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# Awareness, Automaticity, and Memory Dissociations

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There has been considerable recent interest in the relationship between direct and indirect tests of memory (e.g., Richardson-Klavehn & Bjork, 1988). On a direct test, such as recall or recognition, subjects are specifically instructed to consciously recollect a prior episode. On an indirect test, such as word fragment completion or exemplar generation, memory for the target episode is inferred from its effects on task performance (e.g., facilitated fragment completion for previously studied words). Indirect tests are intended to measure automatic influences of memory—that is, effects of memory that are not mediated by intentional retrieval and are not accompanied by a subjective experience of remembering—whereas direct tests are intended to measure intentional, aware uses of memory. The exciting finding is that performance on these two types of memory tests can be independent. For example, Weiskrantz and Warrington (1975) reported that amnesic subjects, who performed very poorly on a direct test of recognition memory, gained as much benefit from prior exposure to solution words on fragment completion as did control subjects.

It is tempting to assume that there are direct one-to-one correspondences (1) between the type of test subjects are given and the underlying memory system that supports test performance, and (2) between the underlying memory system and subjective experience. For example, subjects given an indirect test might use memory for a prior episode without having the subjective experience of remembering that episode, and such effects might reflect the operation of a special implicit memory system or process (Schacter, 1987). Most researchers have made these assumptions, if only tacitly, and treated deviations from these one-to-one correspondences as matters of measurement error. In what follows, we argue that the linkage among kind of test, kind of subjective experience, and kind of underlying memory process is not so fixed. Drawing a parallel between memory and attention, we argue that performance on any memory test is a joint product of controlled and automatic uses of memory, and propose that the subjective experience that accompanies task performance (e.g., remembering) is the product of an interpretive process by which current mental events are attributed to specific sources (e.g., memory) on the basis of evidence. One implication of these claims is that particular memory processes cannot be identified with



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particular tasks, because all tasks draw on multiple processes. As an alternative to identifying processes with tasks, we describe a "process dissociation procedure" that allows one to separate the contributions of different processes to performance on a given task. We believe that these procedures, developed in studies with normal undergraduates, will prove useful for specifying the nature of memory deficits suffered by patient populations.

## Subjective Experience

Although cognitive psychology has been defined as "the science of the mental life" (e.g., Miller, 1966), most contemporary theorists pay scant attention to subjective experience (but see Bowers & Hilgard, 1988; Gardiner, 1988; Johnson, 1988). This is unfortunate, because people often act on the basis of their subjective interpretation of events. One possible reason for the neglect of subjective experience is that it is often viewed as simply reflecting the activation of underlying memory representations or systems; for instance, the subjective experience of remembering is assumed to arise from activation of episodic memory traces. An alternative view is that subjective experience reflects an inference or interpretation, created to make sense of the way people interact with the world around them. In such a constructive view of consciousness (Jacoby & Kelley, 1987; Mandler & Nakamura, 1987; Marcel, 1983), there is no necessary correspondence between subjective experience and form of underlying representation. For example, people can have the subjective experience of remembering in the absence of a corresponding "episodic" memory trace (as in *déjà vu*), and can use memories of specific past events without being aware of doing so (as in involuntary plagiarism; Brown & Murphy, 1989). We propose that subjective experience is based on qualitative aspects of how an event is processed, coupled with the (subjectively assessed) demands present in the current situation (Kelley & Jacoby, 1990).

It is reasonable to propose that qualities of current mental events provide a basis for memory judgments, because the use of memory does in fact influence the nature of current processing. One common effect of past experience is to make processing in the present more efficient, rapid, or fluent. For example, prior experience can enhance the perception of briefly flashed words or visually degraded pictures (Jacoby & Brooks, 1984; Jacoby & Dallas, 1981), the completion of word fragments (Tulving, Schacter, & Stark, 1982), the ability to solve problems or answer questions (Jacoby & Kelley, 1987; Kelley & Lindsay, 1992; Needham & Begg, 1991), and the speeded reading of text (Kolers, 1976).

