Separating the Recollective and Automatic Influences on Memory Using Simultaneous Judgements about Fame and Memory for Prior Occurrence

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Abstract

Two experiments evaluated the utility of reconstructing exclusion and inclusion responses which are used in the process dissociation procedure (Jacoby, 1991) from simultaneous subject responses about fame and recollective memory. In Experiment 1, subjects studied 60 nonfamous-names with full or divided attention. In Experiment 2, subjects studied both 60 nonfamous and 60 famous-names under the same attention conditions. Subjects were tested using either a) separate inclusion and exclusion judgements of fame as described in the process dissociation procedure or b) simultaneous judgements of fame and prior occurrence. In the simultaneous conditions, subjects responded using a forced-choice paradigm with four choices: A) famous and studied, B) not famous and studied, C) famous and not studied, or D) not famous and not studied. Inclusion responses were constructed by summing across responses A, B and C, while exclusion responses were constructed using only response C. Comparisons were made between reconstructed and actual inclusion and exclusion responses and estimates of recollective and automatic memory for both test conditions. In addition, the use of simultaneous judgements provided means to directly calculate the relation between estimates of recollective and automatic memory. In both Experiment 1 and 2 the use of simultaneous judgements qualitatively replicated findings from separate judgements. For both test groups, it was found that relative to full attention, divided attention reduced estimates of recollective memory but had no effect on automatic memory performance. Experiment 1 found negative dependence between the factors of recollection and fame judgements in the simultaneous groups (attributed to a responses bias based on subjects'

knowledge that no famous names were included on the study list), while Experiment 2 found independence between recollective and automatic memory in the simultaneous groups.

Introduction

Traditionally, the study of memory has relied upon tests involving explicit recall and recognition (for a review see Craik, 1979). These tests require conscious recollection of specific prior events (Tulving, 1983). More recently, the study of memory has come to include the examination of knowledge of a prior occurrence that may occur without deliberate or conscious recollection (*e.g.*, Squire & Cohen, 1984; Schacter, 1987; Graf & Schacter, 1985; Jacoby, 1981; 1991). These researchers have presented evidence that memory is not a unitary or single process. Instead, memory for prior events can have an effect on later performance which is independent of conscious recollection of that event (see Richardson-Klavehn & Bjork, 1988, for a review).

The present investigation examined procedures for classifying separate memory components using the process dissociation procedure described by Jacoby (1991). The process dissociation procedure was designed to circumvent limitations associated with the process of identifying separate memory components (*i.e.* recollective and automatic) by using separate or independent tasks. Instead, the process dissociation procedure used a single task with separate instructions, thus avoiding the assumption that there was a one to one mapping between each task and the respective memory source. Calculations in the process dissociation procedure however require two assumptions that are difficult to examine. Specifically, the process dissociation procedure assumes independence between the different sources of memory and it assumes that subjects are using the same response criteria in the separate instruction conditions. The present research provides a method that potentially avoids both of these limitations associated with the process dissociation procedure by measuring judgements of two memory components within a single task, using simultaneous judgements of two dependent variables.

Literature Review

Sources of Dissociations

The retrieval of an item in standard memory tests such as cued recall, free recall, or recognition consists of a conscious attempt by subjects to retrieve previously studied items (Richardson-Klavehn & Bjork, 1988). In contrast, the retrieval of memory in priming tasks such as word stem completion or word fragment completion tasks (e.g., Jacoby & Dallas, 1981; Tulving, Schacter & Stark, 1982) do not make such an assumption because subjects are not required to retrieve a specific prior episode (Richardson-Klavehn & Bjork, 1988). That is, the retrieval of an item in standard memory tests and the retrieval of that same item in a priming or indirect test can be said to reflect two distinct forms of memory (Graf & Schacter, 1987). Moreover, dissociations observed between these two distinct forms of memory led to dichotomous classifications of memory processes. These include implicit and explicit (Schacter, 1987; Graf & Schacter, 1985); semantic and episodic (Tulving, 1983); familiarity and contextual (Mandler, 1980); unconscious and conscious (Jacoby, Kelley & Dywan, 1989; Jacoby & Kelley, 1992), recollective and automatic (Jacoby, 1991; Jacoby, Toth & Yonelinas, 1993; Jennings & Jacoby, 1993); procedural and declarative (Squire & Cohen, 1984) and a ternary classification by Tulving (1985) with procedural, semantic and episodic distinctions of memory. Evidence supporting these classifications suggests that memory is not a unitary or single process.

Schacter (1987; Graf & Schacter, 1985) used the terms implicit and explicit memory to characterize the dissociations observed between different tests of memory. Schacter (1987) defined *explicit* memory as the conscious recollection of a past occurrence, and *implicit* memory as the passive consequence of stimulation revealed by facilitation of previous experiences on a task that does not require conscious or intentional recollection of those experiences. Explicit and implicit memory have been observed to be affected differently by several experimental variables. Implicit memory has been found to be sensitive to the surface features of stimuli such as modality (Hayman & Rickards, 1995; Jacoby, Toth & Yonelinas, 1993) while explicit memory is sensitive to a range of variables including attention (Jacoby, Toth & Yonelinas, 1993; Jennings & Jacoby, 1993; Debner & Jacoby, 1994), level of processing (Jacoby & Dallas, 1981) and retention interval (Tulving, Schacter & Stark, 1982).

In much of the research on implicit and explicit memory it was assumed that specific tests provided measures of specific types of memory (see Richardson-Klavehn & Bjork, 1998 for a review). Performance on an indirect test of memory such as a word stem or fragment-completion task (*e.g.* Jacoby & Dallas, 1981; Tulving, Schacter & Stark, 1982) was assumed to reflect implicit memory for a past event, whereas tests such as free recall, cued recall or recognition provided measures of explicit memory for a past event (Graf & Schacter, 1985). Stochastic or functional independence between different tests of memory (Tulving, Schacter & Stark, 1982) were assumed to reflect different types of memory. Stochastic independence refers to the relation between two events in which the probability of their joint occurrence is equal to the product of the probabilities of the occurrence of each event alone, while functional independence is the relation between two dependent variables in a situation in which one variable does and the other does not vary as a function of a third independent variable (Tulving, 1985). Increased performance on indirect measures of memory in the absence of explicit memory (stochastic) or the manipulation of an independent variable affecting only one form of memory and not the other (functional), were taken as evidence for the presence of two forms of memory.

Stochastic independence between direct and indirect tests of memory has provided evidence supporting the existence of two memory processes. Tulving, Schacter and Stark (1982) employed a word fragment completion task to examine the relationship between recognition and priming effects. Their results were consistent with a distinction between separate sources of memory (*i.e.* implicit and explicit memory). Performance on a word fragment completion task was facilitated by the presentation of words in the study list and this facilitation was independent of explicit memory as indexed by recognition (Tulving, Schacter & Stark, 1982). The same affect was observed in series of experiments conducted by Jacoby and Dallas (1981) where facilitation on a word identification task was shown to be stochastically independent of a subjects' explicit awareness that the words had been presented previously, as assessed by recognition tests.

Functional independence between direct and indirect tests of memory has also provided evidence supporting the existence of two memory processes. Jacoby and Dallas

(1981) conducted experiments manipulating level of processing in word identification tasks where a single presentation of a word during study sometimes doubled the probability of that word being identified on a second list by subjects. A functional dissociation was also observed in Tulving, Schacter and Stark's (1982) experiment where explicit memory was shown to be sensitive to time while implicit memory appeared to be unaffected by time, with the result that priming effects were largely unchanged after a week interval while recognition was found to be significantly diminished (Tulving, Schacter & Stark, 1982).

Converging evidence in support of the distinction between explicit and implicit memory was found in the form of preserved learning in amnesic patients (Milner, Corkin & Teuber, 1968; McAndrews, Glisky & Schacter, 1987; Schacter, 1987). Amnesia is characterized by "normal perceptual, linguistic and intellectual functioning together with an inability to remember explicitly recent events and new information" (Schacter, 1987, p. 509). The observation of preserved learning and hence a form of memory in amnesic patients provided evidence in support of the hypothesis that there were at least two memory systems in operation . Milner, Corkin and Teuber's (1968) work with H.M., a profoundly amnesic patient, provided evidence that some form of memory was preserved in prograde amnesic patients. H.M. was able to learn new motor skills even though he could not explicitly remember that he had performed the tasks previously (Milner, Corkin & Teuber, 1968). Observations of H.M.'s ability to learn new skills despite failure to explicitly remember that he had previously performed the skills was interpreted as evidence supporting the existence of separate sources of memory.

Dissociations on direct and indirect tests of memory have been shown with other amnesic patients who by definition, perform poorly on direct tests of memory but have been found to perform near normal on indirect tests of memory (Schacter, 1987). In a stem completion task amnesics were able to complete a stem with a word that was presented earlier, even though they were unable to recognize or recall that word on a direct test of their memory (Schacter, 1987). McAndrews, Glisky, and Schacter (1987) investigated the effects of priming in amnesic patients on complicated sentence puzzles and found that patients with no explicit recall or recognition showed substantial priming effects which lasted up to a week. Schacter (1985) found that amnesic patients showed near normal priming effects on a free-association test. However, normal priming effects only occurred when amnesic subjects were instructed to complete the stem or idiom with the first word that came to mind, if they were instructed to use the word stems as cues for remembering previously studied words, their performance was impaired compared to control subjects (Schacter, 1985; Graf, Squire & Mandler, 1984). In summary, dissociations between implicit and explicit tests of memory with amnesics patients supported the theory that there were at least two memory processes.

Support for the distinction between implicit and explicit memory also has come from studies that examined the effects of subliminally encoded stimuli. Kunst-Wilson and Zajonc (1980) demonstrated that subjects show implicit memory for subliminally presented stimuli even when they show no explicit memory for those events. Geometric shapes that were visually presented to subjects subliminally (presented too rapidly to be explicitly identified) were preferred on an indirect test in which subjects rated one of two shapes (old and new) but were not recollected on a direct test for explicit memory of the shapes (Kunst-Wilson & Zajonc, 1980).

Support for the distinction between implicit and explicit memory also came from studies examining levels of brain activity (Squire, 1992). During explicit and implicit memory tests different areas of the brain became activated, as indicated by higher levels of blood concentration. PET scans have also shown an increase in activity in the frontal lobe and the hippocampus during direct tests of memory which measure recognition, while an increase in activity has been shown in the occipital lobe during indirect tests of visual memory (Squire, 1992). This distinction provides biological evidence supporting the hypothesis that memory is not a unitary process (*i.e.*, does not take place in a single location in the brain).

Theories of Dissociations

Observations of stochastic independence and functional dissociations have implications for our understanding of human memory. It is argued by some (e.g. Squire & Cohen, 1984; Squire, 1987; Tulving, 1985) that these observations reflect separate memory systems.

Squire and Cohen (1984) argued that conscious or explicit recollection is a property of and supported by a *declarative* memory system. This declarative memory system is said to be involved in the formation of new representations or data structures (Squire, 1987). In contrast, implicit memory for prior occurrence is attributed to *procedural* systems where memory is expressed by ongoing modifications of procedures or processing operations (Squire, 1987). The distinction, as argued by Squire, (1987) is not between different forms of memory, but between different processes, either of which can be used to retrieve the same representation.

