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CHAPTER 10

Unconscious Influences of Memory: Dissociations and Automaticity

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10.1. INTRODUCTION

The unconscious has long held fascination for the lay person as well as for psychologists. The lay person has viewed the unconscious as a potential threat because it represents a source of influence on behaviour that is beyond one's control. That threat has been intensified by sensationalistic claims of subliminal advertising and 'mind control'. Experimental psychologists, in contrast, have countered sensationalistic claims and sometimes have ended questioning the very existence of unconscious influences. Research on unconscious processes has been plagued by theoretical and methodological problems. Because of those problems, the unconscious along with its complement, consciousness, was banished by radical behaviourists and has only recently regained acceptance as a topic for research (see Hilgard, 1980 for a review of the history of consciousness). For most people, the term 'unconscious' brings the psychoanalytic tradition to mind. However, the unconscious that has recently gained prominence is cognitive rather than psychoanalytic (for a discussion of the differences see Eagle, 1987, and Kihlstrom, 1987). The cognitive unconscious and its association with attention owes more to James than to Freud.

Why the resurgence in interest in unconscious processes? Two recent developments in theory and experimental procedures made research on unconscious processes seem tractable in ways that it was not previously. Firstly, the distinction between automatic and controlled processing in theories of attention (LaBerge & Samuels, 1974; Posner & Snyder, 1975; Shiffrin & Schneider, 1977) led to a great deal of research

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into processes that are unconscious by way of being automatic. As a function of extended practice, performance of a task becomes more efficient and seems to no longer require attention. This withdrawal of attention corresponds to James' (1890) description of the automaticity that accompanies the development of habit, and contrasts with the consciously controlled use of reason that would otherwise guide behaviour. Automatic processing is driven by the environment whereas controlled processing is controlled by the person via selective attention. Automatic processing has been defined as not requiring attention, and as occurring with neither intent nor awareness. By its list of putative characteristics, the automatic corresponds to unconscious processes and the controlled corresponds to conscious processes.

Secondly, exciting dissociations between direct and indirect tests of perception and memory reveal effects on indirect tests in the absence of direct report or awareness of those effects. Neurological deficits supply striking examples of perceptual analysis in the absence of conscious seeing and effects of the past in the absence of remembering. For an indirect test, people are not instructed to report on an event, but rather engage in some task that can indirectly reflect the occurrence of that event. For example, completing word fragments or identifying briefly presented words are indirect tests of memory because the probability of a correct response is influenced by earlier reading of the word whether or not people can remember the word.

As noted in other chapters in the present volume, dissociations between performance on indirect versus direct tests are common. In blindsight, patients can make visual discriminative responses without the subjective experience of seeing (Weiskrantz, 1986). In prosopagnosia, patients can make discriminative GSR responses to familiar faces, without the subjective experience of recognizing those faces (for a review see Young & De Haan, 1990, and Chapter 4 this volume). In Korsakoff amnesia, patients can give correct memory responses without the subjective experience of remembering (e.g. Warrington & Weiskrantz, 1974). Normal subjects also show dissociations between their performance on indirect versus direct tests of memory (for reviews, see Richardson-Klavehn & Bjork, 1988, and Hintzman, 1990). In unconscious perception (Marcel, 1983a), subjects show priming effects of briefly presented pattern-masked words in a lexical decision task, although they were unable to report that a word had been flashed when given a direct test of perception.

A direct test involves intention to report a particular event and awareness of having been influenced by that event, whereas an indirect test may not. Because of these differences, performance on an indirect test appears to be more under control of the stimulus environment (as structured by the indirect test) whereas performance on a direct test appears to be more under the control of the subject. This difference in control is partially captured by the use of the distinction between data-driven versus conceptually driven processing to account for dissociations between performance on indirect and direct tests of memory. Performance on indirect tests such as tests of perceptual identification or fragment completion seems to rely on prior data-driven processing of the perceptual characteristics of tested items, whereas performance on direct tests of memory appears to rely on prior conceptually driven processing of tested items (e.g. Jacoby, 1983; Roediger & Blaxton, 1987; Roediger, 1990).

It should be noted that we have used the distinction between direct versus indirect tests (e.g. Marcel, 1983a; Johnson & Hasher, 1987), rather than the implicit versus explicit distinction that is used by others contributing chapters to this volume. We prefer the indirect/direct distinction because the terms implicit and explicit have been used to refer both to the difference in instructions for the types of test and to the processes underlying performance on the two types of test (e.g. Richardson-Klavehn & Bjork, 1988). Distinguishing between tasks and underlying processes is important to us because we describe the processing differences between tasks in terms of the contrast between automatic and intentional processing. We argue that the difference in underlying processing is more fundamental than is the difference between the instructions given for the two types of test.

The distinction between automatic versus consciously controlled processing and that between direct versus indirect tests is more similar than is generally acknowledged (but see Klatzky, 1984). In the case of memory, it seems quite natural to say that performance on an indirect test reflects automatic processing whereby the indirect test automatically recruits and uses information from a prior episode without the subject's intention, without any extra expenditure of attention, and without any awareness of doing so. In this vein, at least some indirect tests of memory are unaffected by divided attention manipulations, whereas direct tests of memory show decrements when attention is divided (Jacoby *et al.*, 1989a). Neurological insult, ageing (Howard 1988) and depression (Hertel & Hardin, 1990) sometimes leave performance on indirect tests intact while disrupting performance on direct tests. Those same factors do not influence automatic processing but do influence consciously controlled processing (e.g. Hasher & Zacks, 1979; Weingartner, 1984, but see Hirst, 1982, for an opposite argument). There is also a parallel in level of control over responses: automatic processes are structured by the stimulus environment, as is performance on indirect tests, whereas controlled processes are structured by the subject, as is performance on direct tests.

Our goal in this chapter is to provide an overview of our research on unconscious influences of memory. We describe several experiments, and concentrate on the procedures used in those experiments as well as the results that they produced. The subjects in most of the experiments were undergraduates. Unlike others contributing chapters to this book,

we have done very little work to examine the nature of the memory deficit produced by neurological insult. However, we think the procedures that we have developed to examine the memory performance of normal subjects will also prove useful for specifying the nature of the memory deficit suffered by various patient populations (see Mayes, Chapter 11, this volume). We argue that a major obstacle for advances in theory is that traditional testing procedures have not been sufficiently analytic to separate different functions of memory.

We begin by discussing the importance of subjective experience and by suggesting that the subjective experience of remembering is not identical to use of a corresponding memory trace. Most memory theorists have subscribed to a naïve realist view of the relation between memory representations and memory experiences. It is common to assume that our stock of theoretical constructs—memory traces, trace strength, access to traces—is identical to memory experience, albeit on different levels of analysis. We would like to call that assumption into question, and more precisely specify the basis for the subjective experience of remembering.

Memory for prior experience automatically influences the processing and interpretation of later events. One ubiquitous effect of past experience is to make processing more efficient, rapid, or fluent. Such fluent processing is then interpreted to give rise to a particular subjective experience. We present evidence to show that subjective experience is constructed and reflects an unconscious inference or attribution process. Next, we argue that consciously controlled processing does sometimes direct behaviour, and show that advantages can be gained by arranging a situation such that consciously controlled and automatic influences of memory act in opposition to one another. An important function of conscious control is to oppose unconscious influences of memory. Also, the opposition of unconscious and conscious influences of memory can be used as a methodological tool to provide a clear separation of the two in performance. More extensive discussions of the topics considered in those first two sections appear elsewhere (e.g. Jacoby & Kelley, 1987, 1990; Jacoby *et al.*, 1989b; Kelley & Jacoby, 1990).