Fluent processing is generally a reliable cue to the use of memory, because past experience so often does facilitate later performance, and these transfer effects are remarkably specific (Jacoby, Kelley, & Dywan, 1989). However, fluent processing can arise from sources other than memory. If oriented to the past, people may mistake ease of processing for an indication of prior occurrence. Consistent with this hypothesis, illusions of remembering have been produced by manipulating the visual clarity of memory test items (Whittlesea, Jacoby, & Girard, 1990) and the ease of completing word fragments presented as recall cues (Lindsay & Kelley, 1991). Similarly, Jacoby and Whitehouse (1989) found that unconscious perception of a new word prior to its presentation as a test item increased the probability of its being falsely recognized as old. Presumably, the unconsciously perceived presentation facilitated processing of the subsequent test word. In turn, the relative ease of processing produced a feeling of familiarity that was attributed to the prior study list. Importantly, when subjects were made aware of the flashed word (by increasing its duration), the probability of false recognition *decreased*. Being aware that the new test item was recently presented, subjects could discount or correctly attribute the source of their fluent processing. Finding qualitatively different effects for aware and unaware conditions is crucial for establishing the existence of unconscious perception (Cheesman & Merikle, 1986; Dixon, 1981; Holender, 1986). More generally, the strategy of placing conscious and unconscious processes in opposition allows one to isolate their separate contributions to performance. We discuss this strategy in greater detail in a later section.

Illusions of memory such as those described above show that one can have the experience of remembering in the absence of an underlying memory representation. Perceptual illusions have been helpful in uncovering the environmental cues that are used to construct perceptual experience (e.g., Brunswik, 1956). Similarly, memory illusions can be used to specify the cues that support an attribution of pastness (Jacoby, Kelley, & Dywan, 1989; Kelley & Jacoby, 1990). Our results suggest that fluency of processing is one such cue, and that subjects' current orientation influences their interpretation of variations in fluency. In each of the experiments described above, subjects were not informed of manipulations of fluency; instead, they were directed to make fine discriminations concerning a past event. Under these conditions, relatively small differences in processing fluency were interpreted as resulting from prior experience. However, if subjects are made aware of the source of these processing differences, illusions of remembering disappear (Jacoby & Whitehouse, 1989; Whittlesea et al., 1990). These results suggest that subjective experience is sensitive to current task demands as well as to prior experience.

Additional support for an attributional basis of subjective experience is provided by studies showing that unconscious influences of memory can be misattributed to the present. Fluent processing as a result of prior exposure can lengthen the apparent duration of a word that is flashed (Witherspoon & Allan, 1985), can lower the background noise accompanying the presentation of a sentence (Jacoby, Allan, Collins, & Larwill, 1988), and can increase the apparent fame of nonfamous names (Jacoby, Kelley, Brown, & Jasechko, 1989). Jacoby, Woloshyn, and Kelley (1989) had subjects study a list of nonfamous names under conditions of either full or divided attention. Later, subjects were asked to make fame judgments on a list of names, some of which were the nonfamous names they had read earlier. Subjects were told that all of the names read earlier were nonfamous. Nevertheless, in comparison to a set of new names, more of the old names were judged as famous in the divided-attention group. This can clearly be interpreted as an unconscious influence of memory, because if subjects could consciously recollect a name's prior occurrence, they could be sure it was not famous. It appears that, like a brief presentation, dividing attention reduces the ability to consciously recollect the past, thus increasing susceptibility to unconscious influences.

An analogous point is made by recent studies investigating the "mere-exposure effect" (Zajonc, 1968). Presentation of geometric shapes (Kunst-Wilson & Zajonc, 1980; Seamon, Brody, & Kauff, 1983a, 1983b) and photographs of human faces (Bornstein, Leone, & Galley, 1987) at exposure durations too short to support above-chance-level recognition performance can nevertheless positively influence subsequent preference judgments (see Johnson, Kim, & Risse, 1985, for related work with Korsakoff patients). Interestingly, exposure effects in the absence of recognition are not specific to preferences, but can also influence judgments of contrast (Merikle & Reingold, 1991), brightness or darkness (Mandler, Nakamura, & Van Zandt, 1987), and even "familiarity" (Bonanno & Stillings, 1986). These findings reinforce our belief that subjective experience reflects an interpretive process, rather than being an inherent characteristic of the memory representation.