In a ternary classification of memory systems, Tulving (1985) proposed distinctions between procedural, episodic and semantic memory. Procedural memory was defined as being a reflection of immediate stimulus and response processing and is taken to reflect retention of learned connections between stimuli and responses. It allows one to respond adaptively to the environment without being aware of the relation between the present and past environment (Tulving, 1985). Semantic memory builds on procedural memory with the addition of the capability to internally represent states of the world that are not perceptually present. It too allows one to respond adaptively to the environment, but on a more sophisticated level. As with procedural memory, semantic memory does not support a direct awareness of the relation between the past and present (i.e., becoming better at naming objects in the world about you does not entail an awareness of each and every time you've used that name). Episodic memory allows one the additional capability of acquiring and retaining knowledge about specific personal experiences and specific uses of procedural and semantic memory. Each of the three memory systems is said to differ in its methods of acquisition, representation and expression of knowledge and in the kind of conscious awareness that characterizes its operation (Tulving, 1985). Evidence for the existence of these further classifications of memory distinctions followed from studies of explicit and implicit memory, with procedural/semantic memory being equated with implicit tests of memory and episodic/semantic with explicit tests of memory.

Limitations of Identifying Memory with Separate Tasks

As pointed out by Jacoby (1991), one of the major problems in many of the experiments seeking to examine implicit and explicit memory, is that there is a problem with the process of identifying separate components of memory by using separate tasks for each component. Moreover, implicit and explicit memory tasks often reflect only a difference in instruction and typically they produce the same response. Thus, they are hard to measure separately. For example, the increased probability of completing a word stem with a word that was previously presented (Jacoby & Dallas, 1981; Tulving Schacter & Stark, 1982) could result from either an unconscious influence on memory (implicit) or from conscious retrieval of the prior presentation of that word (Jacoby, Kelley & Dywan, 1989). Thus, if subjects are asked to complete the stem BO_ _ with the first word that comes to mind, a correct response of BOAT (from a previous list) would be assumed to be due to implicit memory. However, one can not be sure that the subject did not explicitly recall that the word was in the study list and thus both implicit and explicit memory techniques could be used to respond appropriately. Therefore, different processes of memory can retrieve the same overt response (Squire, 1987). This can result in contamination of performance on indirect tests by intentional uses of memory and contamination of performance on direct tests by unconscious uses of memory (Jacoby, 1991; Toth, Reingold & Jacoby, 1994).

The assumption that there is a one to one mapping between direct tests of memory with intentional memory and indirect tests with unconscious uses of memory has been labelled the factor-pure problem (Jacoby, 1991). The factor-pure problem questions whether indirect tests of memory provide a valid estimate of the implicit component of memory, as performance on indirect tests may reflect both intentional and unconscious uses of memory .

A second problem associated with examining separate components of memory with separate tasks is that subjects may be using different response criteria across the two tasks (Toth, et al., 1994). For example, the determined criteria for a subject to indicate that they recognize a word from a previous list in a test of recognition may be completely different from the criteria they set for responding in a stem completion task with the first word that comes to mind. This leaves open the possibility that observed dissociations on direct and indirect tests may be due to differences in response criteria rather than separate memory processes.

As a response to these limitations of identifying separate memory components with separate tasks, Jacoby (1991) proposed a process that put recollective and automatic memory in direct opposition within a single task. According to Jacoby (1991) the process dissociation procedure could separate the contributions of unconsciously and consciously controlled influences on memory within a single task by using different instruction conditions, rather than identifying these processes with different tasks. This procedure provides estimates of recollective and automatic memory that are 'process pure' (Jacoby, 1991). Process dissociation allow for the detection of change (or lack of change) in the specific memory processes rather than assuming a one-to-one mapping between processes and tests as is required with task dissociations (Jacoby, 1991).

Process Dissociation

The process dissociation procedure as described by Jacoby (1991) requires two explicit instruction conditions, inclusion and exclusion. In the inclusion condition, subjects attempt to retrieve a solution to a problem by one of two processes: by recalling an appropriate word from a previously studied list of words, *or* from pre-experimental knowledge. Thus, the inclusion test prompts subjects to use their recollective memory in addition to general problem solving skills to perform a task. If a studied word *is* produced it could be due to conscious retrieval *or* to pre-experimental knowledge, as both are operating when an individual is trying to recall a previously studied word. To separate unconscious and conscious retrieval techniques, performance is also measured in an exclusion condition. The exclusion condition requires subjects to complete a stem with a word that was *not* on the previous study list. The exclusion condition prompts subjects to use their recollective memory in order *not* to produce the studied word. The studied word would be produced only when subjects fail to consciously remember that it was on the previous list. This leads to the conclusion that if a studied word is produced more frequently than it would by chance, then it must be due to unconscious influences on memory.

Assuming independence between recollective and automatic memory, Jacoby (1991) identified which processes were acting on responses to the inclusion and exclusion instructions and from these estimates, calculated the recollective and automatic uses of memory. In the inclusion condition, the probability of responding with a studied word is due to either recollection or familiarity. Thus the probability of responding with a studied word in the inclusion test condition as put forth by Jacoby (1991) would be the probability of recollection (R) plus the probability of the word automatically coming to mind (A) without conscious recollection (1-R):

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

In the exclusion condition the production of a studied word would be due to familiarity of the word with no conscious recollection of it being on the previous study list. Thus, the probability of producing the studied word in the exclusion condition as put forth by Jacoby (1991) would be the probability of the word automatically coming to mind (A) without recollection (1-R) of it being on the previously studied list:

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

Combining the results from the inclusion and exclusion conditions allowed for the assessment of recollective memory without the influence of familiarity. Subtracting the probability of producing a studied word in the exclusion condition from that probability in the inclusion condition provided an estimate of recollective memory:

$$\text{Recollection} = \text{Inclusion} - \text{Exclusion} \quad (3)$$

Once an estimate of recollection is calculated, the automatic component can be calculated by dividing the probability of producing a studied word in the exclusion condition by the probability of a failure in recollection:

$$\text{Automatic} = \text{Exclusion}/(1-R). \quad (4)$$

The effectiveness of the process dissociation procedure as compared to the identification of separate processes with separate tasks was examined by Jacoby (1991) in three experiments. On the basis of the results of these experiments, Jacoby (1991) concluded that the estimations of recollective and automatic memory from the process dissociation procedure produced similar results as experiments that utilized separate tasks to estimate these memory processes. Thus, this new procedure was effective at separating the effects of recollective and automatic memory on performance.

The process dissociation procedure has been used to separate the recollective and automatic components of memory in a number of studies. Examinations of manipulations of attention on recollective and automatic components of memory using the process dissociation procedure have indicated that divided attention at study reduces recollective memory while leaving automatic processes unchanged (Debner & Jacoby, 1994; Jacoby, 1991; Jacoby & Kelley, 1992; Jacoby, Toth & Yonelinas, 1993; Jacoby, Woloshyn & Kelley, 1989; Jennings & Jacoby, 1993). Manipulations of age (Jennings & Jacoby, 1993) and depression (Hertel & Milan, 1994) have also been examined with the process dissociation procedure and have been found to reduce recollective memory performance while leaving automatic memory unaffected.

Using the process dissociation procedure, the effect of the manipulation of attention has been examined in a variety of tasks including stem completion tasks (Jacoby & Kelley, 1992; Jacoby, Toth & Yonelinas, 1993; Debner & Jacoby, 1994) and fame judgement experiments (Jennings & Jacoby, 1993; Jacoby, Woloshyn & Kelley, 1989) and with different stimuli at study including read words (Jacoby, 1991; Jacoby, Toth & Yonelinas, 1993), anagrams (Jacoby, 1991), aurally presented words (Jacoby, Toth & Yonelinas, 1993), and words flanked by pre- and post-masking words (Debner & Jacoby, 1994). In all of these studies the manipulation of attention was found to produce a dissociation between estimates of recollective and automatic memory with one exception. Dividing attention was found to reduce both automatic and recollective memory for words that were presented aurally at study (Jacoby, Toth & Yonelinas, 1993).

The results of these studies indicate that the distinction between automatic and recollective memory can be shown empirically with the process dissociation procedure. This ability to quantify the recollective and automatic components of memory has implications for psychology in general. Research in the areas of eye-witness testimony, false memory syndrome and memory misattribution are based on human ability to differentiate between recollective and automatic sources of memory. Research in eye-witness testimony could examine the affects of misleading information on recollective and automatic memory for the original events. In the same manner, the affect of misleading information on children's memories could be examined in terms of recollective and automatic sources of memory. The induction of false memories may be due to misattributing feelings of familiarity based on automatic memory to recollective memory. With the ability to separate the recollective and automatic sources of memory with the process dissociation procedure, these and other venues of research are available.

Limitations of Process Dissociation

Although the process dissociation procedure solves some of the problems involved in separating recollective and automatic components of memory, it has some limitations. One limitation of process dissociation and its use of separate inclusion and exclusion responses (Jacoby, 1991) is that independence between recollective and automatic influences of memory is assumed but can not be directly assessed. Support for this assumption has come indirectly in the form of evidence demonstrating that recollective and automatic memory are manipulated by different variables (*e.g.* Jacoby, 1991; Jacoby, Toth & Yonelinas, 1993; Jennings & Jacoby, 1993). However, a direct test of this assumption, which is critical for calculations in the process dissociation procedure, is not possible with the use of separate instruction conditions.

A second limitation in the use of the process dissociation procedure (Jacoby, 1991) is that it assumes that subjects are using the same response criterion in the separate test instructional conditions. For example, a subject's criteria for responding with a studied word in the exclusion condition may be higher than in the inclusion condition. Because responses are gathered from two instructional conditions, one can not be certain if the source of differences between tests are those assumed by the process dissociation procedure, to differences in responses criteria, or both.

The present experiments test a procedure of reconstructing inclusion and exclusion responses using simultaneous rather than separate judgements. Such a procedure avoids the problems associated with examining separate components of memory by manipulating the two sets of separate test instructions. The simultaneous response procedure requires that subjects make judgements about fame and memory for prior occurrence, simultaneously. This procedure provides a direct method of assessing independence between recollective and automatic memory.

Simultaneous Response Procedure

It is proposed that simultaneous judgements be made using a four-alternative forced-choice paradigm as presented in Table 1. Subjects responded to a name as: A) famous and remembered from the study list, B) not famous and remembered, C) famous and not remembered, or D) not famous and not remembered. It is proposed that inclusion and exclusion can be reconstructed from these simultaneous judgements about fame and recollection. The inclusion condition can be estimated by summing the probability of responding to choices A, B, and C from the 4-alternative forced-choice paradigm:

$$\text{Inclusion} = P(A)+P(B)+P(C) \tag{5}$$

The exclusion condition can be estimated by the probability of responding to choice C: the name is famous and it was not presented earlier:

$$\text{Exclusion} = P(C) \tag{6}$$

Condition (C) is functionally similar and perhaps identical to Jacoby's (1991) exclusion condition as it assesses the familiarity of a response when the subject believes it was not presented earlier.

Insert Table 1 about here

It is proposed that once the inclusion and exclusion responses are reconstructed in the simultaneous response procedure, then the recollective and automatic components of memory can be calculated using formulas given by Jacoby (1991). Thus, formulas (3) and (4) presented earlier for calculating recollective and automatic components of memory from separate judgements of inclusion and exclusion will also be used for calculating recollective and automatic components of memory from simultaneous judgements. Assessment of how well the simultaneous response procedure predicts responses in the process dissociation procedure using separate inclusion and exclusion responses will be based on these estimates of recollective and automatic memory.

