elderly subjects or amnesics. That is, by manipulating attention, we attempted to produce a deficit in later recollection (a controlled use of memory) but leave automatic influences unchanged.

The inclusion versus exclusion test instructions were important for separating the contributions of controlled and automatic influences of memory. For both types of test, subjects were presented with word stems that they were told to use as cues for recollecting earlier-studied words (e.g., mot_, as a cue for recall of *motel*). For the inclusion test, subjects were instructed to complete stems with recollected words or, if they were unable to do so, complete stems with the first word that came to mind. The inclusion test is the same as a standard direct test of memory with instructions to guess. For the exclusion test, in contrast, subjects were told to complete stems with words that were *not* presented earlier. The exclusion test is akin to testing

people's ability to keep secret their memory for the earlier studied list. They were to recall studied words so as to avoid giving them as responses, just as one might recall a secret to avoid disclosing it. Completing an exclusion test item with an old word would be an action slip of the same sort as described for our math professor.

Not surprisingly, on the inclusion test subjects showed higher recall in the full than divided attention condition (see Table 9.2). However, even after divided attention, the probability of completing a stem with an old word was well above base rate (the probability of completing the stem with a target word when that word was not presented). Subtracting false recall from correct recall (subtracting base rate from the total number of words completed) is a standard way of measuring recollection. But is that method accurate? Does above-base rate performance reflect subjects' ability to recollect earlier presented words or does it reflect automatic influences? This question is important because several experiments have shown that amnesics sometimes perform nearly as well as normals on direct tests of memory (e.g., Bowers, Verfaellie, Valenstein, & Heilman, 1988). In those cases, are the amnesics truly able to recollect, or does their correct responding reflect guessing that is informed by automatic memory influences?

Performance on inclusion and exclusion tests can be used to estimate the separate contributions of recollection and automatic influences of memory, just as was performance on facilitation and interference test items in the action slip experiment. Indeed, the inclusion test is a facilitation test. Subjects could respond correctly on an inclusion test either because they were able to recollect (R) an earlier-studied word, or because although recollection failed ($1 - R$), automatic (A) influences were sufficient to result in the word being given as a guess: $R + A(1 - R)$. The exclusion test is an interference test. For an exclusion test, an earlier-studied word will be given as a response (an action slip) only if subjects fail to recollect the earlier-studied word, but automatic influences are sufficient for the word to be given as a guess: $A(1 - R)$. As should be apparent, these are the same equations as used to separate recollection and automatic influences in our action slip experiment, and estimates are gained in the same manner.

TABLE 9.2
Probability of Correct Stem Completion and Estimates of Recollection and Automatic Influences of Memory as a Function of Attention

	Test Condition		*Estimates*	
	Inclusion	*Exclusion*	*Recollection*	*Automatic*
Full	.61	.36	.25	.47
Divided	.46	.46	.00	.46

Note: The baseline completion rate for items not presented at study was .35.

Estimates of recollection and automaticity (Table 9.2) show that dividing attention during study produced effects that were the same as those produced by aging. Recollection was reduced to 0 by dividing attention. We were successful in making our undergraduates totally amnesic! However, estimated automatic influences after divided attention were near identical to those after full attention. This shows that, after divided attention, correct responding on the inclusion test stemmed totally from correct guessing informed by automatic influences. The same is likely true when amnesics are sometimes found to perform as well as normals on a direct test of memory. Had we used the standard means of correcting for guessing, we would have mistaken automatic influences of memory for recollection. The two bases for responding are different in important ways. For example, automatic influences of memory would result in one mistakenly disclosing a secret (exclusion test), whereas recollection would allow the secret to be withheld. Are elderly subjects less likely to be able to keep a secret? Craik (1982) suggested that age-related differences in memory are the same as those produced by dividing attention.

Special Populations and Recollection. Jacoby (1992) used an inclusion and exclusion test procedure to examine age-related effects of memory. That experiment used the same materials as did the full- versus divided-attention experiment, but the procedure was slightly different. Study and test items were intermixed, and the number of items intervening between the study presentation of a word and its test (spacing) was varied, as was the nature of the test.