The subjective experience of remembering is often a valid indication of previous occurrence. However, the use of the past is often unconscious (Jacoby & Kelley, 1987) or misattributed to the present (Jacoby, Kelley, & Dywan, 1989). Moreover, as shown by illusions of memory as well as by confabulation in certain clinical cases (Baddeley & Wilson, 1986; Johnson, 1991; Moscovitch, 1989; Stuss & Benson, 1986), a feeling of remembering does not require an underlying memory trace. These observations are inconsistent with the assumption that subjective experience resides in memory traces or particular memory systems (e.g., Tulving, 1985). A related assumption—the notion that a memory test can be treated as a pure measure of a specific memory process—is discussed below.

## The Factor-Pure Assumption

"There is no such entity as a 'pure' behavioral task, that is, a task that reflects only a single process or capacity" (Weiskrantz, 1989, p. 102). Weiskrantz offered this statement as one of several "dogmatic propositions with which most practicing neuropsychologist would agree" (p. 102), and we too would endorse it. Yet, despite this apparent consensus, neuropsychologists and others who study cognition often interpret tasks as though they were factor-pure measures of particular processes. Indeed, a good deal of the psychological literature could be characterized as an attempt to develop (or to criticize others' attempts to develop) factor-pure measures (Holender, 1986; Richardson-Klavehn & Bjork, 1988).

Because tasks are not factor-pure measures of processes, memory researchers often rely on findings of task dissociations. The current interest in indirect memory tests owes much to the discovery that amnesic subjects can show retention performance equivalent to that of normals (e.g., Weiskrantz & Warrington, 1975; Shimamura, 1986), and to subsequent findings of task dissociations in normals (e.g., Jacoby & Dallas, 1981; Tulving et al., 1982). Indeed, dissociations between performance on direct and indirect tests have led some researchers to propose a distinct area of research, the focus of which is "implicit memory," the form of memory revealed on indirect tests (Schacter, 1987). A task dissociation constitutes evidence that the tasks differ in at least one underlying process (Dunn & Kirsner, 1989), but could only necessitate postulating distinct forms of memory if retention tests were factor-pure. Tasks are not factor-pure; multiple processes can contribute to performance on any given task. This is evidenced by the variable relationship between tasks across experiments: The studies mentioned above reported dissociations between direct and indirect memory tests, but other studies have reported parallel effects between direct and indirect measures (Hunt & Toth, 1990; Jacoby & Dallas, 1981; Rappold & Hashtroudi, 1991; Schacter & Graf, 1986; Toth & Hunt, 1990) and dissociations between different indirect measures (Hunt & Toth, 1990; Roediger, Weldon, & Challis, 1989; Witherspoon & Moscovitch, 1989). This complex pattern of findings clearly indicates that a factor-pure interpretation of retention measures is untenable.

The theoretical issues surrounding interpretation of "implicit" memory effects are similar to those encountered in discussions of automaticity. We believe that comparisons between direct and indirect tests of memory are best understood as members of a larger class of task manipulations that have been used to explore the distinction between intentional and automatic processes (Jacoby, 1991; Jacoby & Kelley, 1991; Klatzky, 1984; Logan, 1990). Attention researchers have long been concerned with separating the contributions of automatic and controlled processes to task performance. We have found it useful to think of memory in this framework. Direct tests of memory may be described as requiring more controlled processes, whereas indirect tests may reflect more automatic uses of memory. It is becoming increasingly clear, however, that performance is never purely automatic or controlled (Allport, 1989; Neumann, 1984). Viewing task performance as the joint product of automatic and controlled processes provides an alternative to identifying tasks with specific processes or systems. Furthermore, this approach encourages research designed to separate automatic from controlled processes within a single task. In what follows, we describe a technique for accomplishing this goal.