After discussing the advantages of opposition, we describe a procedure to separate the contributions to recognition memory performance of consciously controlled and automatic influences of memory (Jacoby, 1991). That *process dissociation procedure* yields an estimate of the probability of an item being called old because its prior presentation was recollected (a consciously controlled influence of memory) along with an estimate of the probability of the item being called old because of its familiarity (an automatic influence of memory). We discuss advantages of separating the contributions of automatic and consciously controlled processing within a task as compared to focusing on dissociations between tasks and identifying tasks with different types of processing. We argue that a problem for interpreting dissociations between tasks is that tasks are almost never process-pure. That is, people's performance on tasks that supposedly measure one process or system may actually be any mixture of processes. Finally, we discuss parallels between accounts of dissociations and theories of automaticity. We end by arguing that implicit memory should not be treated as a distinct area of research but, rather, the manipulations of direct versus indirect tests should be treated as one factor among many that influences the automaticity of processing.

10.2. THE CONSTRUCTION OF SUBJECTIVE EXPERIENCE

Dissociations between performance on indirect versus direct tests highlight the importance of subjective experience. What is most striking is the general absence of the subjective experience of remembering or perceiving on indirect tests. Without subjective experience, we are uncertain about the basis for our actions. Without the subjective experience of remembering, we may be unaware of how the past has influenced our current experience and so may misjudge current situations. It is important to understand what gives rise to subjective experience.

What could produce dissociations between indirect versus direct tests of memory? One approach explains dissociations in terms of separate memory systems with separate neuroanatomical substrates (e.g. Cohen & Squire, 1980; Tulving & Schacter, 1990): one system is capable of representing contextual and temporal aspects of an episode and is responsible for conscious recollection, whereas the other system does not preserve such memory for prior episodes and supports unconscious influences of the past. By that approach, the subjective experience of remembering reflects properties of the memory trace, so that having and using an episodic memory trace is necessary and sufficient to produce the subjective experience of remembering. For example, an amnesic's inability to have the subjective experience of remembering would be explained as resulting from the lack of ability to represent particular aspects of episodes, such as time and place.

However, the mapping between representation and subjective experience is far from perfect (e.g. Jacoby *et al.*, 1989b; Kelley & Jacoby, 1990). Even people with a normally functioning memory can use memory representations without experiencing remembering. Cryptomnesia or unconscious plagiarism is one example of the use of a memory representation without a corresponding subjective experience of remembering (e.g. Reed, 1974; Brown & Murphy, 1989). The contrasting case of 'remembering' without a corresponding memory representation also occurs. Patients who have suffered frontal lobe damage confabulate events when reporting on their past and seem to experience those confabulations as true memories (Baddeley & Wilson, 1986; Stuss & Benson, 1986; Moscovitch, 1989). Such confabulations are sometimes

also produced by people with normal memory. Although representations obviously play a role in remembering, the presence of a memory representation is neither a necessary nor a sufficient condition for the subjective experience of remembering.

If having and accessing a memory representation does not necessarily produce the experience of remembering, what is the basis for the subjective experience of remembering? Along with others, we treat subjective experience as a construction based on inferences. In the domain of perception, Helmholtz (1867 republished in 1968) proposed that an unconscious inference process underlies subjective experience. He noted that memory can influence subjective experience of the physical present. Marcel (1983b) argued that conscious experience is constructed by a higher order representation that transforms the information from lower order sensory and cognitive processing. A conscious percept is said to result from the constructive act of fitting a perceptual hypothesis to the lower level data 'to make sense of as much data as possible at the highest and most functionally useful level possible (p. 248)'. By Marcel's account, subjective experience is better seen as an attribution or interpretation about cognitive and sensory processing than as a direct mirror of it. Gazzaniga (1988) also proposed that consciousness is not identical with processing but rather represents the work of an interpreter, and further suggested that the interpreter is primarily a left brain function. Schachter and Singer (1962) suggested that the subjective experience of emotion reflects an inference or attribution process.

We show that an inference process underlies subjective experience by showing errors of inference. First, we describe cases of unconscious influences of memory being misattributed to some source other than the past, and argue that measures of subjective experience can serve as valuable indirect tests of cognitive processes. Next, we describe illusions of memory, and discuss the importance of those illusions for uncovering the bases for the subjective experience of remembering.

10.3. MISATTRIBUTIONS OF MEMORY

As a function of prior experience, performance of a task becomes more fluent. Effects of prior experience can occur at any level of activity—reading a word more fluently, solving a problem more easily, or even generating a train of ideas more readily. Subjects can misattribute fluent processing that comes from prior experience to sources other than the past. As a commonplace example, when one is first learning a foreign language, the speech rate of native speakers of that language seems too rapid to comprehend. As one gains knowledge of the language, the speech rate of the native speaker seems to slow. That is, effects of the past (acquired knowledge of the language) are experienced as a change in the current physical stimulus (speech rate). Extensive practice is not

always necessary to produce effects of this sort. A single prior presentation is sufficient to lengthen the apparent duration of a word that is flashed (Witherspoon & Allan, 1985) or lower background noise accompanying the presentation of a sentence (Jacoby *et al.*, 1988). Fluent processing may also be misattributed to a statement's being true, an argument's seeming to flow, or a problem's being easy (Jacoby & Kelley, 1987). The effect of 'mere exposure' in studies of aesthetic judgements may also be a case of the misattribution of fluent processing that is due to prior experience (Kunst-Wilson & Zajonc, 1980; Seamon *et al.*, 1983; Mandler *et al.*, 1987). People attribute effects on performance to whatever source is most obvious or plausible, which often depends on the judgements that they are asked to make.

The inference process is often an unconscious one. To show that this is the case, let us further consider the effects of prior experience on noise judgements. In one experiment, Jacoby *et al.* (1988) presented previously heard and new sentences against a background of white noise of varying loudness. Subjects judged the background noise as less loud when the sentences were old rather than new. The advantage in ease of perception of old sentences was misattributed to a lower level of background noise. That is, people were unable to separate out the contribution of memory to perception when judging noise level and so had the subjective experience of a change in noise level. Later experiments by a McMaster student, Jane Collins, have shown that this effect of prior experience on noise judgements is automatic in that people are unable to avoid the effect. Even when subjects were informed about the effect and told to avoid it, they continued to judge the background noise accompanying old sentences as less loud than that accompanying new sentences. She also found that this effect depends on the synchronous onset of the sentence and the background noise. If onset of the sentence precedes that of the background noise by a sufficient interval, the noise and sentence are perceived as separate 'streams', coming from separate sources, and effects of prior experience with sentences on noise judgements are no longer obtained. Sandra Huard, another McMaster student, has shown that the effects of hearing a sentence on later noise judgements persist over 24 h. These results indicate that effects of past experience on noise judgements reflect unconscious influences on subjective experience, rather than conscious processing carried out to satisfy demand characteristics of the task.