Experiment 1

The first experiment examined the feasibility and utility of using simultaneous responses as a substitute for separate inclusion and exclusion responses. A replication of Jennings and Jacoby (1993) using the process dissociation procedure with separate responses was used as a baseline for comparison of the simultaneous response procedure. Separate inclusion and exclusion judgements and simultaneous judgements about fame and memory for prior occurrence were examined following a manipulation of attention used to provoke a pattern of dissociation between recollective and automatic sources of memory.

Jennings and Jacoby (1993) used judgements of fame to examine recollective and automatic sources of memory. Earlier research (Jacoby, Woloshyn & Kelley, 1989) had indicated that the familiarity of a name that is read in a prior experimental condition can be mistaken for the familiarity that characterizes a famous name. In their experiments, there was an increased probability of mistaking a nonfamous name that was presented during the study phase of the experiment as being famous (Jennings & Jacoby, 1993; Jacoby, Woloshyn & Kelley, 1989). To provide a functional measure of independence, Jennings and Jacoby (1993) manipulated attention during the study period. Dissociations between recollective and automatic memory have been shown with manipulations of attention (Jacoby, Woloshyn & Kelley, 1989). That is, dividing attention has been shown to reduce recollective memory while leaving automatic memory intact (Debner & Jacoby, 1994; Jacoby, 1991; Jacoby & Kelley, 1992; Jacoby et al., 1989; Jacoby, Toth & Yonelinas, 1993; Jennings & Jacoby, 1993). Jacoby et al. (1989) suggested that dividing subjects attention makes it more difficult for subjects to consciously recollect the names that are presented earlier but does not impair subject's feelings of familiarity. A manipulation of attention was incorporated in the present study to determine whether estimates of recollective and automatic memory derived from simultaneous responses would show the same dissociations between recollective and automatic memory observed with separate inclusion and exclusion instructions.

Subjects in the control or separate judgement groups responded using the inclusion and exclusion instruction sets described by Jacoby (1991). The inclusion condition instructed subjects to respond "famous" when they recognized a name as being famous or when they recognized a name as being on a previous list that they read. The exclusion condition instructs subjects to respond "not famous" if they recognized a name as being on a previous list that they read.

Subjects in the simultaneous judgement condition responded using 4-alternative forced-choices described in Table 1. When presented with a name, subjects in the simultaneous judgement condition responded with one of the four choices which indicated whether or not the name was famous and whether or not it was presented previously. This method did not require separate inclusion and exclusion instruction conditions.

In summary, the present investigation evaluated the feasibility and utility of using simultaneous judgements rather than separate judgements to derive estimates of recollective and automatic memory using the equations described in the process dissociation procedure. Attention was manipulated to provide a measure of dissociation between recollection and fame judgements in both separate and simultaneous groups. The study sought to replicate the pattern of findings described by Jennings and Jacoby (1993) with simultaneous and separate judgements. A benefit of simultaneous judgements is that it is possible to directly assess the independence between recollective and automatic memory, an assumption that is critical for calculations in the process dissociation procedure.

Based on earlier research (Jacoby & Kelley 1992; Jacoby, Toth & Yonelinas 1993; Jacoby, Woloshyn & Kelley 1989; Jennings & Jacoby 1993) several hypotheses were made. First, we expected that subjects would indicate famous for studied nonfamous-names more often than for nonstudied nonfamous-names in the inclusion instruction condition. No predictions were made for the exclusion condition. The prediction was based on the fact that the inclusion condition instructs subjects to indicate famous for those names that they recognize as being on the previous study list, hence, studied names should be judged as famous more often than nonstudied names in the inclusion condition. Second, and more importantly, we expected that the estimates of recollective and automatic memory would be quantitatively and qualitatively identical for simultaneous and separate judgements. The estimates would be qualitatively identical if subjects in the divided attention condition showed a reduction in their recollective memory performance while leaving performance on automatic memory unchanged, for both the simultaneous and separate response alternatives. Finally, it was hypothesized that recollective and automatic components of memory would be independent.

The analysis of stochastic independence between recollective and automatic memory was performed in two ways. First, we compared the mean observed and predicted values for each subject. Second, we collapsed the data over subjects and compare observed with expected for a single 2x2 table using a single estimate of dependence - Yules *Q* (Yule, 1900; Hayman & Tulving, 1989). Yules *Q* is a measure of stochastic independence that produces an estimate of the degree of association between recollective and automatic sources of memory. Yule's *Q* is identical to Gamma in a 2x2 table (Goodman & Kruskal, 1954), and is calculated by the following formula:

$$\text{Yule's } Q^{1} = (ad-bc)/(ad+bc), \tag{7}$$

where *a, b, c* and *d* represent the four cells of a 2x2 contingency table (see Table 1). The range of Yule's *Q* is symmetric about 0, with -1 referring to complete negative dependence, +1 referring to complete positive dependence and 0 to neutral or no dependence (Hayman & Tulving, 1989).

Method

Subjects

Sixty-four subjects were recruited from Introductory Psychology courses at Lakehead University and received credit for their participation. Ethical approval was obtained prior to the start of the experiment. The subjects were randomly assigned to one of 4 groups with 16 subjects in each.

Materials

The stimuli used in this experiment were 120 nonfamous-names and 120 famous-names described by Jennings and Jacoby (1993) for young subjects (see Appendix B and C, respectively). Jennings and Jacoby (1993) selected the nonfamous-names from lists used in prior experiments and from the telephone book. The names were matched with the famous-names on the following criteria: gender as indicated by the first name, nationality of first and last name, the number of first and last names beginning with a given letter, and the length of the first and last names. Examples of nonfamous-names are Rudolph Ashe and Dorothy Drumm. The famous-names were selected by Jennings and Jacoby (1993) on the basis that they would be generally recognizable as famous, but that frequently subjects would not be able to identify what had made that individual famous. This criteria was used to encourage subjects to base their fame judgements on a name's familiarity rather than it's identifiability (Jennings and Jacoby, 1993). Examples of famous-names include Joan Baez, Minnie Pearl and Salman Rushdie.

For purposes of counterbalancing, the 120 nonfamous-names were divided into four sub-lists of 30. Two sets of 30 were presented at study and test and were referred to as "studied nonfamous-names". The other two sets of 30 names were presented only during the testing phase of the experiment and referred to as "nonstudied nonfamous-names". The two sub-lists of studied nonfamous-names were required for separate test instruction conditions (inclusion and exclusion) in the separate judgement groups and in pseudo conditions in the simultaneous judgement groups. The sub-lists of names were counterbalanced by being rotated through all of the test conditions. Thus, each set of 30 nonfamous-names appeared an equal number of times in each condition, namely studied/nonstudied and inclusion/exclusion. Although not strictly necessary, the names were split and counterbalanced in the same way for the simultaneous judgement groups.

The famous-names were presented only during the test phases of the experiment. The 120 famous-names were divided into two sets of 60, and were referred to as "nonstudied famous-names". The two sets of 60 nonstudied famous-names were shown in separate test instruction conditions in the separate judgement groups and in the corresponding sub-list conditions in the simultaneous judgement groups. The sub-lists of famous-names were rotated between the inclusion and exclusion conditions.

Subjects in the divided attention condition performed a listening task previously used by Craik (1982) and Jennings and Jacoby (1993). Subjects were required to detect target sequences of three odd numbers in a row (e.g. 3, 5, 7) from a list taken from Jennings and Jacoby (1993). The numbers were random with the exception that a minimum of one and a maximum of five numbers occurred between targeted sequences and not more than two even numbers could occur in a row. The list of numbers is included in Appendix D and is the same as that used by Jennings and Jacoby (1993). Auditory names of the digits were produced by a voice synthesizer driver through a speaker attached to the Apple IIe computer.

An Apple IIe computer and monitor was used to present the study and test stimuli. Subjects' judgements about fame and memory for prior occurrence were made on a keyboard and recorded by a computer program. Data was stored and scored by the same program.

Experimental Design

A 2x2x2x2 design was used in the present study with prior occurrence of names (studied versus nonstudied names) and instruction condition (inclusion versus exclusion) as within-subject factors and attention (full versus divided) and response alternatives (simultaneous judgement versus separate judgement groups) as between-subjects factors. Subjects were randomly assigned to one of four groups, separate judgement groups with full or divided attention, or simultaneous judgement groups with full or divided attention. Dependent measures in Experiment 1 were inclusion and exclusion responses and estimates of recollective and automatic memory.

The separate judgement condition was a replication of Jacoby and Jennings (1993) study. Subjects made judgements about fame and prior occurrence from separate inclusion and exclusion instructions conditions. The simultaneous judgement groups required subjects to rate each name for fame and for prior occurrence simultaneously using the 4-alternative forced-choice paradigm (see Table 1) and provided an opportunity to investigate the relation between subject responses about fame and memory for prior occurrence.

Procedure

Subjects were tested individually by the experimenter in a small room equipped with a computer. There were separate study and test phases. The study phase was identical for the separate judgement and simultaneous judgement groups. Subjects were required to read 60 nonfamous-names out loud that were presented on the Apple IIe monitor. The first and last name were presented simultaneously for 2 seconds in the centre of the screen on one line. The initial letter of each first and last name was capitalized (*e.g.* Patsy Kinsella).

In the divided attention condition, subjects performed an additional listening task while reading the names out loud. The listening task required subjects to listen to a spoken series of numbers and to identify target sequences of 3 odd numbers in a row (*e.g.,* 3,7,5). Subjects raised their hand to indicate when they detected a target sequence. Subjects were instructed to be as accurate as possible, and were given a sample list of digits to familiarize themselves with the procedure. The experimenter informed subjects if they had missed two sequences of odd numbers in a row by saying "Miss". Subject accuracy on this task was also recorded. Instructions for the divided attention task were the same for all subjects and appears in Appendix A.

The timing between words was the same for full and divided attention conditions. In the full attention condition, the computer program generated the same sounds as in the divided attention condition, however, the sounds were not produced through the voice synthesizer. This ensured that the duration of the study phase was the same for both full and divided attention conditions.

A two minute break immediately followed the study phase of the experiment in which the experimenter engaged subjects in conversation. At the end of the two minutes, a computer prompt indicated that the test phase of the experiment was to begin. Instructions for the testing phase of the experiment were then explained to subjects.

All subjects in the separate judgement groups had two instruction conditions. The inclusion condition came first for all subjects and was followed by the exclusion condition (Jennings & Jacoby, 1993). In the inclusion condition subjects were required to make fame judgements on a list of 60 famous and 60 nonfamous-names. Thirty of the nonfamous-names were from the study list. Subjects were instructed to assume that all of the names presented during the study phase were famous-names. Subjects were then told to indicate "famous" when they recognized the name as being famous or if they recognized the name from the study list. They were instructed to call a name "not famous" if they did not recognize it as being in the study list or they did not recognize it as being a famous name.

Instructions for the exclusion condition were given to all subjects following completion of the inclusion condition. In the exclusion condition subjects were instructed to assume that all of the names on the study list were not famous. Subjects were then required to make fame judgements on a new list of 60 famous and 60 nonfamous-names, 30 of which were presented previously on the study list. Subjects were told to respond "not famous" if they recognized a name as being on the study list or did not recognize it as famous. A summary of the inclusion and exclusion instructions remained on the screen for the duration of that condition, and subjects responded famous or not famous by pressing either the closed apple key or the open apple key on the computer keyboard, respectively.