When an inclusion or exclusion test immediately followed presentation of its completion word (0 spacing), performance of the elderly and of the young was near perfect. This finding is important because it shows that the elderly were able to understand and follow instructions. They were able to include and exclude old words when tested immediately after studying those words. In contrast, when a large number of items intervened between the presentation of a word and its inclusion or exclusion test (48 spacing), the elderly performed much more poorly than did the young (Table 9.3).

TABLE 9.3
Probability of Correct Stem Completion and Estimates of Recollection and Automatic Influences of Memory as a Function of Age

	Test Condition		*Estimates*	
	Inclusion	*Exclusion*	*Recollection*	*Automatic*
Young	.70	.26	.44	.46
Elderly	.55	.39	.16	.46

Estimates of automaticity and recollection (Table 9.3) provide evidence that the elderly suffered a deficit in recollection as compared to younger participants but that automatic influences of memory were unchanged. This correspondence between age-related differences in memory and effects of full versus divided attention supports Craik's (1982) claim that dividing attention during study can mimic the effects of aging on memory.

The same pattern of dissociations has been found with a closed-head injured population using the lag procedure described earlier. They, too, show deficits in recollection but intact automatic processing (Ste-Marie, Jennings, & Finlayson, in press). For both populations declines in recollection are pronounced, appearing when only a few items have intervened between presentation and test. The lag paradigm produces consistent results across populations and is highly sensitive as a measure of memory deficits. To truly test memory, one has to measure both a person's ability to intentionally deliver a message (inclusion test) and ability to keep a secret (exclusion test). In some regards, keeping a secret is a greater memory accomplishment than is delivering a message. We later exploit these characteristics in our attempt to diagnose and train recollection.

All the research described thus far serves to illustrate the process dissociation procedure and demonstrate its utility for separating automatic and consciously controlled memory processes. In the following sections we describe application of the procedure as a potential diagnostic test, and highlight the importance of separating automatic and consciously controlled processes for the diagnosis and treatment of memory impairments. An important issue in this regard returns us to our elderly shoplifter to question the relationship between cognitive control as measured objectively by the process dissociation procedure versus subjective reports of memory performance.

APPLIED ISSUES

Relation of Subjective and Objective Measures of Memory

As described in conjunction with our elderly shoplifter, there is usually a very low correlation between performance on standard laboratory tests of memory and performance on cognitive failures questionnaires. The latter test relies on self-reports of memory failures. What is the relation between memory used as a means of cognitive control for performance and memory used as a basis for self-report of remembering? The process dissociation procedure acts as an objective means of measuring cognitive control. For the experiments just described, recollection was measured as the difference between when one is trying to as compared to trying not to engage in some

act. But to what extent are people aware and able to self-report that they are recollecting? Recently, Jennings (1995) addressed this question by asking people to make subjective memory judgments in an adaptation of the remember/know procedure introduced by Tulving (1985) and used extensively by Gardiner and colleagues (Gardiner, 1988; Gardiner & Java, 1991; Gardiner & Parkin, 1990; Parkin & Walter, 1992).

During a test of recognition memory, subjects were asked whether they "remembered" an item as being presented earlier (recollected some specific detail of seeing the word), or they just "knew" that the word had occurred, or thought the word was "new." This "remember/know" paradigm relates well to the process dissociation procedure in that recollection appears to drive "remember" responses whereas automatic influences seem to underlie "know" responses. However, there is an essential difference between the two procedures. The original "remember/know" procedure assumes that the two processes are mutually exclusive (i.e., exclusivity assumption). Subjects can only respond "remember" *or* "know" for any given item, so the processes that underlie these responses can never occur together. In contrast, we assume that automatic influences and recollection act independently, such that each process can occur with or without the other.

Estimating Processes. Applying the independence assumption to the "remember/know" procedure allows us to estimate recollection and automaticity in a manner similar to that used in the process dissociation procedure. "Remember" responses map directly onto recollection, as long as a subject only responds "remember" if he or she recollects specific information about an item. However, "know" responses do not map directly onto automatic influences estimated by the process dissociation procedure but, instead, resemble the exclusion condition. In both cases, subjects give a response based on automatic influences in the absence of recollection $[A(1 - R)]$. An estimate of automatic influences can then be calculated as the proportion of "know" responses divided by a failure in recollection: $A = \text{Know}/(1 - R)$.

Applying this procedure with elderly adults allows us to investigate the correspondence between objective and subjective measures of memory. Using the process dissociation procedure, it has been demonstrated that aging produces a decline in recollection but leaves automatic influences intact. If awareness and cognitive control are related, we should be able to demonstrate the same pattern of results using subjective report.