The subjective experience of amnesics is also affected by the past. Jacoby *et al.* (1989a) found that in normal subjects, prior presentation of names leads to an increase in the names' familiarity, and that familiarity can be misinterpreted as fame. Subjects read a list of names that included famous and nonfamous names; later, those old names were mixed with new names and presented to subjects in a fame judgement test. The familiarity of previously presented names was misattributed by subjects during the fame judgement test, so that both studied

famous and studied nonfamous names were more likely to be judged famous than were new names. We refer to this effect of earlier reading names as a 'false fame' effect. The fame judgement task is an indirect test of memory, because subjects are not asked to judge whether a name had been read earlier, but having read a name earlier can influence later judgement of its fame. Squire and McKee (1991) found that the false fame effect is as large for amnesics as for normal subjects although, of course, amnesics are severely impaired in their ability to recognize names as previously presented when given a direct test of memory. Similarly, Johnson *et al.* (1985) showed that Korsakoff's syndrome patients acquire affective reactions although they are unable to report on the past experiences that produced those reactions.

Measures of subjective experience are useful as indirect tests of other processes in addition to memory. We have done preliminary research using noise judgements as an indirect test of categorization and as an indirect test of attitudes. For attitudes, the goal is to show that one's first reaction or 'gut feeling' about an issue is sometimes very different from the attitude that is expressed in response to a direct question. That is, we predict dissociations between performance on indirect versus direct tests of categorization and of attitudes, similar to those found for memory. In that vein, Greenwald (1989) used the fame judgement task as an indirect test of sexism. He found that for some people, only names of males gain false fame from their prior presentation, and argues that the lack of false fame for female names reveals a bias against females being famous.

For present purposes, the important point is that memory can automatically influence the interpretation of later events. Those automatic influences of memory can be misattributed to sources other than the past and thereby produce a misleading subjective experience. Effects of memory on subjective experience are automatic in that they require neither intent to use memory nor awareness of doing so. Use of a memory representation is not always accompanied by the subjective experience of remembering.

10.4. ILLUSIONS OF MEMORY

We argue that the subjective experience of remembering also relies on an inference or attribution. Effects of the past on current performance, such as increased efficiency or ease of processing may be correctly attributed to the past and so give rise to a feeling of familiarity. Fluent performance is generally a reliable cue to the past because past experience so often does facilitate later performance, and these transfer effects are remarkably specific (Jacoby *et al.*, 1989b). For example, previously reading a word facilitates its later perceptual identification and that fluent perceptual processing can be attributed to the past to produce a

feeling of familiarity (e.g. Jacoby & Dallas, 1981). If ease of perceptual processing is a cue that serves as the basis for the experience of remembering, then experimental manipulations of perceptual processing should influence the subjective experience of remembering. That is, it should be possible to produce illusions of memory by manipulating perceptual processing by means other than past experience. Doing so would show that the subjective experience of remembering can occur without a corresponding memory representation. This is a particularly important line of argument, because such evidence argues against the notion that properties of a memory trace, such as strength, directly mediate the feeling of remembering.

Jacoby and Whitehouse (1989) manipulated the perceptual processing of words on a recognition memory test, independent of their actual status as old and new words, to produce a feeling of familiarity. Unconscious perception of a word flashed immediately prior to its presentation as a new word on a test of recognition memory produced an increase in the probability of false recognition. The flashed word produced more fluent perceptual processing of the new test word, which was interpreted as familiarity. We are confident that this effect is not due to conscious perception of the flashed words: when conditions were changed so that people could consciously see the flashed word, effects were *opposite* to those produced by unconscious perception. When people could see the flashed words, they interpreted the increased familiarity of the recognition test item that followed as due to its immediate prior presentation. That is, conscious versus unconscious perception of the flashed word produced different attributions of the subsequent fluent processing of the test word, as shown by opposite effects on recognition judgements. Placing the effects of unconscious versus conscious perception in opposition was a key feature of the design that allows us to be certain that the effects were due to unconscious perception, rather than conscious perception that was undetected by the experimenters. In a later section of this chapter, we discuss the advantages of placing unconscious and conscious influences in opposition.

More direct manipulations of the ease of perceptual processing produced by varying the perceptual characteristics of an item can also produce an illusion of memory. Whittlesea *et al.* (1990) rapidly presented brief lists of words to subjects, and followed each list with a recognition memory test word. Ease of perceptual processing was manipulated by varying the visual clarity of the test word within a narrow range that was not noticed by subjects (as assessed by reports at the end of the session). This produced an illusion of memory because subjects misinterpreted the variations in visual clarity as due to having read the word on the list. That is, words whose visual presentation was clearer were more likely to be judged old, although the manipulation of clarity was orthogonal to that of prior presentation. This illusion of

memory was destroyed when subjects were informed that visual clarity was manipulated, and could correctly attribute variation in perception to variation in the physical stimulus.

The use of fluent processing as a cue that one is remembering is not restricted to perceptual processing. Lindsay and Kelley (1991) showed that the ease of producing an item during a recall attempt serves as a basis for experiencing that item as remembering. Lindsay and Kelley provided fragments of to-be-recalled words as cues. Some of the fragments were easy to complete and others were relatively difficult to complete. After generating an item for recall, subjects described their subjective experience as 'Clear Memory', 'Feels Familiar', or 'No Memory'. Unbeknown to subjects, a small proportion of the cues were fragments that could only be completed with a new word. Even for those new items, there were significantly more reports of 'Feels Familiar' and 'Clear Memory' for words produced given the easy cues than for words produced given the difficult cues. Thus ease of generating contributed to the subject's experience of remembering and produced an illusion of remembering. In a related vein, Ross (1989) found that memories can reflect people's theories as much as their past experience. We think that people's theories of what must have happened lead them to think readily of those outcomes when they attempt recall, and those constructions from theory are experienced as remembered even when they do not accord with the true past.

In summary, the subjective experience of remembering is not a property of a memory trace but instead relies on an inference. Normal subjects as well as amnesics sometimes use a memory representation without having the subjective experience of remembering. When the subjective experience of remembering is present, it is sometimes an illusion that occurs without a corresponding memory representation. The feeling of familiarity in recognition may be a particular interpretation of ease of processing—that it results from past experience. In a later section, we argue that familiarity is a relatively automatic basis for recognition memory judgements, in contrast to recollection, which is a consciously controlled basis for recognition. Amnesics may experience a feeling of familiarity, as suggested by Squire and McKee's (1991) finding that amnesics exhibit the false fame effect, but they may be unable to engage in the conscious recollection that is necessary to specify correctly the source of familiarity.

10.5. THE ADVANTAGES OF OPPOSITION FOR REVEALING UNCONSCIOUS INFLUENCES

We have described unconscious influences of memory on subjective experience and have shown that subjective experience is sometimes in error. Memory can automatically influence the interpretation of later events and those effects on interpretation can be misattributed to sources other than the past. Subjective experience is an important dimension because people usually act on the basis of their subjective experience. For example, one would behave differently if one concluded that difficulties in comprehension were because of the loudness of a background noise rather than because of a lack of relevant prior experience. Can people escape unconscious influences of memory?