All subjects in the simultaneous judgement groups were given the same instructions as the separate judgement subjects during the study phase. Subjects were required to make fame judgements and judgements about prior occurrence on a list of 120 famous and 120 nonfamous-names. Two test blocks were used to parallel the sequential structure of the separate judgement groups' inclusion and exclusion conditions. During each segment 30 studied nonfamous-names, 30 nonstudied nonfamous-names and 60 famous-names were presented to all subjects. Responses to each name were one of the 4-alternative forced-choices. As each name was presented subjects decided whether the name was famous and presented in the study list, famous but not in the study list, not famous but in the study list, or not famous and not in the study list. Instructions for the simultaneous judgement groups remained on the screen for the duration of the experiment. Subjects' judgements were recorded and scored by condition by the computer program. Appendix A describes instructions given to subjects in the separate judgement and simultaneous judgement groups.

The results of inclusion and exclusion judgements are reported first. The estimations of recollective and automatic memory derived from the inclusion and exclusion responses will be reported in following sections. All t-tests reported are two-tailed. Values presented in parentheses are means.

Results

Divided Attention Performance at Study

In the divided attention condition, subjects failed to detect a mean of 3.9 of the 17 possible target sequences (23%) for the listening task. Subjects made false alarms, indicating an odd sequence when there wasn't one, on an average of 2 times during the divided attention task. There was no difference between the separate judgement group (4.3) and the simultaneous judgement group (3.5) ($t(30)<1$, *ns*) on this task.

Inclusion and Exclusion

The mean probability of inclusion and exclusion responses for the separate and simultaneous judgement groups as a function of full and divided attention are presented in Table 2. The probability of rating a nonfamous-name as famous in the inclusion and exclusion conditions was calculated using formulas (1) and (2) for the separate judgement groups and was calculated for the simultaneous judgement groups using formulas (5) and (6). Overall, the pattern of results were in accordance with what was predicted. Fame responses to nonfamous-names appeared to be greater for studied names compared to nonstudied names in the inclusion condition but not in the exclusion condition. Fame responses to studied nonfamous-names appeared to be greater in the inclusion compared to the exclusion condition. A similar pattern was observed for subjects responding with separate and simultaneous judgements. However, responses in the simultaneous groups appeared to be greater than in the separate groups in the inclusion condition, while the opposite pattern was observed in the exclusion condition, where responses in the separate groups appeared to be greater than the simultaneous groups.

Insert Table 2 about here

Significance of the differences observed between these means was assessed with a 2x2x2x2 mixed ANOVA comparing prior occurrence of names (studied versus nonstudied) and instruction (inclusion versus exclusion) as within-subject factors and attention (full versus divided) and response alternatives (separate versus simultaneous) as between-subjects factors. There was a significant main effect of prior occurrence

($F(1,60)=264.01$, $p=0.0001$, $MS_e=.0097$) and instruction ($F(1,60)=355.54$, $p=0.0001$, $Ms_e=.0142$), as well as a significant interaction between prior occurrence and instruction ($F(1,60)=267.69$, $p=0.0001$, $MS_e=.0078$) which was consistent with the observation that fame responses were greater for the inclusion (.398) compared to the exclusion condition (.118) and that the effect of prior presentation was observed only in the inclusion condition (.588 versus .207 for studied and nonstudied names). There was a significant three-way interaction between prior occurrence, instruction and attention (discussed in the following paragraph), but it did not affect interpretation of the two-way interaction.

The significant three-way interaction involving prior occurrence and instruction was with attention, $F(1,60)=13.67$, $p=0.0001$, $MS_e=.0078$. This was in addition to the significant main effects of prior occurrence and instruction discussed previously, and a two-way interaction between prior occurrence and attention ($F(1,60)=5.23$, $p=0.026$, $MS_e=.0097$) with no main effect of attention ($F<1$). Inspection of the means suggests that the effect of attention was seen only for studied nonfamous-names in the inclusion condition. A t-test comparing the means of responding to studied names in the inclusion condition for full (.646) and divided attention (.529) was significant ($t(62)=3.59$, $p=0.006$), revealing that dividing attention reduced performance only for studied names in the inclusion condition.

There was a significant interaction between instruction and response alternatives ($F(1,60)=20.24$, $p=0.0001$, $MS_e=.0142$) where fame responses were greater for simultaneous than separate (.444 versus .325) in the inclusion condition, while the opposite was true for the exclusion condition (.077 versus .158). Using the MS_e term from the ANOVA a critical difference (Fisher's LSD) was calculated to be .060, (p=.05, two-tailed). Comparison of the means using this critical difference revealed that the difference in responses for simultaneous and separate was significant for both inclusion and exclusion conditions. All other main effects and interactions with the response alternatives were not significant (F's<1), suggesting that both procedures had the same effect on inclusion and exclusion.

Recollective Memory

The effect of the manipulation of attention on the estimates of recollective memory was compared between simultaneous and separate groups. Estimates of recollective memory were calculated using equation (3) for both simultaneous and separate groups. The mean proportions of recollective memory estimates for studied and nonstudied nonfamous-names are presented in Table 3 in the left two columns. The results were largely consistent with predictions. Divided attention compared to full attention produced decrements in recollective memory in both response conditions. However, unexpected quantitative differences were observed between the simultaneous and separate groups, with estimates of recollective memory being higher for the simultaneous compared to separate judgement groups.

Insert Table 3 about here

Significance was assessed using a 2x2 ANOVA with attention (full versus divided) and response alternatives (separate versus simultaneous) as between-subjects factors. There was a significant main effect of attention ($F(1,60)=14.052$, $p=0.0001$, $MS_e=.022$) where recollective memory was found to be greater for full (.531) compared to divided attention (.392). There was a significant main effect of response alternatives ($F(1,60)=14.052$, $p=0.001$, $MS_e=.022$) where recollection of studied nonfamous-names was greater in the simultaneous (.531) compared to the separate judgement groups (.392). The interaction between attention and response alternatives was not significant ($F<1$) indicating that both the separate and simultaneous groups showed a similar decrease in recollective memory with divided compared to full attention.

Automatic memory

The effect of the manipulation of attention on the estimates of automatic memory were compared between simultaneous and separate groups. Estimates of automatic memory were calculated by using equation (4) for both simultaneous and separate groups. The mean proportions of automatic memory estimates for studied and nonstudied nonfamous-names are presented in the right two columns of Table 3. As predicted, the manipulation of attention did not appear to affect estimates of automatic memory for studied nonfamous-names. However, estimates of automatic memory appeared to be higher for the separate compared to the simultaneous groups.

Significance was assessed using a 2x2 ANOVA with attention (full versus divided) and response alternatives (separate versus simultaneous) as between-subject factors. The main effect of attention and the interaction between attention and response alternatives were not significant (all F's<1). This confirmed that the manipulation of attention did not affect estimates of automatic memory for either separate or simultaneous groups. There was a significant main effect of response alternatives $F(1,60)=10.3$, $p=0.002$, $MS_e=.0228$, where automatic fame responses were greater for separate (.253) compared to simultaneous (.159). Thus, subjects responding to the separate inclusion and exclusion conditions had an advantage over subjects in the simultaneous judgement groups when attributing fame to studied names on the basis of familiarity.

Independence

Independence between estimates of recollective and automatic memory was assessed for the simultaneous groups only. The observed marginal mean probabilities for recollection and fame judgements and the observed and expected probabilities are given in Table 4 for studied and nonstudied nonfamous-names. The recollective probabilities are identical to data presented in Table 3, while fame judgements are the observed sum of Cells A and C (see Table 1) rather than conditional estimates of fame used in the process dissociation procedure. Fame judgements reflect the knowledge of subjects about whether a name was famous irrespective of whether it was recalled as being studied or not. Whereas the process dissociation estimates of automatic memory are based on subjects' knowledge of fame in the absence of memory for prior occurrence and the assumption of independence between recollection and automatic memory. If fame judgements and recollection were independent then the estimates of automatic memory would equal the marginal total for fame judgements. Independence, however, was tested with the conventional method where the observed intersect of the two responses (*i.e.,* both recalled and judged famous) is compared with the expected value (*i.e.,* the product of the marginal probabilities of recall and fame responses).

Insert Table 4 about here

The analysis of stochastic dependence between recollective and automatic memory was performed in two ways. First, we compared observed and expected values for each subject, and second, we collapsed over subjects and compared observed with expected in a single 2x2 table.

In the within-subject comparison, we calculated Cell A for each subject and derived an expected value for each subject by multiplying the probability of a fame judgement with the probability of recollection. This expected value was compared with the observed for each subject. For the overall sample, the observed value was lower (.065) than the expected value (.083) ($t(31)=3.89$, $p=0.0001$). The same pattern of observed lower than expected was found for each attention condition (.077 versus .092, $t(15)=2.40$, $p=.03$ for full attention; .052 versus .075, $t(15)=3.03$, $p=.008$ for divided attention). Because the observed A cell means were less than the expected values for studied nonfamous-names, judgements of recollection and fame were found to be negatively related.

The data was collapsed across subjects into a single 2x2 table to link the results to previous work examining different judgements of memory (*e.g.,* Hayman & Tulving, 1989; Hayman & Rickards, 1995; Tulving, Schacter & Stark, 1982). Using Yules *Q*, the single 2x2 table also provided a measure of the degree of dependence between the two sources of memory. Yules *Q* (Yule, 1900; Hayman & Tulving, 1989) also known as Gamma (Goodman & Kruskal, 1954) was calculated using equation (7). The range of *Q* (-1 to +1) is symmetric about 0, with the end points corresponding to complete negative or positive association and with 0 corresponding to no association (Hayman & Tulving, 1989). The Q statistic was calculated for full and divided attention and for the overall sample (Q's = -0.303, -0.270, -0.289, respectively). The negative dependence, although small, was significant for full attention ($\chi^2(1, N=240)= 4.97, p=0.05$) and when the data was collapsed over attention conditions ($\chi^2(1, N=480)=9.606, p<0.01$) but not for the divided attention condition ($\chi^2(1, N=240)=2.19$, *ns*). The findings imply that for studied names, judgements about recollective and automatic components of memory appear to be negatively dependent.

The relation is said to be negatively dependent because observed probabilities for Cell A were lower than the expected probabilities (see FaRec for observed and Fa*Rec for expected values in Table 4). In contrast, observed probabilities for Cell C, as given by the Exclusion column in Table 2, were higher than expected. Thus, subjects are responding less than expected to Cell A which increases their probability of responding to Cell C. It is mathematically necessary that observed values of Cell D differ from the expected values in the same direction as values in Cell A, and that observed values of Cell B differ from the expected values in the same direction as values in Cell C.

The relationship between recollective and automatic sources of memory for nonstudied names was also compared within-subjects for full, divided and collapsed across attention conditions (all t's <1), and compared collapsed across subjects (Q's=0.172, -0.060 and 0.015, for full, divided and collapsed across attention conditions -- all χ^2's<1). This finding is consistent with the assumption that for nonstudied names, judgements about recollection and automatic components of memory are independent.

Reaction Times

Subjects' mean reaction times as a function of attention and responses alternatives are presented in Appendix E. Prior to analysis, the reaction times were examined for missing values and extreme scores ($z > +3.00$) which were omitted from the analyses, leaving 51 of the original 64 subjects. The missing data points occurred when a subject did not respond to one of the cells. One extremely high score was found in each of the four groups: separate group with full attention, separate group with divided attention, simultaneous group with full attention and simultaneous group with divided attention. Overall, reaction times appeared to be greater for simultaneous compared to separate groups.

Significance was assessed with a 2x2 ANOVA with attention (full versus divided) and response alternatives (separate versus simultaneous) as between-subject factors[2]. There was a significant main effect of response alternatives ($F(1, 47)=44.77, p=0.0001, MS_e=7480.62$) where reaction times were found to be greater for simultaneous (337.16) compared to separate (173.39). The main effect of attention and the interaction between attention and responses alternatives were not significant (F's<1).