According to both the independence and exclusivity assumptions, "remember" judgments are equivalent to conscious recollection and, as shown in Table 9.4, these "remember" responses decreased with age. However, comparing "know" responses with our automaticity estimates distinguishes the exclusivity and independence assumptions. Taking the "know" responses as a measure of automatic influences suggests that the elderly "remember"

TABLE 9.4
Probability of Responding "Remember" or "Know" and Estimates of Recollection and Automatic Influences of Memory as a Function of Age

	Test Responses		*Estimates*	
	Remember	*Know*	*Recollection*	*Automatic*
Young	.56	.22	.56	.50
Elderly	.35	.33	.35	.47

less but "know" more than the young (for similar results, see Parkin & Walter, 1992). Although it is comforting to think that we know more as we become older, that result is surprising if one identifies knowing with the use of familiarity as a basis for recognition memory. Based on the earlier reported study of fame judgments, one might expect familiarity to be a more automatic basis for recognition that is not influenced by aging. Indeed, when estimates of automaticity are calculated assuming independence (i.e., $A = K/(1 - R)$), they again show that recollection declines with age, but automatic influences are unchanged. Evidence supporting the assumption of independence over exclusivity has been discussed elsewhere (see Jacoby, Yonelinas, & Jennings, in press) and will not be reviewed further here.

In summary, the findings of the present "remember/know" experiment showed the same pattern of results that has been found using our more objective measure: "Remember" responses declined with age, but automatic influences were invariant (see Table 9.4).

This latter pattern of results found with subjects' reports suggests that there can be a high degree of correspondence between objective and subjective measures of memory, and that both young and elderly adults can be aware of using recollection. However, evidence to support the correspondence between objective and subjective measures of memory would be more compelling if similar estimates were obtained when both types of measures were compared for the same subjects within a common task. We investigated this possibility in the action slip experiments, by asking young and elderly adults to make subjective memory judgments after completing a fragment during the test phase (Jacoby & Hay, 1993). Subjects were told to say "recall" if they could remember that their response came from the preceding study list. "Recall" responses resemble the "remember" responses from the previous experiment and, thus, the probability of completing a fragment correctly and saying "recall" served as a subjective measure of recollection.

The results of this experiment again revealed that recollection and subjective remembering declined with age. Comparing the subjective and objective measures of recollection revealed near identical results for both the young (.44 vs. .44) and the elderly adults (.24 vs. .29). In addition, these

estimates were significantly correlated for both groups, with coefficients of .71 and .81 for young and old, respectively. Clearly, the agreement between subjective and objective measures of memory did not differ with age. Both young and elderly subjects were very accurate in their ability to assess whether they were recollecting. Of course, this may not always be true. Comparing effects on objective and subjective measures of recollection provides a means of detecting discrepancies between the two. One of our goals is to determine whether there are situations in which the elderly underestimate their ability to recollect.

Memory in the Real World Versus Lab Performance

Given the close relation between objective and subjective measures within the lab, one may also expect a close correlation between objective lab tasks and subjective reports of everyday memory, as measured by self-report questionnaires. However, based on the current literature (see Herrmann, 1990, for review) this does not seem to be the case. Many different questionnaires examining everyday memory failure have been reported in the literature (e.g., Broadbent, Cooper, Fitzgerald, & Parkes, 1982; Reason, 1993), yet responses on these instruments correlate weakly with laboratory tests of memory (Herrmann, 1982).

The lack of convergence between memory performance in the lab and self-report of memory as measured by questionnaires has been a source of disappointment for those investigating memory and aging. Some researchers have interpreted these findings as evidence that older adults are unaware of their everyday memory performance, overestimating or underestimating their abilities depending on the situation (Rabbitt & Abson, 1991). Others have used the poor correspondence between performance in the lab and subjective estimates of everyday memory to question the ecological validity of laboratory measures (e.g., Broadbent et al., 1982). It has been proposed that laboratory tasks do not reveal true memory capabilities, but merely reflect the task demands of unnatural situations in which specific memory strategies are induced.