Consciously controlled processing is often described as a prerequisite for intentional action (e.g. Kuhl, 1986; Shallice, 1988). However, consciousness also serves the equally important function of inhibiting action by opposing influences that would otherwise prevail. For example, we can use conscious recollection to avoid repeating our stories to the same audience, or to avoid plagiarism. In these cases, recognition in the form of conscious recollection allows one to avoid undesirable effects of the past. More generally, effects of misleading subjective experience can be avoided by abandoning subjective experience as a basis for responding and shifting to more analytic, consciously controlled processing (Jacoby & Kelley, 1987). Controlled processing in the form of monitoring one's performance can allow one to oppose undesirable unconscious influences of the past. The opposition of conscious and unconscious influences of memory can also be used as a methodological tool to separate clearly the two in performance.

Supposed demonstrations of unconscious perception and those of unconscious memory have been called into question on the grounds that the experimenter has mistakenly measured conscious rather than unconscious performance. Holender (1986) argued that because of problems in establishing a threshold, there is so far no convincing evidence of unconscious perception: reputed unconscious perception effects may actually be due to conscious perception that has gone undetected by the experimenter. Similarly, in studies of memory, performance on indirect tests of memory may be contaminated by conscious recollection (Richardson-Klavehn & Bjork, 1988). For example, the enhanced completion of word fragments for studied words relative to new may sometimes rely on intentional conscious retrieval of studied words. These problems for interpretation arise when unconscious and conscious influences would exert effects that are in the same direction. The problems can be avoided by arranging the situation such that unconscious and conscious influences produce opposite effects. Such a strategy of looking for opposite effects is a variant of methods that pit unintended processes against one's conscious intentions, as in the Stroop test, and is also a variant of the strategy of searching for qualitative differences in performance produced by conscious versus unconscious influences (e.g. Dixon, 1981; Jacoby & Dallas, 1981; Cheesman & Merikle, 1986).

To set conscious and unconscious influences of memory in opposition, we have used the 'false fame' effect described earlier (Jacoby

et al., 1989a, experiments 2 and 3). In the first phase of those experiments, people read a list of all nonfamous names, such as 'Sebastian Weisdorf'. In the second phase, they judged the fame of those old names mixed with new famous and new nonfamous names. We correctly informed subjects that all of the names they had read in the first list were nonfamous, so if they recognized a name on the fame test as from the first list, they could be certain that the name was nonfamous. Thus, conscious recollection of a name from the list opposed unconscious influences of the past on fame judgements. Given this arrangement, any increase in the probability of mistakenly calling an old, as compared with new, nonfamous name 'famous' must result from an unconscious influence of memory for its prior presentation. Conscious recollection of the prior presentation of a name would produce an opposite effect by allowing subjects to reject the name as nonfamous.

The attention to an event that is necessary to produce later awareness of memory for the event may differ from the attention that is necessary to produce unconscious influences (see Dixon, 1981 for a review). We placed conscious and unconscious memory in opposition to investigate differential effects of attention (Jacoby *et al.*, 1989a). Subjects in the false fame paradigm read a list of nonfamous names in the first phase under conditions of either full or divided attention. Dividing attention between reading the list of names and monitoring an auditory list of digits resulted in old nonfamous names later being more likely to be mistakenly called famous than new nonfamous names. The opposite occurred when full attention was given to reading the list of nonfamous names: subjects presumably could consciously recognize old names from the list, and so know that they were nonfamous. Further analyses of these studies showed that dividing attention reduced a person's ability to recognize a name as having been read earlier, but had no effect on gains in familiarity produced by that earlier reading.

Others (Grand & Segal, 1966; Koriat & Feuerstein, 1976; Eich, 1984) have shown similar dissociations between the effects of dividing attention on performance of indirect versus direct tests of memory. The opposition strategy that we used more clearly separates unconscious from conscious influences. In the experiments done by others, the situation was such that conscious and unconscious influences would produce effects in the same direction. Consequently, dissociations could arise even if the indirect and direct tests that were used did not measure different functions of memory but differed only in sensitivity. This possibility is ruled out by the opposition strategy. Our finding of opposite effects of prior presentation under conditions of full versus divided attention clearly reveals a qualitative difference between unconscious and conscious influences of memory.

Some types of neurological insult as well as normal ageing might produce a deficit in controlled processing while leaving unconscious influences of memory intact. Dywan and Jacoby (1990) found that aged

subjects showed a larger false fame effect than did younger subjects. Aged subjects under conditions of full attention behaved similarly to younger subjects under conditions of divided attention. Hasher and Zacks (1988) suggested that because of a deficit in attention, older adults are less able to suppress their processing of and responding to stimuli that are to be rejected. This deficit produced by normal ageing may be due to a decline in frontal lobe functioning. Patients suffering frontal lobe damage are less able to monitor their memory performance than are normal people (e.g. Moscovitch, 1989). In that vein, Dywan (personal communication) has found that frontal lobe patients are severely impaired in their ability to use conscious recollection to avoid the false fame effect. As described earlier, Squire and McKee (1991) have found that amnesics show a false fame effect. In their experiment, names read in the first phase included both famous and nonfamous names, so conscious recollection was not placed in opposition to effects on familiarity. However, one would expect that amnesics would be unable to use conscious recollection to avoid the false fame effect.

Amnesics show near normal memory for the prior presentation of a word as measured by the indirect memory test of word fragment completion (e.g. Warrington & Weiskrantz, 1974). As argued earlier, a difficulty for interpreting effects of the past on fragment completion performance is that in addition to automatic influences of memory, performance may sometimes reflect subjects' intentional retrieval of the earlier studied words. To avoid this difficulty, the opposition strategy can be applied to a word fragment completion test by instructing subjects that they must complete word fragments with words that were not presented earlier. Under those instructions, any advantage of old over new words in fragment completion performance must be due to an unconscious influence of memory. Cermak (personal communication) has used such instructions and found that amnesics were very likely to complete fragments with old words although they were instructed to avoid doing so. Normals used conscious recollection to avoid using words from the studied list. The advantage of placing conscious recollection and unconscious influences of the past in opposition is that one's measure of unconscious effects is not contaminated by conscious effects.

The problem of separating bases for judgements is a more general one than simply separating conscious from unconscious influences. In particular, some memory deficits might result in people being unable consciously to recollect memory for a prior experience, but leave them able to use familiarity as a basis for memory judgements (e.g. Mandler, 1980; Johnson, 1988). To determine whether this is indeed the case, one needs some way of separating recognition memory judgements based on familiarity from those based on conscious recollection. In the next section, we describe a procedure devised to separate those two bases for recognition memory judgements.

10.6. SEPARATING AUTOMATIC FROM CONSCIOUSLY CONTROLLED BASES FOR JUDGEMENTS: THE PROCESS DISSOCIATION PROCEDURE

Performance on indirect tests of memory may rely more heavily on automatic forms of processing than does performance on direct tests of memory. However, there is not a one-to-one mapping between the direct versus indirect test distinction and the automatic versus consciously controlled processing distinction. Automatic forms of processing play a role in performance on direct as well as indirect tests. With regard to performance on direct memory tests, the distinction between automatic and controlled processing has been applied to both differences in encoding and differences in retrieval. Hasher and Zacks (1979) suggested that whereas the encoding of some attributes of an event is automatic, the encoding of other attributes requires effort and is consciously controlled. In regard to retrieval, dual-process theories (e.g. Atkinson & Juola, 1974; Mandler, 1980; Jacoby & Dallas, 1981) hold that both conscious recollection and familiarity serve as bases for recognition memory decisions. Conscious recollection may depend on more controlled processing at retrieval, whereas familiarity may be relatively automatic in that it is generally faster, less effortful, and less reliant on intention.