## Advantages of Opposition

Most indirect memory tests (e.g., fragment completion) can be described as "facilitation paradigms," in that the use of memory facilitates performance of a task (e.g., prior exposure to solution words facilitates fragment completion). One major problem with facilitation paradigms is that both automatic and intentional uses of memory for studied items can facilitate task performance. How can one be sure that a particular finding reflects unaware rather than aware uses of memory? One approach is to ask subjects to report on their awareness. A problem with this method is that it relies on subjects' definitions of "awareness" (Merikle, 1984). Furthermore, asking subjects to describe their subjective experience while taking the test (e.g., Gardiner, 1988) may affect that experience as well as performance, and posttest recollections of awareness during the test (e.g., Bowers & Schacter, 1990) may not be accurate or easy to interpret.

An alternative approach to demonstrating automatic influences of memory is to use an interference paradigm instead of a facilitation paradigm. In an interference paradigm, the situation is set up so that aware remembering will have an effect opposite to that of automatic influences of memory. Thus any effect of the study episode can be attributed to automatic effects of memory. For example, in Jacoby, Woloshyn, and Kelley's (1989) "false fame" studies, we know that the effect of prior exposure to nonfamous names on subsequent fame judgments reflected an automatic influence of memory, because subjects were told that the studied names were not famous. Likewise, it is clear that Jacoby and Whitehouse's (1989) subjects did not consciously perceive the briefly presented previews of recognition test items, because aware perception of preview items in a long-exposure condition had an opposite effect to that obtained with brief exposures. As a final example, by telling subjects at test not to report any postevent information, Lindsay (1990) provided unambiguous evidence that misleading postevent suggestions can impair ability to recall event details (e.g., Loftus, Miller, & Burns, 1978).

Interference paradigms allow one to demonstrate the existence of automatic effects of memory. However, those effects are underestimated because they are countervailed by controlled uses of memory. Also, interference paradigms do not yield quantitative estimates of separate processes, and so cannot be used to detect invariances in a particular kind of process across different conditions or populations. For example, early evidence suggested that performance on indirect memory tests does not decline with age, but more recent studies have reported age-related deficits in performance (see Hultsch & Dixon, 1990). This lack of consistency across studies may reflect differential contributions of automatic and controlled processes to different indirect tasks. In order to answer a question such as "Are automatic retrieval processes invariant across age?", one must be able to estimate the separate contributions of different processes to task performance. In the next section, we describe how interference and facilitation paradigms can be combined to yield separate quantitative estimates of automatic and controlled processes.

## A Process Dissociation Procedure

Dual-process theories of recognition (e.g., Atkinson & Juola, 1974; Jacoby & Dallas, 1981; Mandler, 1980) propose that conscious recollection and judgments of familiarity are alternative bases for recognition memory decisions. Compared with recollection, judgments of familiarity are relatively automatic, in that they tend to be faster, less effortful, and less reliant on intention. It follows that, as with indirect tests of memory, performance on direct tests such as recognition is jointly determined by controlled and automatic uses of memory.

Jacoby (1991) has introduced a method for obtaining separate estimates of the contributions of familiarity and recollection to recognition memory judgments. The procedure involves comparing performance in a facilitation or "inclusion" test condition (in which familiarity and recollection have the same effect) with performance in an interference or "exclusion" test condition (in which familiarity and recollection have opposing effects). For example, to assess the separate contributions of recollection and familiarity to recognition of a visually presented list of words, subjects may be given two lists at input—one presented visually, the other presented aurally. In an inclusion test condition, subjects are told to accept (say "yes" to) all old items regardless of presentation list, and to reject only new items. Because to-be-included items could be correctly accepted on the basis of either familiarity or recollection, the probability of accepting a to-be-included item is the sum of the probability of the item being familiar (F) and the probability of the item being recollected (R), minus the intersect ($F \circ R$):