Discussion

Experiment 1 was conducted to examine the feasibility and utility of estimating recollective and automatic memory from inclusion and exclusion conditions derived from simultaneous judgements about fame and memory for prior occurrence. These estimates were evaluated against a replication of Jennings and Jacoby's (1993) experiment with expectations that the use of simultaneous judgements would quantitatively and qualitatively replicate those findings. A manipulation of attention was used to provoke a pattern of dissociation between recollective and automatic memory, as estimated by both simultaneous and separate response alternatives (Debner & Jacoby, 1994; Jacoby, 1991; Jacoby & Kelley, 1992; Jacoby et al., 1989; Jacoby et al., 1993; Jennings & Jacoby, 1993).

The reconstruction of inclusion and exclusion responses from simultaneous judgements produced similar effects as observed with separate inclusion and exclusion instructions. For both separate and simultaneous judgements, fame judgements were greater for studied nonfamous-names compared to nonstudied nonfamous-names in the inclusion, while no differences were observed in the exclusion condition. This indicates that subjects were following instructions for the separate instruction conditions, and that the use of simultaneous judgements effectively reconstructed those conditions.

Estimates of recollection and automatic sources of memory for separate and simultaneous responses were found to be qualitatively but not quantitatively equivalent. Quantitative estimates of recollection were found to be greater for simultaneous judgements compared to separate judgements, while estimates of automatic memory were greater for separate judgements compared to simultaneous judgements. The same differences were noted for the inclusion and exclusion conditions with simultaneous greater than separate for the inclusion and separate greater than simultaneous for the exclusion condition.

However, the manipulation of attention produced the same qualitative dissociation between recollective and automatic memory with separate and simultaneous judgements. Specifically, dividing attention at study reduced estimates of recollective memory while leaving estimates of automatic memory unchanged. Thus, although we were unable to predict quantitative estimates of recollection and automatic memory with separate responses from simultaneous responses, we were able to predict qualitative differences.

One interpretation of the quantitative differences observed between the separate and simultaneous judgements is to assume that processing demands with simultaneous retrieval are more rigorous or extensive than with separate retrieval. An increase in retrieval processing would be expected to increase the overall accuracy of recall for simultaneous compared to separate judgements, as was observed.

The simultaneous response procedure provided a means to directly assess independence between recollective and automatic components of memory. The results indicated that recollective and automatic memory processes for nonfamous-names may be negatively dependent. Thus, although a functional dissociation between recollective and automatic memory was observed as a function of the manipulation of attention, the stochastic relation between recollective and automatic memory responses was found to be slightly but significantly negatively dependent. Negative dependence is an unusual relation between different measures of memory. Independence is typically observed between tests of implicit and explicit memory (*e.g.* Blaxton, 1989; Hayman & Tulving, 1989; Tulving, Schacter & Stark, 1982), while dependence is consistently positive between successive tests of explicit (recollective) memory (*e.g.* Ogilvie, Tulving, Paskowitz, & Jones, 1980; Postman, Jenkins & Postman, 1948; Rabinowitz, Mandler &

Patterson, 1977; Tulving & Watkins, 1975; Wallace, 1978; Watkins & Todres, 1978). In short, the negative dependence observed here is not consistent with previous research, which suggests that it could be occurring as a result of unique experimental conditions.

One source of negative dependence might be the presence of a response bias. If subjects believed that there were few, if any, famous-names in the original study list, then such a bias would make subjects' guesses about fame and prior occurrence negatively related. In effect, responses in Cell A, the name is famous and in the study list, would be less frequent than that expected by chance or the assumption of independence. A belief that there were few if any famous-names in the study list would be an accurate assessment of the true test conditions, as no famous-names were included in the original study list. If famous names actually occurred in the study list, then it is possible that this would remove the response bias between recall and fame judgements. Experiment 2 was conducted to examine whether the inclusion of famous-names at study would remove this bias and provide evidence for the independence between recollective and automatic memory.

Experiment 2

Experiment 1 found that engaging in a divided attention task reduced the recollection of studied nonfamous-names but not automatic judgements of fame. This was true of both separate and simultaneous groups. Tests of stochastic dependence revealed a significant negative dependence between judgements of recall and fame. This negative dependence might have been due to a response bias based on a subject's awareness of a real negative contingency where the study list did not contain famous-names. If subjects were more or less aware of this fact, then they should be less willing to guess famous for a name that they remembered from the study list.

The second experiment was conducted to examine whether the inclusion of famous-names at study would remove the negative dependence observed between recollective and automatic components of memory in Experiment 1. It was hypothesized that the presence of famous-names at study should increase a subjects' willingness to guess responses to Cell A, that is, it should increase a tendency to guess that the name is famous and was in the study list. Experiment 2 was also a replication of Experiment 1 with one change: the inclusion of famous-names in the study list. We expected to replicate the principle findings of Experiment 1. Specifically, we hypothesized that the manipulation of attention would produce a dissociation between recollective and automatic memory, with divided attention producing decrements in recollective but not automatic memory. One the basis of Experiment 1, we expected to find quantitative differences between separate and simultaneous judgements with recollection and inclusion being greater for simultaneous compared to separate judgements. However, it was hypothesized that the inclusion of famous-names would remove the negative dependence observed in Experiment 1, and provide evidence that recollective and automatic components of memory are stochastically independent judgements.

Method

Subjects

Sixty-four subjects were recruited from several psychology courses at Lakehead University. Subjects recruited from Introductory Psychology received credit for their participation. The subjects were randomly assigned to one of 4 groups with 16 subjects in each group.

Materials

The stimuli used in this experiment were the same as those used in Experiment 1, with the exception that the famous-names were now divided into four sub-lists of 30 names for purposes of counterbalancing, studied/nonstudied and inclusion/exclusion. As with the nonfamous-names, two sub-lists of 30 famous-names were presented at study and test and were referred to as "studied famous-names". The other two sub-lists of famous-names were presented in separate test instruction conditions for the separate judgement groups and in separate test blocks for the simultaneous judgement groups and were referred to as "nonstudied famous-names". As with the nonfamous-names, the sub-lists of famous-names were counterbalanced over 4 rotations, with each sub-list of 30 names appearing equally often in each condition.

Experimental Design and Procedure

The experimental design and procedure for Experiment 2 was the same as Experiment 1 except for the inclusion of famous-names during study. This required that all subjects read 120 names out loud, 60 of which were famous and 60 were nonfamous. For the separate judgement groups during the testing phase, the inclusion and exclusion conditions were comprised of 30 studied famous and 30 studied nonfamous-names that were presented to subjects for fame judgements with 30 nonstudied famous and 30 nonstudied nonfamous-names. Separate test phases were incorporated for the simultaneous judgement groups to mimic the separate judgement groups' inclusion and exclusion conditions. The sub-lists of names were presented to these subjects in the same way.

The data were scored and reported separately for nonfamous and famous-names for inclusion and exclusion responses and for estimates of recollective and automatic memory. All t-tests reported are two-tailed and values presented in parentheses are means.

Results

Divided Attention Performance at Study

In the divided attention condition, subjects failed to detect a mean of 8.75 of the 36 possible target sequences (24%) for the listening task. Subjects made false alarms, indicating an odd sequence when there wasn't one, on an average of 5 times during the divided attention task. There was no difference between the separate judgement group (9.38) and the simultaneous judgement condition (8.13), ($t(30)<1$, *ns*) on this task.

Inclusion and Exclusion for Nonfamous-Names

The mean probability of inclusion and exclusion responses for the separate and simultaneous judgement groups as a function of full and divided attention for nonfamous-names are presented in Table 5. Overall, the means were in the predicted direction. Fame responses to nonfamous-names appeared to be greater for studied names compared to nonstudied names in the inclusion condition but not in the exclusion condition. Fame responses to nonfamous-studied names appeared to be greater in the inclusion than the exclusion condition. A similar pattern was observed for subjects responding with separate and simultaneous judgements. As in Experiment 1, responses in the simultaneous groups appeared to be greater than in the separate groups in the inclusion condition, while the opposite pattern was observed in the exclusion condition, where responses in the separate groups appeared to be greater than the simultaneous groups.

Insert Table 5 about here

Significance of the differences observed between these means was assessed with a 2x2x2x2 mixed ANOVA comparing prior occurrence of names (studied versus nonstudied) and instruction (inclusion versus exclusion) as within-subject factors and attention (full versus divided) and response alternatives (separate versus simultaneous) as between-subjects factors. There was a significant main effect of prior occurrence ($F(1,60)=349.98$, $p=0.0001$, $MS_e=.0078$) and instruction ($F(1,60)=302.89$, $p=0.0001$, $MS_e=.0162$), as well as a significant interaction between prior occurrence and instruction ($F(1,60)=307.58$, $p=0.0001$, $MS_e=.009$), which was consistent with the observation that fame responses were greater for the inclusion condition (.369) compared to the exclusion condition (.091) and that the effect of prior presentation was observed only in the inclusion condition (.576 versus .161 for studied and nonstudied names). There was a significant three-way interaction between prior occurrence, instruction and attention (discussed in the following paragraph), but it did not affect interpretation of the two-way interaction.

The significant three-way interaction involving prior occurrence and instruction was with attention, $F(1,60)=10.09$, $p=0.002$, $MS_e=.009$. This was in addition to the significant main effects of prior occurrence and instruction discussed previously, and a two-way interaction between prior occurrence and attention ($F(1,60)=7.90$, $p=0.007$,

Ms_e=.0078). There was no main effect of attention (F<1). Inspection of the means suggests that the effect of attention was seen only for studied nonfamous-names in the inclusion condition. A t-test comparing mean responses to studied names in the inclusion condition for full (.625) and divided attention (.527) was significant ($t(62)=2.29$, $p=0.026$), revealing that dividing attention reduced performance on studied names in the inclusion condition.

There was a significant interaction between instruction and response alternatives ($F(1,60)=13.11$, $p=0.001$, $MS_e=.01617$) where fame responses were numerically greater for simultaneous than separate (.395 versus .343) in the inclusion condition and marginally lower in the exclusion condition (.059 versus .124). Using the MS_e term from the ANOVA, a critical difference (Fisher's LSD) was calculated to be 0.064 ($p=.05$, two-tailed). Comparison of the means using this critical difference confirmed that the difference between simultaneous and separate responses was significant only for the exclusion condition, and failed to be significant for the inclusion condition. All other main effects and interactions with the responses alternatives were not significant (F's<1), suggesting that both procedures had the same effect on inclusion and exclusion.

Recollective Memory for Nonfamous-Names

The mean proportions of recollective memory estimates for studied and nonstudied nonfamous-names are presented in Table 6 in the left two columns. The results were consistent with predictions, divided attention compared to full attention produced decrements in recollective memory in both response conditions. As in Experiment 1, differences between simultaneous and separate groups were also observed, with estimates of recollection being higher for the simultaneous compared to separate judgement groups.

Insert Table 6 about here

Significance was assessed using a 2x2 ANOVA with attention (full versus divided) and response alternatives (separate versus simultaneous) as between-subjects factors. There was a significant main effect of attention ($F(1,60)=10.03$, $p=0.002$, $MS_e=.03$) where recollective memory was found to be greater for full (.555) compared to divided attention (.486). There was a significant main effect of response alternatives ($F(1,60)=5.56$, $p=0.02$, $MS_e=.03$) where recollection of studied nonfamous-names was greater in the simultaneous (.537) compared to the separate judgement groups (.435). The interaction between attention and responses alternatives was not significant ($F<1$) indicating that both the separate and simultaneous groups showed a similar decrease in recollective memory with divided compared to full attention.