We will next describe an experiment done to gain evidence of automatic versus consciously controlled bases for recognition memory judgements by showing differential effects of dividing attention during the prior presentation of items. The results from that experiment further illustrate the advantages of placing automatic and controlled processes in opposition as compared with a situation in which the two types of processing produce effects in the same direction. Then we will show that comparisons of effects in the opposition case with those in the same-direction case can provide separate estimates of the contributions of recollection and of familiarity to recognition memory judgements. Therefore, it is possible to investigate the effects of variables such as divided attention and meaningfulness of encoding on familiarity versus recollection. The *process dissociation* procedure described there serves as an alternative to other procedures that have been used to separate automatic from consciously controlled processes. Furthermore, the process dissociation procedure can be used to separate different bases for judgements in categorization and perceptual tasks, as well as memory tasks.

We will end this section by discussing the relation between types of processing and tasks. Many explanations of dissociations between performance on indirect versus direct tests identify the types of test with different types of processing. For example, Graf and Schacter (1989, experiment 1) showed that use of a story to organize words presented at study enhanced performance on a direct test but not on an indirect test of memory. They concluded that relating items with a story influences grouping and that grouping facilitates performance on direct tests, but that performance on indirect tests relies on unitization rather than grouping. However, one could probably produce a dissociation between two direct tests of the same form as the dissociation Graf and Schacter found between an indirect and a direct test of memory. For example, if subjects were required to respond prior to a short deadline on a direct test of memory, they would not have time to engage in the consciously controlled processing that is probably necessary to remember a story to aid retrieval of studied items. Consequently, performance on a direct test that required rapid responding would rely heavily on automatic processing (as does performance on an indirect test), and so should dissociate from performance on a direct test that allowed ample time for responding. That is, the dissociation might better be thought of as being between automatic versus consciously controlled bases for responding rather than between indirect versus direct tests of memory. Rather than searching for task dissociations and identifying tasks with types of processing, it would be better to separate the contribution of different types of processing to performance of a single task.

10.7. DIFFERENTIAL EFFECTS OF DIVIDING ATTENTION DURING STUDY

In our fame judgement experiments (Jacoby *et al.*, 1989a) described in the last section, we found that divided as compared to full attention to reading the names in the first phase reduced subjects' ability to recollect reading a name later, but did not influence the gain in the name's familiarity that was produced by its being read. That study placed the effects of recollection and familiarity on fame judgements in opposition, so that we could separately study the two. We have used a similar opposition procedure to separate recollection and familiarity as bases for recognition memory judgements. We begin by describing the effects of divided attention when the situation was such that recollection and familiarity would produce effects in the same direction, and then contrast the conclusions that can be drawn from those results with conclusions that can be drawn when effects of the two types act in opposition.

We were particularly interested in how variation in the processing of meaning has its effect on recognition memory performance (cf. Craik & Lockhart, 1972). We predicted that processing meaning aids recollection rather than familiarity. Processing was varied by having subjects judge whether word pairs were related or not, for both related and unrelated pairs. The meaningful processing that results from judging the relatedness of a pair could benefit later recognition memory for a word from that pair by increasing the probability of recollection rather than familiarity. Subjects might later be better able to recollect reading a

word earlier that had been in a related pair of words as compared with in an unrelated pair of words (cf. Gardiner, 1988).

Jacoby (in preparation) examined the effects of dividing attention during study on the later use of recollection and familiarity as bases for recognition memory judgements. An outline of the procedure appears in Table 10.1. In Phase 1 of that experiment, subjects were asked to judge whether pairs of words presented visually were related or unrelated. Attention to that task was either full or divided by requiring subjects to monitor simultaneously a string of digits presented auditorially. In Phase 2 of the experiment, subjects in both the full- and divided-attention conditions *heard* a list of words that they were told to study for a later test (both groups studied this list with full attention). In Phase 3, subjects were given a visually-presented, forced-choice recognition memory test. Each pair of recognition test words consisted of a new word paired with an old word from either the Phase 1 word pairs or from the list heard in Phase 2. Fifty test pairs contained a word that was earlier heard, 15 test pairs contained a word from a related pair presented in Phase 1, and 15 test pairs contained a word from an unrelated pair presented in Phase 1.

Subjects in a condition referred to as the inclusion condition (we will

TABLE 10.1
Procedure for separating recollection and familiarity as bases for recognition memory

	PHASE 1	
40 pairs	20 Related 20 Unrelated	Visually presented for judgement task
Full vs divided attention		
	PHASE 2	
60 single words		Aurally presented to be remembered
	PHASE 3	
80 pairs	50 Phase 2 (Heard)-New 15 Phase 1 (Related)-New 15 Phase 1 (Unrelated)-New	Visually presented for recognition task

Inclusion vs exclusion force-choice recognition

	Subject to respond	
	Inclusion	Exclusion
Phase 2 (Heard)	Old	Old
Phase 1 (Related)	Old	New
Phase 1 (Unrelated)	Old	New

elaborate on this term later) were instructed to pick the word from each pair that had earlier been presented in *either* Phase 1 or Phase 2. In the inclusion test condition, as in most recognition memory tests, subjects could use either recollection or familiarity as a basis for recognition memory judgements, and use of the two bases would produce responses in the same direction. In line with results reported earlier for the fame judgement experiments, divided as compared to full attention to judging whether words in a pair were related was expected to reduce later recollection but to leave gains in familiarity intact. Furthermore, because of their more meaningful processing, words presented in related pairs were predicted to hold an advantage in recollection over words presented in unrelated pairs.

Results for the inclusion test conditions are shown in the top two rows of Table 10.2. Our main interest was in recognition memory performance for words presented in related versus unrelated pairs, and it was only for those words that attention was manipulated. The results show that words presented in related pairs were more likely to be recognized as old than were words that were presented in unrelated pairs. For both related and unrelated pairs, divided as compared with full attention to judging relatedness reduced later recognition memory performance. One could argue that the effect of divided attention was to reduce subjects' ability to use recollection later as a basis for recognition memory judgements. However, surprisingly, there was no interaction of relatedness of pairs and attention condition, and therefore the results do not provide support for the suggestion that the advantage for words presented in related pairs was specific to recollection.

Although the above results are consistent with the claim that dividing attention during study affected later recognition by its influence on recollection, the results are not conclusive. This is because recollection and familiarity would produce results in the same direction, so a reduction in either or both could be responsible for the poorer recognition

TABLE 10.2
Probabilities of calling an item 'old'

	Probability of responding 'Old'		
	Related	Unrelated	Heard
Inclusion test			
Full attention	0.83	0.70	0.79
Divided attention	0.75	0.61	0.77
Exclusion test			
Full attention	0.31	0.38	0.70
Divided attention	0.47	0.49	0.70

memory performance following divided attention. What is needed is a means of placing familiarity and recollection in opposition to more clearly separate effects on the two bases for judgements.

To separate familiarity and recollection, subjects in an exclusion test condition were instructed to pick a word as old on the recognition memory test only if the word was one that they had heard in Phase 2. Subjects in this condition were warned that some of the tested words had been presented in Phase 1 but they should not be picked as old. Subjects were told that if they could recollect having earlier encountered a word as a member of either a related or an unrelated pair presented in Phase 1, they could be certain that the word was not one that they had heard earlier, and consequently should not be picked as old. That is, whereas subjects in the inclusion test conditions were to include words presented in related and unrelated pairs as words that were to be called old for the test of recognition memory, subjects in the exclusion test conditions were to exclude those words. These differences in test instructions were the only differences between the inclusion and exclusion test conditions.