We believe the fundamental problem with the literature comparing memory in laboratory tasks with questionnaire reports has been the failure to separate automatic and consciously controlled influences within the lab. Given that age-related deficits are found in recollection but not automatic influences, we expect questionnaires of everyday memory to relate only to recollection. This being so, it is not surprising that others who have failed to separate out the two memory processes have found very low correlations.

We wanted to determine whether subjects who showed poor recollection in our experiments would report a high frequency of memory failures in daily life. That is, would our elderly shoplifter and our aging math professor

demonstrate poor recollection in our experimental tasks? To explore this issue, we (Jennings & Hay, 1994) designed a memory questionnaire focusing on everyday situations that relied on recollection, and compared the results to lab performance. Some questions were taken from existing questionnaires (Broadbent et al., 1982; Reason, 1993), whereas others were created specifically for our study. Subjects were asked to rate the frequency of everyday memory errors, such as the likelihood of forgetting to take medication or turn off the stove. These same subjects also performed in the "remember/know" experiment described earlier, allowing us to estimate their ability to use recollection in the lab.

The results of this study revealed that memory complaints were highly correlated with recollection ($r = .56$), but uncorrelated with automatic influences ($r = .08$). Furthermore, when we examined the correlation between the questionnaire and overall recognition performance on the lab task (when the contributions of the two processes were not separated), we found a much weaker correlation ($r = .33$). These results suggest that prior findings of low correlations between memory complaints measured by questionnaires and performance on laboratory tasks were not due to the poor ecological validity of the lab tasks. Instead, low correlations resulted because the lab tasks contained both controlled and automatic influences. Given that recollection alone correlates with everyday memory complaints, failing to examine the effects of recollection separately from automatic influences dilutes this relationship.

The rationale underlying the process dissociation procedure holds that recollection serves as a basis for control. This being so, it should not be surprising that recollection can be revealed by self-report in the "remember/know" procedure and through questionnaire responding. However, it is important to realize that although awareness and control can be highly correlated, they need not always coincide. There will be occasions when awareness and control diverge.

The dissociation between awareness and control can be seen in the behavior of patients with schizophrenia and other frontal dysfunctions when they perform the Wisconsin Card Sorting Task. This task requires subjects to sort cards according to constantly changing categories in response to verbal feedback. Schizophrenics and frontal patients typically achieve a small number of categories and continue to sort by the same criterion, despite feedback indicating they are incorrect. The behavior of these patients illustrates that they can often explicitly state the underlying principles of the task, indicating awareness, yet fail to utilize these principles in their actual performance (e.g., Cohen & Servan-Schreiber, 1992; Goldberg & Weinberger, 1988; Stuss & Benson, 1984).

Questions about the relation between awareness and control touch on a number of applied issues. Perhaps there are situations in which we have

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more cognitive control than we are able to report. We may find cases for which elderly subjects' recollection, as measured by their objective performance, is higher than indicated by their subjective reports. Other times, subjective reports may claim more control than is evidenced by objective behavior. These discrepancies may arise because we sometimes do act and then make our excuses (e.g., Jacoby, Kelley, & Dywan, 1989) or, as with frontal-lobe patients, awareness is not always translated into a basis for cognitive control of behavior. Further, subjective experience is highly important for purposes of training performance, as discussed by Jacoby, Bjork, and Kelley in a report for the National Academy of Sciences (1994).

Diagnosing Age-Related Deficits in Recollection

The evidence, thus far, suggests that elderly adults experience pronounced declines in their ability to recollect, which can lead to dramatic action slips. But can we identify elderly adults who are more prone than others to these action slips? That is, can we diagnose individuals who suffer from extremely poor recollection? One common complaint about the elderly is their propensity for repeatedly telling the same story to the same audience. This error is produced in a similar manner as action slips—automatic influences of memory that push toward repeatedly telling a story are not successfully opposed by recollection for having previously told the story to the same individuals. Rather than serving as a basis for recognition of a story as previously told, automatic influences that result from an earlier telling might be misattributed to the story being particularly appropriate for the present audience. As a related example, it sometimes happens that we see a friend and think of a funny story that we are sure she would enjoy. After relating the story to our friend, she tells us that she did enjoy it, and that is why she earlier told it to us. Similar errors happen in professional settings, but are sometimes much less humorous. For example, a person presents a new idea for an experiment to another person but is discouraged from doing the experiment. Later, the critic presents the same idea as his own to the person from whom he unintentionally stole it. Not only can errors of this sort signify a deficit in recollection, but they can also indicate the severity of that deficit. For example, one would be less concerned about a colleague who repeats a story or idea one month later than a colleague who repeats a story or idea after five minutes.