$$P(\text{accept}|\text{to-be-included}) = F + R - (F \circ R)$$

In contrast, an exclusion test condition asks subjects to accept *only* items that were heard and to reject items from the visual list as well as new items. Subjects are correctly told that if they can recollect an item as one that they saw, they can be certain that the word was *not* presented in the list that they heard. Thus, to-be-excluded items that subjects incorrectly accept (i.e., visual items) must be familiar (F) but not be recollected (1 − R); otherwise, subjects would not accept them. The probability of incorrectly accepting a to-be-excluded item can therefore be expressed as follows:

$$P(\text{accept}|\text{to-be-excluded}) = F \circ (1 - R) = F - (F \circ R)$$

These equations and the observed probabilities permit estimates of the contributions of recollection and familiarity to be derived with simple algebra. For example, Jacoby (1992; see Jacoby & Kelley, 1991) explored the effects of dividing attention at study on subsequent recollection and familiarity. Subjects judged the relatedness of word pairs under conditions of full or divided attention, then heard a second list of words. At test, subjects in the inclusion condition were to accept any word presented in either of the earlier phases, whereas subjects in the exclusion condition were to accept only heard words. The results are presented in Table 4.1. In the inclusion conditions, subjects correctly accepted more words from related than from unrelated pairs, and dividing attention at study decreased correct recognition. In the exclusion conditions, on the other hand, subjects incorrectly accepted more words from unrelated than from related pairs, and dividing attention at study increased erroneous acceptance. The observed probabilities are sufficient to permit the conclusion that recollection was greater for words from related pairs, and that dividing attention impaired the use of recollection. However, without separate estimates of the two processes, these proba-

**TABLE 4.1.** Observed Probabilities of Accepting Test Items and Estimated Probabilities of Recollection and Familiarity as a Function of Attention at Study, Item Type, and Test Instructions

| | Observed probabilities | | Estimated probabilities | | | |
|---|---|---|---|---|---|---|
| | Item type | | Recollection | | Familiarity | |
| | Rel. | Unrel. | Rel. | Unrel. | Rel. | Unrel. |
| Full attention | | | | | | |
| Inclusion | .83 | .70 | .52 | .32 | .646 | .558 |
| Exclusion | .31 | .38 | | | | |
| Divided attention | | | | | | |
| Inclusion | .75 | .61 | .28 | .12 | .652 | .557 |
| Exclusion | .47 | .49 | | | | |

*Note*. Estimated recollection = P(accept|to-be-included) − P(accept|to-be-excluded). Estimated familiarity = P(accept|to-be-excluded)/(1 − recollection). From *Separating Automatic and Intentional Bases for Recognition Memory: Attention, Awareness, and Control* by L. L. Jacoby, 1992, manuscript submitted for publication.

bilities do not allow definitive conclusions concerning the effects of relatedness and attention on familiarity.

Using the process dissociation formulas described above, Jacoby (1992) estimated the separate contributions of familiarity and recollection to recognition responses on words studied in related and unrelated pairs. These estimates, presented in Table 4.1, can be derived from the equations presented at the bottom of the table. For example, the recollection (R) value of words from related pairs in the full-attention condition can be obtained by subtracting the probability of accepting to-be-excluded items from the probability of accepting to-be-included items (.83 − .31 = .52). Familiarity (F) can then be calculated by dividing the probability of accepting to-be-excluded items by the inverse of recollection (.31/[1 − .52]). Applying this same procedure to each set of conditions yields separate estimates of R and F.

As predicted, dividing attention at study dramatically reduced estimates of recollection (from .52 to .28 for words from related pairs, and from .32 to .12 for words from unrelated pairs), but had absolutely no effect on estimates of familiarity (.646 and .652 for words from related pairs, and .558 and .557 for words from unrelated pairs). Similar results were obtained by Jacoby (1991); estimations of familiarity were found to fit the observed probabilities of erroneously accepting to-be-excluded old items when attention was divided at test. These studies suggest that dividing attention at study or at test can block subjects' use of recollection as a basis for recognition judgments, thus leaving familiarity-based responding relatively unopposed. Most important, the invariance in familiarity across conditions could not have been established by equating processes with tasks and then examining task dissociations, because tasks are rarely process-pure.