In the exclusion test condition, presentation of a word in Phase 1 was expected to increase its familiarity and thereby increase the probability of its being falsely recognized as having been heard earlier. Any such increase would necessarily reflect an automatic influence of memory. This is true because conscious recollection would have an opposite effect. If subjects recollected having earlier encountered the word as a member of either a related or unrelated pair, they could be certain that the word had not been heard, and so they should not pick it as old. In Phase 1, judgements of the relation between words in a pair were made under conditions of full or divided attention. Dividing attention was expected to reduce later recollection and thereby leave effects of familiarity due to presentation in Phase 1 largely unopposed.

The effect of divided attention and the effect of word-pair relatedness on recollection are shown in the results from the exclusion test conditions (see the bottom two rows of Table 10.2). Dividing subjects' attention when they were judging whether words in a pair were related reduced later recollection, and so increased the probability of those words later being falsely recognized as heard. Words presented in related pairs in Phase 1 held some advantage in recollection over words presented in unrelated pairs. The increase in false recognition produced by divided attention was slightly larger for words from related compared to unrelated pairs, as would be expected if words from related pairs held a larger advantage in recollection when attention was full rather than divided.

Looking at results for 'heard' words in Table 10.2, it can be seen that those words were more likely to be correctly recognized in the inclusion test conditions than they were in the exclusion test conditions. One possible reason for that result is that subjects may have sometimes been

unable to recollect earlier hearing a word and confused words that were heard with words that were earlier presented in related or unrelated pairs. Confusion of that sort would result in words that were heard being mistakenly rejected in the exclusion test conditions but not in the inclusion test conditions.

Results from the exclusion test conditions are sufficient to allow the conclusion that dividing attention during the presentation of items reduces later recollection. However, those results do not allow one to conclude that dividing attention had no effect on familiarity. To draw that conclusion, one needs some way of separately estimating the effects on recollection and the effects on familiarity. We describe how the results of the inclusion and exclusion conditions can be combined to allow a process dissociation of familiarity and recollection.

10.8. SEPARATELY ESTIMATING AUTOMATIC AND CONSCIOUSLY CONTROLLED INFLUENCES

If responding is under conscious control, people should be able to follow instructions to respond differentially to items of a given class. For example, in the inclusion test conditions in the experiment described above, conscious recollection allowed subjects to select for earlier presented items and increased the probability of correctly calling words old. In the exclusion test conditions, conscious recollection allowed subjects to select against words that were earlier presented in related or unrelated pairs and decreased the probability of those words being falsely recognized as heard earlier. In contrast, automatic influences of memory do not support such selective responding. Familiarity increased the probability of responding old to words earlier presented in related or unrelated pairs, regardless of whether those words were to be called old (inclusion test conditions) or new (exclusion test conditions).

Typically, recognition memory tests tap a mixture of consciously controlled recollection and automatic familiarity. However, given that only recollection can allow subjects to selectively respond to items (select for or select against those items), it should be possible to estimate the separate contributions of recollection and familiarity to recognition memory judgements. To do so, a process dissociation procedure was developed. The rationale underlying the process dissociation procedure is that consciously controlled processing or recollection can be measured as the difference between the likelihood of responding to an item of a given class when people are attempting to select *for* items of that class as compared with when they are attempting to select *against* items of that class.

To illustrate, consider the case in which conscious control of responding is complete so that the probability of recollection is 1.0. In that case,

a word read earlier in Phase 1 would always be called old in the inclusion test condition and never be called old in the exclusion test condition. The difference between the probabilities of calling an item of the particular type old between the two conditions would then be 1.0, the probability of recollection. In contrast, consider a case where the probability of recollection is 0 and words are called old solely on the basis of their familiarity. In that case, the probability of calling an item old would not be controlled by instructions. Rather, the probability of calling an item of a particular type old would be the same in the inclusion and the exclusion conditions. More generally, the difference between the probabilities of calling an item old in the inclusion and the exclusion conditions can be used to estimate the probability of recollection.

Following others (e.g. Mandler, 1980), it is assumed that recollection (R) and familiarity (F) serve as two independent bases for calling an item old on a test of recognition memory. In the *inclusion* condition, the probability of saying old to a word earlier presented in a related pair (O_{IR}) can be written as

$$O_{IR} = R_R + F_R - R_R F_R \quad (1)$$

In the *exclusion* condition, an item earlier presented in a related pair would be called old (O_{ER}) only if the item was familiar and its presentation as a member of a related pair was not recollected.

$$O_{ER} = F_R(1 - R_R) = F_R - R_R F_R \quad (2)$$

The probability of recollection can then be estimated as

$$R_R = O_{IR} - O_{ER} \quad (3)$$

Of course, the same equations hold for words that were presented in unrelated pairs as for words presented in related pairs. As can be seen by comparing Equations 1 and 2, when recollection equals 0, the probability of calling an item old is the same in the inclusion and exclusion test conditions, and totally reflects familiarity. By simple algebra, F can be estimated given an estimate of R and the observed probability of calling items old (e.g. O_{IR}).

The process dissociation procedure can be applied to the data in Table 10.2 to estimate separately the effects of dividing attention on recollection and familiarity. The difference between the inclusion and the exclusion conditions in the probability of selecting an item as old can be used to estimate the probability of recollection as a function of attention, separately for words presented in related and unrelated pairs. Those estimated probabilities of recollection can then be used to estimate the probabilities of selecting an item as old on the basis of its familiarity. Estimated probabilities are shown in Table 10.3.

Words presented in related pairs held an advantage both in recollection and in familiarity over words presented in unrelated pairs. The

TABLE 10.3
Estimates of recollection and of familiarity

	Estimated probabilities	
	Related	Unrelated
Recollection		
Full attention	0.52	0.32
Divided attention	0.28	0.12
Familiarity		
Full attention	0.646	0.558
Divided attention	0.652	0.557

effect of relatedness on familiarity is surprising and intriguing, and has not been revealed by previous methods of separating the two bases for recognition memory judgements (e.g. Mandler, 1980). For words previously presented in either a related or unrelated word pair, dividing attention during their prior presentation reduced subjects' ability later to use recollection as a basis for recognition memory judgements. In contrast, dividing attention during the earlier presentation of words had no effect on familiarity-based judgements. Results reported by Jacoby *et al.* (1989a) also showed that dividing attention during study had no effect on the use of familiarity as a basis for fame judgements, but did have an effect on recollection. The procedure used in that paper for separating effects of recollection and effects of familiarity on fame judgements was based on a rationale that is similar to that underlying the process dissociation procedure.

Other experiments (Jacoby, 1991) have examined the effects of dividing attention at test. In those experiments, subjects made yes/no recognition memory judgements either under conditions of full or divided attention. Inclusion and exclusion conditions were as described for the above experiment. The process dissociation procedure was used to separate the effects of dividing attention at test on recollection and on familiarity as bases for recognition memory judgements. Results showed that dividing attention at test almost totally eliminated subjects' ability to use recollection, but had no influence on familiarity-based judgements. Again, the effects were similar to those earlier found for fame judgements (Jacoby *et al.*, 1989a).