We (Jennings & Jacoby, 1993b) designed a lab situation that mirrors this real-life example and allows us to determine the magnitude of change in recollection with age. The task we developed is similar to the fame task (Jacoby, Kelley, Brown, & Jasechko, 1989; Jacoby, Woloshyn, & Kelley, 1989) in producing misattributions of familiarity and draws on the lag paradigm originally used with stem completion. Young and elderly adults were

asked to study a list of 60 words followed by an inclusion and exclusion test. Both tests consisted of old and new words. The old words were given only a single presentation, but each new word was repeated once after 0, 3, or 12 intervening items. The second presentation of new words can be referred to as "catch items" (see later in this chapter) and are critical for assessing a misattribution of memory of the same sort that underlies repeated telling of a story.

For the exclusion test, subjects were asked to identify study words; they were to respond "yes" to old words but to respond "no" to new and catch items. The first presentation of catch items should increase their familiarity (Fischler & Juola, 1971; Underwood & Freund, 1970)—somewhat like telling a story once increases its chance of coming to mind again—and subjects could misattribute this familiarity to the prior study phase, confuse catch words with old ones, and mistakenly respond "yes." However, if subjects could recollect the source of a word's initial presentation (study vs. test), or recollect that they had already responded to a word, then any influence of familiarity would be opposed, and subjects would avoid responding "yes" (much like refraining from repeating a story). Telling subjects to respond "no" to catch words placed the automatic influence of familiarity and recollection in opposition; a catch word would elicit a "yes" only if it was sufficiently familiar (F) and not recollected as presented at test ($1 - R$).

In contrast, on the inclusion task, we told subjects to respond "yes" to *any* words they had seen before (words they had read aloud and catch words). In this case, both recollection and familiarity would lead to correctly responding "yes" to catch words. For an inclusion test, subjects could respond "yes" to a catch word either because it was recollected as being on the test list (R) or because, although recollection failed, the word was sufficiently familiar [$F(1 - R)$]. The process dissociation equations then allowed us to estimate the probability of basing a decision on recollection and automatic influences (familiarity) at each lag interval. Based on the example of repeating a story after five minutes, we wanted to determine the length of the interval between study and test necessary to show age differences in recollection; if this interval proved to be very short we could consider age deficits to be very strong.

Age-related declines in recollection proved to be surprisingly pronounced (see Table 9.5). Older adults revealed significantly worse recollection than young adults when only *three* items had intervened between the first and second presentation of a catch word, a time interval of less than 10 seconds! Moreover, performance continued to decline as the lag intervals increased. In contrast, automatic influences revealed no significant effect of age or delay (Table 9.5), although it should be noted that the elderly showed slightly higher estimates of familiarity than the young. This discrepancy stemmed from the elderly's tendency to show a higher level of base rate

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Young	.96
Elderly	.94

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TABLE 9.5
Probability of Basing a Decision on Recollection and Familiarity in a Recognition-Lag Task

	Recollection			*Familiarity*		
	0	*3*	*12*	*0*	*3*	*12*
Young	.96	.90	.83	—	.64	.66
Elderly	.94	.71	.51	—	.67	.74

Note: Estimates of familiarity could not be calculated at Lag 0. Because most subjects had a probability of correctly responding "yes" in inclusion of 1.0, and a probability of mistakenly responding "yes" in exclusion of 0, recollection equals 1.0, making the estimate of familiarity undefined.

responding "yes" to new items (.16), relative to the young (.10), inflating their estimates of automatic influences. When base rate is removed from these estimates, the difference between young and elderly is inconsequential.

This lag paradigm has provided us with a useful procedure for revealing deficits in recollection at short intervals. Moreover, this technique can easily be developed into a format that acts as a diagnostic tool. For example, deficits in recollection after only one or two intervening items or performance levels below the mean (i.e., greater than 25% errors) at longer intervals may act as warning signals for dementia.