Automatic memory for Nonfamous-Names

The mean proportions of automatic memory estimates for studied and nonstudied nonfamous-names are presented in the right two columns of Table 6. As expected, the manipulation of attention did not appear to change estimates of automatic memory for studied nonfamous-names. As in Experiment 1, estimates of automatic memory appeared to be higher for the separate compared to the simultaneous judgement groups.

Significance was assessed using a 2x2 ANOVA with attention (full versus divided) and response alternatives (separate versus simultaneous) as between-subject factors. The main effect of attention ($F=1.11$, *ns*) and the interaction between attention and responses alternatives (F=1.42, *ns*) were not significant. This confirmed that the manipulation of attention did not significantly affect estimates of automatic memory for either separate or simultaneous groups. The main effect of response alternatives approached significance ($F(1,60)=3.86, p=0.054, MS_e=.023$), where automatic fame responses appeared to be greater for separate (.159) compared to simultaneous (.103). This suggests that subjects responding to the separate inclusion and exclusion conditions had a slight advantage over subjects in the simultaneous judgement groups when attributing fame to studied names on the basis of familiarity.

Independence for Nonfamous-Names

Independence between estimates of recollective and automatic memory was assessed for the simultaneous groups only. The observed marginal mean probabilities for recollection and fame judgements and the observed and expected probabilities are given in Table 7 for studied and nonstudied names. The recollective probabilities are identical to data presented in Table 6, while fame judgements are the observed sum of Cells A and C (see Table 1) rather than conditional estimates of fame used in the process dissociation procedure. Fame judgements reflect the knowledge of subjects about whether a name was famous irrespective of whether it was recalled as being studied or not. Independence, was tested by comparing the observed intersect of the two responses (*i.e.,* both recalled and judged famous) with the expected value (*i.e.,* the product of the marginal probabilities of recall and fame responses).

Insert Table 7 about here

The analysis of stochastic dependence between recollective and automatic memory was performed in two ways. First, we compared observed and expected values for each subject, and second, we collapsed over subjects and compared observed with expected for a single 2x2 table.

In the within-subject comparison, we calculated Cell A for each subject and derived an expected value for each subject by multiplying the probability of a fame judgement with the probability of recollection. The expected value was compared with the observed for each subject. For the overall sample, the observed value was only slightly lower (.063) than the expected value (.065) ($t(31)<1$, *ns*). A different pattern was found for the attention conditions (.053 versus .052 for full attention and .072 versus .077 for divided attention, all t's<1). Because the observed A cell means were not significantly different than the expected values for studied nonfamous-names, judgements of recollection and fame can be said to be independent.

The data were collapsed across subjects into a single 2x2 table to link the results to previous work examining separate judgements of memory (*e.g.* Hayman & Tulving, 1989; Hayman & Rickards, 1995; Tulving, Schacter & Stark, 1982). Yules Q was calculated for full and divided attention and for the overall sample (Q's =.170, -.097, .065; all χ^{2}'s<1). This implies that, for nonfamous-names, judgements of recollective and automatic memory are independent.

The relation between recollective and automatic sources of memory for nonstudied names was also compared for full, divided and collapsed across attention conditions between subjects (all t's <1) and in a single 2x2 table (Q's=.079, -.052, .027

for full, divided and collapsed across attention --all χ^2's<1). This implies that, for nonstudied nonfamous-names, judgements of recollective and automatic memory are independent.

Inclusion and Exclusion for Famous-Names

The mean probability of inclusion and exclusion responses for the separate and simultaneous judgement groups as a function of full and divided attention for famous-names are presented in Table 8. Fame responses to famous-names appeared to be greater for studied names compared to nonstudied names in the inclusion condition, while in the exclusion condition responses appeared to be greater for nonstudied names than for studied names. Fame responses to studied and nonstudied famous-names appeared to be greater for the inclusion compared to the exclusion condition. A similar pattern was observed for subjects responding with separate and simultaneous judgements, although responses in the separate groups appeared to be greater than in the simultaneous groups for both inclusion and exclusion.

Insert Table 8 about here

Significance was assessed with a 2x2x2x2 mixed ANOVA comparing prior occurrence of names (studied versus nonstudied) and instruction (inclusion versus exclusion) as within-subject factors and attention (full versus divided) and response alternatives (separate versus simultaneous) as between-subjects factors. There was a significant main effect of prior occurrence ($F(1,60)=25.86$, $p=0.0001$, $MS_e=.0213$) and instruction ($F(1,60)=637.61$, $p=0.0001$, $MS_e=.014$), as well as a significant interaction between prior occurrence and instruction ($F(1,60)=416.13$, $p=0.0001$, $MS_e=.0098$), which was consistent with the observation that fame responses were greater for the inclusion (.814) compared to the exclusion condition (.441) and that the effect of prior presentation was observed for both conditions, but in opposite directions. Specifically, fame responses to studied names was greater than to nonstudied names (.894 versus .734) in the inclusion condition, while fame responses to studied names was lower than to nonstudied names (.268 versus .614) in the exclusion condition. There was a significant three-way interaction between prior occurrence, instruction and attention (discussed in the following paragraph), but it did not affect interpretation of the two-way interaction.

The significant three-way interaction involving prior occurrence and instruction was with attention, $F(1,60)=12.12$, $p=0.001$, $MS_e=.0098$. This was in addition to the significant main effects of prior occurrence and instruction discussed previously, and a main effect of attention ($F(1,60)=4.60$, $p=0.036$, $MS_e=.0736$) and a significant two-way interaction between instruction and attention ($F(1,60)=8.75$, $p=0.004$, $MS_e=.014$). Inspection of the means suggests that the effect of attention was seen only for studied famous-names in the exclusion condition. A t-test comparing the means of responding to studied names in the exclusion condition for full (.191) and divided attention (.346) was significant ($t(62)=4.53$, $p=0.0001$), revealing that full attention reduced performance on studied names in the exclusion condition.

There was a significant interaction between instruction and response alternatives ($F(1,60)=6.30$, $p=0.015$, $MS_e=.014$), as well as a main effect of response alternatives ($F(1,60)=8.61$, $p=0.005$, $MS_e=.0737$), where the difference between separate and simultaneous was larger in the exclusion (.509 versus .373) compared to the inclusion condition (.845 versus .783). Using the MS_e term, critical difference (Fisher's LSD) was calculated and found to be 0.059, (p=0.05, two-tailed). Comparison of the means using this critical difference revealed that for both the inclusion and exclusion conditions the differences were significant. All other interactions with the response alternatives were not significant (attention by response alternatives, F=1.02, MS_e=.0737, *ns*; prior occurrence by attention by response alternatives, F=1.6, MS_e= .0213, *ns*; and all other F's<1).

Recollective Memory for Famous-Names

The mean proportions of recollective memory estimates for studied and nonstudied famous-names are presented in Table 9 in the left two columns. Divided attention compared to full attention produced decrements in recollective memory in both response conditions.

Insert Table 9 about here

Significance was assessed using a 2x2 ANOVA with attention (full versus divided) and response alternatives (separate and simultaneous) as between-subjects factors. There was a significant main effect of attention (F(1,60)=18.89, p=0.0001, MS_e=.026) where recollective memory was found to be greater for full (.712) compared to divided attention (.539). The main effect of response alternatives was not significant (F=2.64, MS_e=.026, *ns*) as well as the interaction between attention and response alternatives (F<1) indicating that both the separate and simultaneous groups showed a similar decrease in recollective memory with divided compared to full attention.

Automatic Memory for Famous-Names

The mean proportions of automatic memory estimates for studied and nonstudied famous-names are presented in the right two columns of Table 9. Estimates of automatic memory were greater for divided compared to full attention, for simultaneous groups, while attention had no effect on automatic memory for separate groups. However, estimates of automatic memory appeared to be higher for the separate compared to the simultaneous groups.

Significance was assessed using a 2x2 ANOVA with attention (full versus divided) and response alternatives (separate versus simultaneous) as between-subject factors. There was a significant main effect of attention ($F(1,60)=7.32$, $p=0.009$, $MS_e=.035$) and response alternatives ($F(1,60)=20.49$, $p=0.0001$, $MS_e=.035$), as well as a significant interaction between attention and response alternatives ($F(1,60)=4.604$, $p=0.036$, $MS_e=.4885$), which was consistent with the observation that estimates of automatic memory were higher for separate (.822) compared to simultaneous (.610) and that the effect of attention was observed only in the simultaneous groups (.496 versus .723 for full and divided attention). But because the same interaction was observed for nonstudied famous-names (.541 versus .711) in the simultaneous groups, it is likely that the differences reflected changes in the decision criteria across conditions, rather than a difference due to memory.

Independence for Famous-Names

Independence between estimates of recollective and automatic memory was assessed for the simultaneous groups only. The observed marginal mean probabilities for fame judgements and recollection and the observed and expected probabilities are given in Table 7 for studied and nonstudied famous-names. The data is presented in a similar fashion as the data for nonfamous-names.

In the within-subject comparison, we calculated Cell A (see Table 1) for each subject and derived an expected value for each subject by multiplying the probability of a fame judgement with the probability of recollection. The expected value was compared with the observed for each subject. The means of the observed value was slightly greater (.488) than the expected (.471) ($t(31)=2.65, p=.013$). The same pattern of observed greater than expected was found for full attention (.502 versus .478, $t(31)=2.18$, $p=0.046$), and the divided attention (.473 versus .463, $t(31)=1.54$, *ns*). Because the observed A cell means were greater than the expected values judgements of recollection and fame for studied famous-names, were found to be positively related.

The data was collapsed across subjects into a single 2x2 table, and Yules *Q* (Yule, 1900; Hayman & Tulving, 1989) was calculated for full and divided attention and for the overall sample (*Q*'s=.435, .416, .482, respectively). The positive dependence was significant for full (χ^2 (1, N=240)=9.88, $p<0.01$) and divided attention (χ^2 (1, N=240)=8.46, $p<0.01$), and when the data was collapsed over attention conditions (χ^2 (1, N=480)=27.03, $p<0.01$). As in the previous analyses, these findings imply that subject responses about recollective and automatic components of memory were positively dependent for studied famous-names.

The relationship between recollective and automatic sources of memory for nonstudied famous-names was also compared within-subjects. When collapsed across attention conditions observed values were found to be numerically lower than expected (.069 versus .079, $t(31)=-1.97$, *ns*). The same pattern was found for full attention (.058 versus .066, $t<1$), and divided attention where it proved to be significantly lower (.080 versus .091, $t(31)=-2.59$, $p=0.021$). Comparisons of observed and expected values collapsed over subjects (*Q*'s = -.477, -.314, -.406 for full, divided and collapsed across attention conditions) were significant for full attention ($\chi^2(1,N=240)=9.04$, $p<0.01$), and for the overall sample ($\chi^2(1,N=480)=12.02$, $p<0.01$), but not for the divided attention condition ($\chi^2(1,N=240)=2.97$, *ns*). These findings imply that for nonstudied famous-names, subject responses about recollective and automatic sources of memory tended to be negatively dependent.

Reaction Times

Subjects' mean reaction times as a function of attention and responses alternatives are presented in Appendix E. Prior to analysis, the reaction times were examined for missing values and extreme scores ($z > +3.00$) which were omitted from the analyses, leaving 45 subjects. The missing data points occurred when a subject did not respond to one of the cells. One extremely high score was found for each of the following: separate group with full attention, separate group with divided attention and simultaneous group with divided attention. Overall, reaction times appeared to be greater for simultaneous compared to separate groups.