The above-described findings suggest that dividing attention has effects similar to those seen in certain amnesic syndromes. Speculatively, amnesia may produce deficits in controlled processing (e.g., recollection) while leaving automatic influences of memory (e.g., familiarity) in place. However, the effects of dividing attention do not always parallel those of amnesia (e.g., Nissen & Bullemer, 1987). This may be because some secondary tasks act to change the segmentation of the primary task or break up its continuity, thereby influencing automatic as well as controlled processing. To understand the effects of divided attention on memory along with its relation to amnesia, it will probably be necessary to specify the relation between primary and secondary tasks more fully (Allport, 1989; Broadbent, 1989; Neisser, 1980). Without a method for separating automatic from controlled uses of memory, any selective impairments produced by either amnesia or divided attention cannot be clearly identified.

We believe that the process dissociation procedure is an important methodological tool that can be used to investigate a number of problems confronting memory researchers. For example, in the experiment described above, Jacoby (1992) found that words studied in related pairs were later more familiar than words studied in unrelated pairs (Table 4.1). Similarly, Jacoby (1991) obtained higher estimates of familiarity on items studied as anagrams to be solved than on items studied as words to be read aloud. These are important findings, because familiarity has previously been described as reflecting the match between study and test in perceptual characteristics (Jacoby & Dallas, 1981; Mandler, 1980). The results described here show that familiarity is not totally reliant on perceptual characteristics, but, rather, can also reflect prior conceptual processing.

The ability to compare a particular cognitive process in different populations and conditions is an important goal for memory researchers. Similar to signal detection theory (Swets, Tanner, & Birdsall, 1961), the process dissociation procedure separates the contribution of different processes to task performance, allowing one to discern invariance in one process across variations in another. In the studies reported above, for example, recollection was shown to be greatly impaired by dividing attention, whereas familiarity remained invariant across manipulations of attention. That invariance could not be shown without a procedure for separately estimating the processes contributing to performance.

The formulas described above were designed to separate the contributions of controlled and automatic processes to recognition memory judgments, but they can be applied to any domain in which two processes are hypothesized to make independent contributions to performance. One assumption of the process dissociation procedure is that similar judgment criteria are used in the inclusion and exclusion conditions. We know that this assumption was met in Jacoby (1991), because performance in the two conditions was nearly identical on heard and new items; Jacoby (1992) avoided criterion differences by using a forced-choice test. In other experiments, however, we have sometimes encountered differences in judgment criteria. Thus, as the approach is extended to other domains, details of the experimental conditions and/or formulas may need to be modified. For example, we are currently using process dissociation procedures to explore cued recall, stem and fragment completion, unconscious perception, and Stroop (1935) effects. Preliminary results in each of these areas are very encouraging.

## Summary and Conclusions

In this chapter, we have challenged the notion that there are direct one-to-one mappings between tasks and processes and between processes and subjective experiences. Our argument is that the linkage among kind of test, kind of underlying representation, and kind of subjective experience is a rather loose one. One implication of this view is that subjective experience involves an unconscious inference whereby current mental events are attributed to sources on the basis of evidence. Another implication is that particular cognitive processes cannot be identified with particular tasks, because virtually all tasks involve the integration of multiple processes. Finally, we have described a "process dissociation procedure" that allows one to derive separate estimates of the different processes contributing to performance on a task. Application of the procedure in studies of recognition memory provided support for a dual-process model of recognition (Jacoby & Dallas, 1981; Mandler, 1980) and evidence that familiarity-based responding can reflect prior conceptual as well as perceptual processing.

We have described the process dissociation procedure in some detail, because we believe that it will prove useful for specifying the nature of cognitive deficits caused by neurological damage. For example, a process dissociation might reveal that frontal lobe patients have deficits in recollection but retain normal levels of familiarity. Other studies might show parallel disruptions in different clinical populations (e.g., frontal damage vs. normal aging). Findings of this sort would be important, not only for illuminating the consequences of neurological insult, but also for suggesting approaches to rehabilitation.

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