Effects of Environmental Support on Memory Performance

Is nature so perverse that we are more likely to repeat a "stolen" story or idea to the person from whom we stole it than to anybody else? Perhaps. Consider the effects of reinstating context on automatic influences of memory. A person, originally from Scotland, enters a pseudo-Scottish pub in a North American city in which he has lived for a large number of years. Upon doing so, his Scottish accent becomes so "thick" that he cannot be understood by those accompanying him, and with some embarrassment he has to explain that he just asked if they would like to buy him a beer. A more important consequence of reinstating context can be seen in one condition of parole for ex-criminals. Upon release, they are not allowed to return to the environment that surrounded their crime. The belief is that returning to their old environment will cause them to reassume their automatic, antisocial ways of responding.

The distinction between controlled and automatic influences of reinstated context is important for treating those who have suffered a severe deficit in memory. What can be done about memory impairment? One approach is to design special environments that offer external cues and support to assist

memory performance (Park, 1992). The idea of environmental support was originally suggested by Craik (1983, 1986) to account for different patterns of age-related declines in a variety of memory tasks. Age differences in free recall are usually large, whereas differences in recognition are typically small (Craik & McDowd, 1987). To account for these differences, Craik suggested that memory and other cognitive tasks vary in the extent to which external context induces or supports the mental operations appropriate for the specific situation. Furthermore, he suggested that older adults are more reliant on such environmental support and can perform relatively well if support is present. The poor performance of the elderly in the absence of environmental support is said to result from their lessened ability to engage in self-initiated processing.

When the idea of environmental support is applied generally, it suggests that improving encoding or retrieval conditions should produce a pattern of compensation, with older people deriving more benefit from improved conditions than younger people, whose self-initiated processing is unimpaired. This pattern was observed in some early experiments reported by Craik and Byrd (1982); however, other studies have shown that older subjects benefited to the same extent as did their younger counterparts, or that younger subjects benefited more (Craik & Jennings, 1992; Light, 1991). How can these contradictory patterns of results be understood? One possible explanation is that environmental support may enhance only consciously controlled processes in some cases or only automatic processes in other circumstances, or improve both processes simultaneously. Consequently, the pattern of results may be dependent on the type of processing affected.

To truly understand the effects of environmental support, it is necessary to separate the contributions of automatic and controlled processes. Recent research using the process dissociation procedure has examined the effects of environmental support in the form of reinstating context across study and test conditions (Jacoby, in press). Subjects studied word pairs under conditions of full or divided attention. At test, subjects were asked to complete fragments corresponding to the second member of each pair under inclusion and exclusion instructions. For half of the test items, study context was reinstated. The results show that reinstating context increased estimates of automatic and consciously controlled processing for both groups (see Table 9.6).

However, there was a strong interaction between group and process. Automatic processing was equally enhanced for both full and divided attention subjects, whereas consciously controlled processing showed greater improvements in the full attention condition. Although these data do not shed light directly on the confusing pattern of results found in the aging literature, they do suggest that effects of environmental support on both automatic and consciously controlled processing must be considered.

TABLE 9.6
Estimates of Recollection and Automatic Influences as a Function of Reinstating Context for Full and Divided Attention

	Recollection	*Automatic*
Same context		
Full attention	.32	.45
Divided attention	.15	.46
Different context		
Full attention	.09	.37
Divided attention	.04	.38

Note: The baseline completion rate for items not presented at study was .32.

Although environmental support has the potential to facilitate memory performance in older adults, relying on highly structured environments can also have negative consequences. Research carried out by Langer (1981) suggests that oversimplifying or routinizing environments for the elderly can limit the potential stimulation for active, conscious information processing leading to "mindlessness." Environmental support is a two-edged sword, with the potential to both help and harm older adults. A similar paradox is reflected in childrearing. To parent effectively, one wants to structure the environment to encourage desirable behaviors but not completely rob a child of control or autonomy when eliciting such conduct; one wishes to be caring but not overbearing. Similarly, with older adults, incapacititating consciously controlled processing with highly structured environments can lead to self-induced dependence, perceived loss of control, and poor mental health (Langer, 1981).

Rehabilitating Recollection

Rather than structuring the external environment to aid memory, a more internal approach lies in the rehabilitation of memory through training. Typically, efforts to improve memory in the aged have focused on elaborate encoding schemes (for a review, see Kotler-Cope & Camp, 1990), such as pegword mnemonics (Wood & Pratt, 1987) and method of loci (Kliegl, Smith, & Baltes, 1989; Robertson-Tchabo, Hausman, & Arenberg, 1976). Although some improvement has been demonstrated, these effects are usually task specific and shortlived (Scogin & Bienias, 1988; Wood & Pratt, 1987).