The results of our experiments have changed the way that we think about familiarity. First, it is clear that familiarity does not depend only on the perceptual characteristics of a tested item, but, rather, also depends on the prior processing of the item (e.g. relatedness of a pair). Although, as described in an earlier section, ease of perceptual processing contributes to the subjective experience of familiarity, the processing of meaning also influences familiarity. This is shown by the

finding that words from related pairs were more familiar than were words from unrelated pairs.

Second, the results reinforce our belief that familiarity is not simply a correlate of some characteristic of a memory trace, such as strength. We predict that the estimated values of familiarity of words read in Phase 1 would change if the list of words presented to be remembered in Phase 2 are read rather than heard. That is, familiarity is better described as arising from relationships among items, in the same way that similarity is traditionally described, rather than as an absolute characteristic of memory for an item. We believe familiarity is context dependent in a way that results in its changing across tasks and situations. The view of familiarity that we are developing is in some way similar to the treatment of familiarity in global memory models (e.g. Gillund & Shiffrin, 1984; Hintzman, 1988). In a related vein, the issue of whether dissociations arise from a difference in memory representations or a difference in retrieval processes will be discussed in the final section of this chapter in conjunction with theories of automaticity.

We have gone into a good deal of detail describing the process dissociation procedure because we think it is likely to be useful for better specifying the nature of the memory deficits produced by neurological insult. For example, frontal-lobe patients might suffer a deficit in recollection but show normal use of familiarity. Also, variants of the process dissociation procedure are useful for separating automatic from consciously controlled influences in categorization and in perceptual performance as well as in memory performance. The use of rules for categorization relies on consciously controlled processing, as does recollection, whereas categorization on the basis of similarity to earlier-presented instances relies on more automatic forms of processing, as does the use of familiarity for recognition memory judgements. For perception, a corresponding distinction is that between perception above the subjective threshold and perception below the subjective threshold (e.g. Reingold & Merikle, 1990). Preliminary experiments using the process dissociation procedure to separate unconscious from conscious perception and to separate the use of rules from categorization on the basis of similarity have produced promising results.

10.9. TASKS AND PROCESSES

The strategy of attempting to separate different functions of memory by estimating their effects within a task contrasts with the strategy of searching for dissociations between tasks. Some have suggested that indirect tests typically rely on prior data-driven processing, whereas direct tests typically rely on prior conceptually driven processing (Jacoby, 1983; Roediger & Blaxton, 1987; Roediger *et al.*, 1989). Others (e.g. Cohen & Squire, 1980; Tulving & Schacter, 1990) have suggested

that performance on indirect tests reflects the use of a memory representation that is anatomically distinct from the memory representation that is responsible for performance on direct tests of memory.

A difficulty for identifying processes with tasks is that tasks are probably never process-pure (e.g. Dunn & Kirsner, 1989; Reingold & Merikle, 1990). For example, consider the conditions that have been said to give rise to responses based on automatic processes. The use of an automatic basis for responding is more likely when subjects must respond rapidly, when attention is divided, and when an indirect test is given. However, it is doubtful that any of those conditions produce responding that is purely automatic. Likewise, it is doubtful that allowing ample time to respond along with full attention for a direct test insures a pure measure of consciously controlled processing. Indeed, Jacoby and Hollingshead (1990) have shown that subjects given a direct test under those conditions do sometimes use an automatic basis for responding just as they would had they been given an indirect test of memory. The process dissociation procedure described here allows one to avoid treating tasks as process-pure by providing a means of separating effects of different types of processing within a task. By using the process dissociation procedure, one need not assume that an indirect test relies only on automatic processes. Rather, effects of task instructions at test on automatic and consciously controlled bases for responding can be separately observed in a manner parallel to the studies of the effects of full versus divided attention.

The goal of the process dissociation procedure used here is the same as that motivating others' attempts (e.g. Mandler, 1980) to estimate separately the influence of different bases for recognition memory decisions. However, the process dissociation procedure is very different from other procedures: it is the difference between separating processes within a task and identifying processes with tasks that is important (see Jacoby, 1991, for a discussion). The intent of separating processes within a task is the same as in signal-detection theory (e.g. Swets *et al.*, 1961). It is meant to separate different bases for responding and to reveal invariance in one basis for responding across variance in the other.

The emphasis on differences in processing that accompanies the search for task dissociations has obscured the importance of finding invariance (cf. Stevens, 1951). To be certain that a variable does not influence a particular basis for responding, one must have a means of separating bases for responding within a task. Extending the analogy with signal-detection theory, identifying types of processing or memory representation with tasks makes no more sense than it would to identify sensitivity and bias with separate tasks. Both sensitivity and bias contribute to performance of any particular judgement task so it would not be reasonable to claim that one task measured only sensitivity whereas a different task measured only bias. The same can be

said for consciously controlled versus automatic processing, and can probably also be said for other contrasts that have been used to account for dissociations between performance on indirect and direct tests.

10.10. PARALLELS BETWEEN ACCOUNTS OF DISSOCIATION AND THEORIES OF AUTOMATICITY

Identifying dissociations between performance on indirect versus direct tests with the contrast between automatic versus consciously controlled processing reduces the number of problems that are to be solved only by virtue of the fact that problems for explanations of dissociations are the same problems as encountered by theories of automaticity. That is, there are parallels between theorizing about automaticity and theorizing about dissociations.

One parallel is that awareness and intentionality are often confounded in discussions of dissociations just as they are in the definition of automaticity (e.g. Bargh, 1989). The relation between awareness and intentionality is an asymmetric one: when people are unaware of the stimuli controlling their responses we conclude that the responses are unintentional, but when they are aware of the stimuli, the responses are not necessarily intentional. In fact, awareness of a stimulus may follow the response, rather than be responsible for initiation of a response. Performance on the Stroop test (1935) illustrates this point. Subjects are aware of the colour words that interfere with their naming of the colour of the words, although they clearly do not intend to read the colour names. Reading the colour words seems to be driven by attention to the stimulus even though it is counter to the intention to name the colour of the words. Similarly, the false fame effect in our experiments seems to result from stimulus-driven processing that makes a name seem familiar. Use of memory for the prior presentation of names when making fame judgements is unintentional, and for the false fame effect to occur, any awareness of earlier reading of the name in the list of nonfamous names must follow responding. Freudian slips and actions slips are cases where awareness immediately follows responses that happen unintentionally. One interpretation of these cases is that the interference is an automatic, unintentional result of processing environmental stimuli. In other cases, facilitation has been attributed to automatic processing, as in the case of priming in lexical decisions (e.g. Neely, 1976).

Both priming and interference effects have been interpreted as resulting from automatic processes happening without awareness or intention. The automatic processes are controlled by stimuli whereas consciously controlled processes are controlled by intentions (LaBerge & Samuels, 1974; Posner & Synder, 1975; Shiffrin & Schneider, 1977; Hasher & Zacks, 1979). Automatic processing has been modelled as activation spreading among abstract representations such as nodes in a network that can be primed by mere exposure to stimuli. The abstract representations that are responsible for automaticity are distilled from extensive prior experience and differ from the memory representations upon which the novice relies. In contrast to the reliance of automaticity on the spread of activation, conscious control is treated as due to the operation of a control system of limited capacity (Shiffrin & Schneider, 1977; Shallice, 1988). The association of control and phenomenal awareness has been developed further by Johnson-Laird (1983, 1988).