Significance was assessed with a 2x2 ANOVA with attention (full versus divided) and response alternatives (separate versus simultaneous) as between-subject factors[3]. There was a significant main effect of response alternatives ($F(1, 41)=43.02$, $p=0.0001$,

MS_e=4946.58) where reaction times were found to be greater for simultaneous (303.02) compared to separate (167.36). The main effect of attention (F=3.98, MS_e=4864.58, *ns*) and the interaction between attention and responses alternatives (F=2.38, MS_e=4864.59, *ns*) were not significant.

Discussion

Experiment 2 examined if the inclusion of famous-names at study would remove a small but significant negative stochastic dependence between recollective and automatic measures of memory which had been observed in Experiment 1. In Experiment 2 estimates of recollective and automatic memory for nonfamous-names were found to be stochastically independent. Thus, the inclusion of famous-names appeared to have removed the response bias observed in Experiment 1.

Experiment 2 also provided a replication of the pattern of results found in Experiment 1. As in Experiment 1, estimates of recollection and automatic sources of memory for separate and simultaneous responses were found to be qualitatively but not quantitatively equivalent. Quantitative estimates of recollection were found to be greater for simultaneous compared to separate judgements, while estimates of automatic memory were greater for separate compared to simultaneous judgements. The same differences were noted for the inclusion and exclusion conditions with simultaneous greater than separate for inclusion responses and separate greater than simultaneous for exclusion responses. It should be noted however, that the manipulation of attention produced the same qualitative dissociation between recollective and automatic memory in both separate and simultaneous judgement groups. Specifically, dividing attention at study reduced estimates of recollective memory for nonfamous names while leaving estimates of automatic memory essentially unchanged. In summary, Experiment 2 replicated the pattern of results found in Experiment 1.

Experiment 2 was different from Experiment 1 in that famous names were also presented in the study session. Many factors were found to be the same for famous-names as for nonfamous-names, except no differences were observed between simultaneous and separate judgements in recollective memory, and an effect of attention on automatic memory was observed for simultaneous judgements, with automatic fame responses greater in the divided than full attention conditions, for both studied and nonstudied famous-names.

Of greater interest, positive dependence was observed between recollective and automatic memory judgements for studied famous-names and negative dependence was observed for nonstudied famous-names. In retrospect, it is not unreasonable to find a positive dependence between recall and judgements of fame because episodic memory for known names is expected to be better than for unknown names, and of course fame judgements for famous-names should be greater for known names than unknown names. A simple test of this prediction is to compare recollective and automatic memory for famous-names with that for nonfamous-names. In Experiment 2, recollective memory for studied famous-names (.625) was greater than nonfamous-names (.486) ($t(63)=7.12$, $p=.0001$) and automatic judgements of fame for famous-names (.716) were greater than for nonfamous-names (.171). In short, there is a common memory factor in both recollective memory and fame judgements, knowledge about famous-names

The negative dependence observed between judgements of recollective memory and fame with nonstudied famous-names is perhaps surprising in the presence of the positive dependence observed with studied famous-names but it could reflect a subjects' awareness of the positive dependence that actually exists between fame and recollection. Given such knowledge, subjects should exhibit a negative response bias when judging fame and prior occurrence of nonstudied famous-names. This negative responses bias would reflect the knowledge that famous names are more memorable and thus are likely to have been recalled if they had been presented at study. In those situations where a famous name is identified and the subject is uncertain about whether it was studied or not, then given the preceding assumption, the best strategy is to guess that the famous-name was not studied. That is, if a subject knows that a name was famous but is uncertain about whether they had studied it or not, then they should guess that they had not studied the name if it is assumed that a studied famous-names is likely to be recalled.

In summary, the results of Experiment 2 found that the inclusion of famous names at study removed the negative dependence between recollective and automatic sources of memory observed in Experiment 1 for studied nonfamous-names and replicated the similarity in qualitative predictions of recollective and automatic memory for separate and simultaneous judgements.

General Discussion

The present research was designed to examine whether simultaneous judgements could be used to reconstruct separate judgements about fame and memory for prior occurrence. A benefit of simultaneous judgements is that it avoids limitations associated with the use of separate judgements as required in the process dissociation procedure (Jacoby, 1991). Specifically, it avoids assumptions of independence and uncertainty about whether subjects are using the same response criteria across separate test conditions as required by the process dissociation procedure. The use of simultaneous judgements provides a means to directly assess independence between recollective and automatic components of memory, and provides a single set of instructions that allows for a straightforward interpretation of the results.

The results of Experiment 1 and 2 suggest that simultaneous judgements qualitatively, but not quantitatively, replicated estimates of recollective and automatic memory. The manipulation of attention produced a qualitative functional dissociation between recollective and automatic memory in both simultaneous and separate judgement conditions. Specifically, the results of Experiment 1 and 2 found that engaging in a divided attention task reduced the probability of recollection of studied nonfamous-names but left automatic memory unchanged. This is consistent with previous findings (Debner & Jacoby, 1994; Jacoby, 1991; Jacoby & Kelley, 1992; Jacoby et al., 1989; Jacoby et al., 1993; Jennings & Jacoby, 1993).

An advantage of simultaneous judgements is that it provides researchers with additional information which can be used to check that assumptions about independence are met. With separate judgements independence can only be assessed indirectly. Although in Experiment 1 there appeared to be a small negative dependence between recollective and automatic memory judgements, the inclusion of famous names at study in

Experiment 2 resulted in stochastic independence between recollective and automatic judgements of memory.

It appears that failure to meet the assumption of independence does not automatically remove the dissociation between recollective and automatic sources of memory. A negative dependence was observed between recollective and automatic memory in Experiment 1 and not in Experiment 2, but the pattern of relations between recollective and automatic memory judgements were the same in both experiments.

One limitation of tests of stochastic independence as argued by Hintzman and Hartry (1991) is that findings of nonsignificant dependence does not mean that factors are independent. Rather, it may be that we failed to detect a small but significant dependence between recollective and automatic memory. In order for this to be a valid argument, there should be a small but consistent pattern of either positive or negative dependence within the data. It can be seen from examination of the data presented in Table 7 that for nonfamous-names this is not true. Instead, Yules *Q* represents insignificantly small positive and negative dependence and this is consistent with observations that vary about zero. Thus it is unlikely that dependence exists and was not detected between recollective and automatic sources of memory.

The use of simultaneous judgements also avoids uncertainty about whether subjects are using the same criterion for judging prior occurrence in different instruction conditions as occurs with separate test conditions. Buchner, Erdfelder and Vaterrodt-Plünnecke (1995) and Curran and Hintzman (1995) have also called attention to the ambiguity associated with the assumption that the criterion for responding on the basis of automatic and recollective memory is equivalent in the inclusion and exclusion conditions. With simultaneous judgements there is no need to make this assumption nor is there any need to attempt to correct for this possibility.

The major advantage of using simultaneous judgements in the process dissociation procedure (Jacoby, 1991) to separate recollective and automatic sources of memory is that it allows for a direct assessment of independence. With this ability, one can examine whether specific materials possess the required independence between recollection and familiarity for calculations based on the process dissociation procedure. For example, in Experiment 2, at the same time as independence was observed for nonfamous-names, strong positive dependence was observed between recollection and fame judgements of studied famous-names. Although this too might be due to a response bias, it is likely that this dependence is intrinsic to the materials because the same knowledge about people mediates both episodic memorability and judgements of fame (see the Discussion of Experiment 2). Thus, the nature of the materials appears to affect the relation observed between recollective and automatic sources of memory. The strategy of using simultaneous judgements allows one to ensure that specific materials produce the necessary independence between recollective and automatic sources of memory.

Future research with simultaneous judgements for identifying and separating recollective and automatic influences on memory should focus on using the procedure with other materials that have been examined using the process dissociation procedure. For example, the simultaneous response procedure could be adapted and used in stem completion tasks (Jacoby, Toth & Yonelinas, 1993; Debner & Jacoby), anagrams (Jacoby, 1991) aurally presented words (Jacoby, Toth & Yonelinas, 1993) and words flanked by pre- and post-masking words (Debner & Jacoby, 1994) to check the assumption of independence with those materials.

The simultaneous response procedure, with its simpler instructions might be a useful alternative in populations that find inclusion and exclusion instructions arbitrary. For example, instructions for the simultaneous responses procedure might be more appropriate for older populations as data from one third of the older subjects in Jennings and Jacoby's (1993) study had to be discarded as they were unable to follow the separate inclusion and exclusion instructions. Studies examining recollective and automatic memory might also be easier to perform with children using simultaneous judgements rather than separate instructions.

In conclusion, the use of simultaneous judgements has empirically been shown to produce the same qualitative dissociations as separate judgements within the process dissociation procedure (Jacoby, 1991). Because simultaneous judgements avoid limitations associated with using separate judgements and provides a direct opportunity to test underlying assumptions of independence, it can provide researchers with an additional tool with which to identify, separate and understand recollective and automatic influences of memory.

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Appendix A: Instructions for Experiment 1 and 2.

I. Instructions for the separate judgement groups.

Study: A series of names are going to appear on the screen in front of you one at a time. As each name appears read it out loud.

Test: Inclusion

Assume that all of the names that you just read out loud were famous-names. I'm going to show you a not studied list of names some of which you have seen. As each name is presented indicate whether it is a famous name or a nonfamous name. So if you think that you saw the name before, call it famous, or if you know that it is famous indicate that it is famous.

The names will appear in the center of the screen and will remain there until you make a response. At that time the computer will automatically present another name. The instructions will stay on the screen for the entire exercise. To call the name famous press the closed apple key and press the open apple key if it is not famous.

Example: If Humprey Bogard was presented on the screen you would call him famous. If Sally Sue was presented, you would call her not famous. However, if you recalled that Sally Sue was on the study list then you would call her famous.

Exclusion

Now I'm going to show you another list of names. And I want you to do the same thing and indicate whether each name is famous or not famous. However, for this part of the study, assume that all of the names that you read were not famous. So if you think that you read the name during the first part of the experiment or you know that it is not famous, indicate not famous by pressing the open apple. Indicate famous when you know that the name is famous and you have not seen it on the study list.

Example: Now, if Humprey Bogard was presented on the screen you would call him famous, unless you recognized him as being on the study list, then he would be not famous. If Sally Sue was presented, you would also call her not famous.

II. Instructions for the simultaneous judgement groups.

Study: A series of names are going to appear on the screen in front of you one at a time. As each name appears read it out loud.

Test: Now I am going to show you another list of names. As each name appears on the screen I want you to indicate if the name is famous or not famous. I also want you to indicate whether the name was presented in the first list of names or not.

So to repeat indicate whether each name that appears is famous or not and whether it was presented during the first part of this experiment.
The names will appear in the center of the screen and will remain there until you make a response. At that time the computer will automatically present another name. Press 1 when the name is famous and in the study list; press 2 when the name is famous but not in the study list, press 3 if the name is not famous but in the study list, or press 4 when the name is not famous and not in the study list. The instructions will stay on the screen for the entire exercise.

Example: If Humprey Bogard came on the screen you would call him famous but not on the list. If Sally Sue was presented, you would call her not famous and not on the study list.