More recently, rehabilitation has focused on training automatic retrieval processes. The spaced retrieval technique (Camp & Schaller, 1989; Landauer & Bjork, 1978; Schacter, Rich, & Stampp, 1985) and method of vanishing cues (Schacter & Glisky, 1986) are designed to create habits or automatic responses through repeated rehearsal, allowing memory-disordered subjects to acquire a limited amount of new information. Unfortunately, these techniques are

open to error. If the strongest automatic response that comes to mind during training is erroneous, then the wrong habit may be strengthened (Baddeley & Wilson, 1994). One means for avoiding this drawback, which we are currently exploring, involves training controlled uses of memory (i.e., recollection).

We believe that training recollection may be possible with memory-impaired individuals who retain some consciously controlled processing, such as the elderly, and patients with mild to moderate memory deficits. It is this approach for improving memory performance that we are currently attempting to use with older adults. In the experiments described earlier, elderly adults showed some degree of spared recollective processing. We (Jennings & Jacoby, 1993b) want to train that ability by placing the elderly in a situation in which recollection is easy, and then, by gradually increasing the difficulty, shape recollective processing. Slowly moving the elderly from a situation in which they can perform competently may allow them to adapt their recollective process to more demanding situations.

The rationale underlying our attempt to train recollection harks back to the example of an elderly adult repeatedly telling the same stories. Even if memory is badly impaired, the elderly adult is quite unlikely to immediately repeat a story. What if we could train him or her to extend that delay? What is needed are many stories along with some method of controlling the opportunity for retelling a story so as to "shape" recollection. The methodology employed for the recognition lag paradigm described earlier has been adapted for training, although only the *exclusion* condition was used. Because this condition sets familiarity (automatic influences) and recollection in opposition, we can infer recollection, or lack thereof, through errors (responding "yes" to catch words). Moreover, we can reinforce responses that are based on recollection (responding "no" to catch words). During training, elderly subjects had to recollect catch words shortly after their initial presentation when recollection was easy (i.e., one intervening item). Positive feedback followed each correct response. The test intervals increased slowly across the training sessions as performance improved. Ideally, with repeated practice and feedback, the elderly should show accurate recollection across longer and longer delays.

The critical question was whether recollection could be improved by shaping across a small number of training sessions. Elderly subjects received four training sessions a day for seven days, and each training session was a miniature exclusion task. For each session, subjects were asked to read aloud and learn a list of 30 words. They were then given a training phase in which they were shown the 30 words they had seen at study and 30 new words, and the 30 new words were repeated at one of two lags. Subjects were asked to respond "yes" to the study words, but "no" to the new and catch items, and were given positive feedback whenever they responded correctly. See Table 9.7 for the method.

Study Phase:
30 words read aloud and
Test Phase:
Yes/no recognition test
30 old words
30 new words, each prese
Respond "yes" to old word
Respond "no" to new wor
Positive feedback for corre
Remaining Sessions:
Same procedure but lag int
Lag conditions can increase

The shaping proced
Session 1 words were re
performed to criterion, t
and three items. If subje
to 2 and 4 items, and s
that subjects were alwa
and was therefore easy
difficult. Criterion perfo
young adults in our pr
criterion at both lags, th
many sessions as requir
intervals increased. Impr
ing the length of the inte
and last day of training
training, then we improv

Because the experime
the seven experimental su
tion during training. Exan
the first day of training,
item intervened between
training, however, these
occurred.

In order to ascertain
technique or merely arose
control subjects. These sui
experimental subjects wit
increases in the lag inter
ordered set of lag pairs
improvements, we could l
the experimental group w

TABLE 9.7
Example Training Session

Study Phase:
30 words read aloud and studied (2 sec rate)
Test Phase:
Yes/no recognition test
30 old words
30 new words, each presented twice after one or two intervening items (Lags 1 & 2)
Respond "yes" to old words only
Respond "no" to new words for both presentations
Positive feedback for correct responses
Remaining Sessions:
Same procedure but lag intervals increase when performance reaches criterion
Lag conditions can increase from 1 and 2, to 1 and 3, to 2 and 4, and so on to 16 and 40