Is the separation between control by stimuli versus conscious intentions ever really the case? After extensive learning, automatic responses are said to become as encapsulated and uncontrolled as reflexes. However, even reflexes can be modified by attention (see review by Anthony, 1985). Neumann (1984) argued that automaticity is not a characteristic of processing controlled by stimuli, but rather is an emergent property of the exercise of specific skills in an environment. When all the parameters of the task are specified by the combination of memory for the skill and the environment, then the task is automatic. He suggests that automaticity cannot be driven by stimuli separately from skills that are brought into play by intentions. For example, priming in lexical decision is not a result of seeing the prime which then automatically activates the target, but is due to the exercise of the skill of predictive reading. That is, stimulus-driven processing is integrated with, and done in the context of, the goals and intentions set by consciously controlled processing, rather than being invariant across contexts. Models of the sort proposed by Neumann describe interference as arising from problems in co-ordinating tasks rather than from a limited-capacity processor (Allport, 1989).

Logan (1988) has described automaticity as relying on memory for instances, rather than on the development of an abstract representation (cf. Schneider & Shiffrin, 1977), and has pointed out parallels between performance on indirect tests of memory and automaticity (Logan, 1990). By Logan's view, automaticity comes about when people change over from computing responses algorithmically to relying on memory for a past episode. He models the decrease in speed of responding that reflects the development of automaticity by assuming that instance-based responding is faster than is algorithm-based responding, and by also assuming that experience with a task makes reliance on instances more likely by increasing their number.

Abstractionist (e.g. Schneider & Shiffrin, 1977) and instance (Logan, 1988) theories of automaticity are paralleled by accounts of dissociations. Like abstractionist theories of automaticity, multiple memory system accounts of dissociations hold that performance on indirect tests relies on a memory representation that is different from that responsible for performance on direct tests (e.g. Cohen & Squire, 1980; Tulving & Schacter, 1990). In contrast, processing accounts of dissociations (e.g. Jacoby & Brooks, 1984; Roediger *et al.*, 1989) and the instance theory of automaticity hold that memory for prior episodes

contributes to performance on both indirect and direct tests of memory. Elsewhere (e.g. Jacoby & Brooks, 1984; Jacoby & Kelley, 1987), we have described how dissociations can arise although both indirect and direct tests rely on memory for episodes, and have given reasons for preferring a processing account over an abstractionist or memory systems account of dissociations.

The concern with the integration of stimulus-driven with consciously controlled processing described for theories of automaticity also has its parallel in accounts of dissociations. Accounts of memory dissociations in terms of data-driven and conceptually driven processing (e.g. Roediger *et al.*, 1989) require that the two types of processing not be terribly interactive. Otherwise, it would not be meaningful to claim that some tests rely primarily on data-driven processing whereas other tests rely primarily on conceptually driven processing. Similarly, accounts of dissociations in terms of separate memory representations require that the use of the different representations not be so interactive as to rule out identifying memory representations with types of test. However, akin to the relation between stimulus-driven and consciously controlled processing in automaticity, memory for data-driven and memory for conceptually driven processing appear to be integrated in their contribution to performance on indirect tests of memory (e.g. Levy & Kirsner, 1989; Jacoby *et al.*, 1991). Returning to a point made earlier, tests cannot legitimately be treated as pure with regard to either processes or memory representations.

One can describe the integration of data-driven and conceptually driven processing in terms similar to Neumann's (1984) by describing skill as relying on memory for prior episodes (cf. Logan, 1988): memory on an indirect test is not simply processing controlled by stimuli, but rather reflects the use of memory for prior episodes used in an 'environment' that includes the indirect test cues. When all of the parameters of the task used as an indirect test are specified by the combination of memory for prior episodes and the environment, then the effects of memory on an indirect test will automatically emerge. Neumann argues that conscious control is made necessary by a poor fit between skill and the environment. Similarly, when engaged in a task whose performance can benefit from memory for prior episodes, awareness of the past may spontaneously arise only when the mismatch is such that performance is not sufficiently well served by unconscious memory.

10.11. SUMMARY AND CONCLUSIONS

Let us end by briefly summarizing the main points that we have made. We began by suggesting that dissociations between performance on indirect and direct tests of memory can be understood in terms of the contrast between automatic and consciously controlled processing. Memory for past experience automatically influences the ease of processing and the interpretation of later events. Subjective experience is constructed and reflects an unconscious attribution or inference process that attributes effects to a source. Because of errors in the attribution process, measures of subjective experience are valuable as indirect tests of memory. However, tests are not process-pure. That is, indirect tests cannot be treated as pure measures of automatic processing nor can direct tests be treated as pure measures of consciously controlled processing. To be certain that effects are produced by unconscious influences of memory, it is necessary to arrange a situation such that automatic and consciously controlled influences are placed in opposition. Doing so allows one to separate clearly the two types of effect, but does not allow one to estimate their magnitude.

Next, we described a process dissociation procedure that can be used to separately estimate effects of variables on consciously controlled and automatic processes. That procedure estimates consciously controlled processing as the difference between performance under conditions in which consciously controlled and automatic processes produce effects in the same direction as compared with performance under conditions in which the two processes act in opposition. Use of the process dissociation procedure to estimate effects showed that dividing attention, either at test or during study, reduced subjects' ability to use conscious recollection as a basis for recognition memory judgements, but had no effect on familiarity-based judgements. It seems likely that variants of the process dissociation procedure will be useful for specifying the nature of memory deficits, and for separating automatic and consciously controlled processes in categorization and perceptual tasks as well as in memory tasks.

Accounts of dissociations parallel theories of automaticity. We hold that performance on both indirect and direct tests of memory relies on memory for prior episodes, just as Logan (1988) argues that automaticity reflects memory for instances. Although we lacked sufficient space to describe the relevant evidence, we concluded that memory revealed by indirect tests is not a characteristic of processing wholly controlled by the present physical stimuli (cf. Roediger *et al.*, 1989), nor is it a characteristic of a memory representation of present physical stimuli (cf. Tulving & Schacter, 1990). Processing is too interactive to allow types of processing or types of memory representation to be isolated by mapping them on to tasks. Although our interest in unconscious influences began with the finding of dissociations between performance on direct and indirect tests (Jacoby & Dallas, 1981), we have moved away from relying on dissociations between tasks and have developed techniques to separate the contribution of different types of processing within a task. Following Neumann's analysis of automaticity (1984, who in turn describes his approach as following Wundt's), we believe

that memory revealed on an indirect test reflects the fit between memory for prior episodes and the requirements of the present task.

In a commentary on research in decision making, Estes (1980) made a distinction that seems pertinent to memory research, i.e. the distinction between a task orientation and a process orientation. He noted that work in problem solving and decision making at that time primarily had a task orientation. For example, psychologists had studied water-jug puzzles, missionaries and cannibals, and the Tower of Hanoi, rather than more abstract processes that might cut across areas. He noted that two consequences of such a task orientation are a lack of citations across research areas and an attempt to construct taxonomies of tasks. Estes urged researchers in decision making and problem solving to take a more process-oriented approach (and he warned that 'theoretically significant classifications more often follow than precede the development of process-oriented models (p. 269)...'). We think much can be gained from adopting a process orientation in memory research, and in particular from relating dissociations to the contrast between automatic versus consciously controlled processing.

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