The shaping procedure was implemented through the lag conditions. In Session 1 words were repeated after one or two intervening items. If subjects performed to criterion, then in Session 2 the lag conditions increased to one and three items. If subjects again performed to criterion, the lags increased to 2 and 4 items, and so on to 16 and 40. These lag pairs were chosen so that subjects were always working at one lag interval they had mastered and was therefore easy, and a second interval that was new and more difficult. Criterion performance was the level of performance shown by young adults in our previous experiment. If subjects did not achieve the criterion at both lags, they continued to work at those lag intervals for as many sessions as required to reach it. Once the criterion was met, the lag intervals increased. Improvements in performance were gauged by comparing the length of the interval in which subjects reached criterion on the first and last day of training. If interval length increased significantly during training, then we improved recollection.

Because the experiment is still in progress, our data are preliminary. Six of the seven experimental subjects revealed a dramatic improvement in recollection during training. Examining the group results, one can see those gains. On the first day of training, subjects performed below criterion when only one item intervened between the first and second presentation of a word. After training, however, these subjects performed to criterion when 28 items occurred.

In order to ascertain whether these effects stemmed from our shaping technique or merely arose from practice or bias effects, we tested a group of control subjects. These subjects were given the same amount of training as our experimental subjects without the shaping procedure. Rather than gradual increases in the lag intervals, control subjects were presented a randomly ordered set of lag pairs across sessions. If they did not show significant improvements, we could be more confident that any gains in performance by the experimental group were due to training.

The control subjects did not show the same level of improvement found with the experimental subjects. Two control subjects demonstrated gains in performance, whereas the other three subjects showed no improvement. The group data thus indicated moderate positive change, which suggests that the control subjects experienced a practice or training effect that was unrelated to the shaping procedure. In contrast, the experimental group's results, which exceeded the control group's gains, suggest that shaping has some additional influence on performance. The results of our training procedure appear encouraging thus far, but this experiment was only meant to be a preliminary attempt at training. Future work will capitalize on these results and involve changes designed to increase training effects, produce transfer from these effects to real life, and maintain long-term performance.

SUMMARY AND CONCLUSIONS

Among the most important practical problems faced by psychology is that of measuring cognitive control. Everyday life is replete with examples showing the necessity of distinguishing between automatic and consciously controlled influences of memory. To understand errors such as action slips and repeated telling of a story, it is necessary to separate the contributions of these processes within a task, rather than identifying each type of process with a different task, as is done by the implicit and explicit memory distinction. The process dissociation procedure accomplishes this goal by combining results from a condition for which automatic and controlled processes act in opposition with results from a condition for which the two types of processes act in concert. Doing so provides the intuitively appealing definition of cognitive control as the difference in performance between when one is trying to versus trying not to engage in some act or be influenced by information from some source.

Results from use of the process dissociation procedure are highly encouraging. Factors traditionally associated with reduced cognitive control, such as divided attention and age-related deficits in memory, have the effect of reducing recollection but leave automatic influences unchanged. The effects on estimated recollection are sufficiently large and reliable to enable the procedure to be used as a diagnostic tool. Moreover, the process dissociation procedure offers advantages over traditional measures of recollection, which are inflated by guessing that reflects automatic influences of memory. Further, subjective reports of memory deficits are in good accord with the objective measure of cognitive control provided by the process dissociation procedure, suggesting that a diagnostic test based on this procedure would reflect capacities relevant to real life. Finally, use of the process dissociation procedure to analyze the effects of reinstated context showed effects on automatic

influences that are separate from effects on controlled use of memory. That there are two effects of reinstating context is important for the design of special supportive environments to diminish consequences of memory impairment. However, a more ambitious goal for memory remediation is to devise techniques for rehabilitating recollection. Such techniques would complement attempts to exploit preserved, automatic influences of memory through training or special environments (e.g., Baddeley & Wilson, 1994).

The layperson refers to cognitive control by using terms such as *will* that have long been in disrepute because of their philosophical implications but are important for society. Recently, the philosophical issues surrounding consciousness and intention have again gained prominence in psychology. Psychologists can contribute to those discussions by showing the *practical* importance of the distinction between automatic and controlled processes. This distinction can be applied to improve methods for the diagnosis and treatment of memory deficits. A failure to do so reflects a lack of will.

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