III. Instructions for the divided attention task.

After subjects were told to read the names off of the screen, those subjects assigned to the divided attention task were given the following instruction:

While you are reading the name out loud, the computer is going to be calling out numbers. I want you to listen to the numbers and indicate to me when you hear 3 odd numbers in a row. For example if you heard the numbers 2 4 5 9 7 you would indicate by raising your hand that you heard 3 odd numbers, namely 5 9 7 in a row. Try to be as accurate as possible. Odd numbers in a row can include repeats, such as 3 1 1. Do you understand? If you miss two sequences in a row I will indicate this to you by saying "MISS". To give you an idea of what you are looking for, there are 36 sequences in this task.[4] Here is an example of how the numbers will sound. The computer will count from 1 to 9 and then backwards. The numbers will be presented much slower during the experiment.

Appendix B: Non-famous-names used in Experiment 1 and 2.[5]

Alfred Barry
Jana Behrman
Nick Bianchi
Glenda Bibby
Rodney Bryant
Bud Cable
Ted Collins
Boris Derzko
Stef Finlayson
Hanna Flegg
Polly Garrett
Bart Hanley
Lionel Nincks
Andrew Kovac
Wallace Lidstone
Jennifer Morden
Jordan Pacenti
Doug Renshaw
Francoise Stein
Craig Waterhouse
Trisha Grayson
Margot Todd
Staci Carroll
Geoff Dumas
Iris Highgate
Otis Manning
Mitch Peters
Rudolph Ashe
Jeffrey Gorka
Elmer Linton
Jules Archer
Edward Barnbury
Terry Booker
Glynis Boucher
Michael Cadean
Steven Fern
Gref Forbes
Albert Gailing
Laurence Gauthiert
Boyd Goth
Sharon Keene
Lance Laforge
Janice Luongo
Adrian Marr
Wendy Marsh
Bartholomew Mill
Paul Porters
Roger Spink
Ralph Taggart
Sam Ulbrich
Jill Urbina
Oliver Wynne
Lars Bachmann
Russell Selkirk
Chris Brymer
Joshua Cassidy
Gilbert Churchland
Dorothy Drumm
Philip Hanna
Mel Hanover
Felix Adams
Lillian Brophy
Marilyn Connelly
Rick Doran
Ty Filipe
Joanne Henshaw
Alan Higgins
Ellen Hstudieden
David Jarr
Sue Lofchik
Wilson Love
Adam Mackie
Gus Marcoux
Trevor Pollack
Julian Ranson
Jeb Saunders
Brandy Squires
Bert Walmer
Melanie Danielson
Grant Fallows
Eric Filler
Sebastian Graf
Patsy Kinsella
Cecil Ganover
Henry Ucci
Alec Baverstock
Sylvester Blaszyk
Joseph Cogan
Manuel Festa
Patrick Innis
Sandra Baker
Monica Beswick
Tito Buzzelli
Gwendolyn Cousins
Robin Dawes
Graham Earl
Juan Esta
Jake Giles
June Guilfoyle
Scott Hebb
Stanley Hill
Francine LaBerge
Wilt Logan
Johnna Loy
Bob Madson
Clive Martin
Vanessa Reeves
Brian Strand
Marc Cadeau
Gordon Hastings
Jude Strecker
Andrea Burke
Garth Forsyth
Dale Kleinham
Everett Parsons
Perry Boland
Ray Candlish
Lewis Clayton
Lyn Fionelli
Thomas Milne
Gregory Duncan
Jonathon Taylor
Brenda Harrison
Kirsten Edwards
Andre Jewell
Gillian Ryan

Appendix C: Famous-names used in Experiment 1 and 2.[6]

Joan Baez
Robert Bateman
Milton Berle
Niels Bohr
Erma Bombeck
Gerry Cheevers
Toller Cranston
Jamie Farr
Timothy Findley
Barbara Frum
Low Gehrig
Larry Hagman
Bill Haley
Charlton Heston
Lena Horne
Bobby Hull
Diane Keaton
Tommy Lasorda
Vivian Leigh
George Lucas
Steve McQueen
Warren Moon
Al Pacino
Christopher Plummer
Sidney Poitier
Salman Rushdie
Eddie Shack
Sidney Sheldon
Mike Wallace
Gene Autry
Pearl Bailey
William Blake
Liona Boyd
Joyce Brothers
Raymond Chandler
Francis Coppola
Marie Curie
John Dalton
Bill Davis
Duke Ellington
William Faulkner
Geraldine Ferraro
Ava Gardner
Estelle Getty
Benny Goodman
Lee Grant
Gary Hart
Judith Krantz
Peggy Lee
Jack London
Peter Mansbridge
Walter Matthau
Arthur Miller
Minnie Pearl
Omar Sharif
Mickey Spillane
Cat Stevens
Jim Unger
Oscar Wilde
Herb Alpert
Tracy Austin
Frederick Banting
Steve Bauer
Tony Bennett
Jack Benny
Irving Berlin
Leonard Bernstein
Pierre Berton
Pat Boone
Robert Browning
Emily Carr
Cassius Clay
Samuel Clemens
Gary Cooper
Buster Crabbe
Tony Curtis
Salvador Dali
Jack Dempsey
Amelia Earhart
Jerry Falwell
Mia Farrow
Marty Feldman
Ella Fitzgerald
Alexander Fleming
George Gershwin
Dizzy Gillespie
Jane Goodall
Glenn Gould
Betty Grable
Rita Hayworth
Foster Hewitt
Jimmy Hoffa
Billie Holiday
Aldous Huxley
John Irving
Shirley Jones
John Keats
MacKenzie King
Burt Lancaster
Stephen Leacock
Guy Lombardo
Joe Louis
Marcel Marceau
James Mason
Audrey Mclaughlin
Audrey Meadows
Gregor Mendel
Anthony Perkins
Roman Polanski
Helen Reddy
Rex Reed
Gloria Steinem
Sinclair Stevens
Lana Turner
Desmond Tutu
Jonh Updike
Peter Ustinov
Shelley Winters
Robert Duvall

Appendix D: Number Sequence used for the divided attention task in Experiments 1 and 2.[7]

5	3	9	2	7	6	9	5	3	4	3	4	1	5	7
4	1	1	8	9	5	9	2	3	1	7	6	5	4	7
1	9	4	9	1	3	2	5	3	9	4	3	2	9	3
7	4	1	2	3	5	3	2	3	3	1	4	1	5	1
6	5	1	7	8	2	9	1	5	2	9	6	3	5	9
6	8	7	5	9	2	5	2	1	3	7	6	8	5	7
1	4	5	9	7	8	3	9	7	6	3	7	4	2	3
5	1	8	9	6	7	1	3	6	5	5	8	9	1	3
4	9	3	1	1	6	5	1	2	1	7	7	8	2	5
1	3	6	9	3	2	5	3	1	4	3	7	1	8	4
9	5	3	2	1	8	1	1	7	4	1	2	9	7	9
8	3	1	5	6	4	7	1	9	4	9	5	3	2	7
3	9	4	3	2	9	3	7							

Appendix E: Mean Reaction Times in Experiment 1.

Nonfamous Names

	Inclusion				Exclusion			
	Studied		Nonstudied		Studied		Nonstudied	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Full Attention								
Separate	203.73	20.04	208.00[a]	22.07	204.75[c]	49.88	218.36[d]	48.44
Simultaneous	373.67	32.05	366.40	36.53	368.93	32.22	358.64[a]	39.88
Divided Attention								
Separate	206.20	17.92	228.14[a]	21.21	203.60	30.16	189.67	24.97
Simultaneous	322.60	23.13	338.27	22.03	343.87	22.46	335.60	26.00

Note. n=15, except where indicated differently.
[a] n=14. [b] n=13. [c] n=12. [d] n=11.

Famous Names

	Inclusion				Exclusion			
	Studied		Nonstudied		Studied		Nonstudied	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Full Attention								
Separate	146.87	14.26	139.07	9.37	133.07	12.26	138.80	15.38
Simultaneous	416.64[a]	39.62	362.40	43.83	366.40	36.53	373.67	32.05
Divided Attention								
Separate	144.53	14.55	160.87	13.00	126.47	10.13	153.60	17.09
Simultaneous	335.29[a]	43.55	288.80	20.70	338.27	22.03	322.60	23.13

Note. n=15, except where indicated differently.
[a] n=14.

Appendix F: ANOVA source table for reaction times as a function of attention and response alternatives in Experiment 1.

Source		df	F
Between-subjects effects			
	Attention (A)	1	0.43
	Response Alternatives (B)	1	44.75***
	A x B	1	0.12
	Within-group Error	47	(59844.93)
Within-subjects effects of Fame			
	Fame (C)	1	20.68***
	A x C	1	0.37
	B x C	1	23.28***
	A x B x C	1	2.04
	Within-group Error	47	(4190.68)
Within-subjects effects of Prior Occurence			
	Prior Occurrence (D)	1	2.11
	A x D	1	2.78
	B x D	1	11.45**
	A x B x D	1	0.30
	Within-group Error	47	(1796.07)
Within-subjects effects of Instruction			
	Instruction (E)	1	0.29
	A x E	1	0.03
	B x E	1	0.08
	A x B x E	1	4.07*
	Within-group Error	47	(5136.63)
Within-subjects effects of Fame (C) by Prior Occurrence (D)			
	C x D	1	0.76
	A x C x D	1	0.02
	B x C x D	1	1.04
	A x B x C x D	1	0.35
	Within-group Error	47	(3170.59)
Within-subjects effects of Fame (C) by Instruction (E)			
	C x E	1	0.18
	A x C x E	1	3.11
	B x C x E	1	0.02
	A x B x C x E	1	0.40
	Within-group Error	47	(3219.48)
Within-subjects effects of Prior Occurrence (D) by Instruction (E)			
	D x E	1	0.87
	A x D x E	1	2.07
	B x D x E	1	5.67*
	A x B x D x E	1	2.48
	Within-group Error	47	(1534.23)
Within-subjects effects of Fame (C) by Prior Occurrence (D) by Instruction (E)			
	C x D x E	1	13.72**
	A x C x D x E	1	0.64
	B x C x D x E	1	1.13
	A x B x C x D x E	1	0.09
	Within-group Error	47	(1848.55)

Note. Values encloses in parenthese represent mean square errors. * p<0.05. ** p<0.001. *** p<0.0001.

Appendix G: Mean Reaction Times in Experiment 2.

Nonfamous Names

	Inclusion				Exclusion			
	Studied		Nonstudied		Studied		Nonstudied	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Full Attention								
Separate	158.75	13.01	199.50[b]	23.04	279.54[c]	58.54	250.46[c]	38.28
Simultaneous[a]	313.07	22.32	341.13	30.43	313.60	23.12	300.60	26.80
Divided Attention								
Separate	176.73	11.77	211.86[d]	18.60	240.53	26.33	236.00[e]	52.39
Simultaneous	370.67	18.51	389.13	32.50	381.13	27.02	378.29[d]	41.78

Note. n=15, except where indicated differently.
[a] n=16. [b] n=12. [c] n=13. [d] n=14. [e] n=10.

Famous Names

	Inclusion				Exclusion			
	Studied		Nonstudied		Studied		Nonstudied	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Full Attention								
Separate	93.75	6.22	131.25	10.29	52.75	7.22	210.25	25.93
Simultaneous[b]	293.14[a]	25.57	292.47	23.88	47.80	8.82	313.07	22.32
Divided Attention								
Separate	96.93	7.40	119.40	9.23	58.67	7.56	198.53	17.04
Simultaneous	374.17[c]	45.39	417.87	38.71	42.47	8.54	370.67	18.51

Note. n=15, except where indicated differently.
[a] n=14. [b] n=16. [c] n=12.

Appendix H: ANOVA source table for reaction times as a function of attention and response alternatives in Experiment 2.

Source		df	F
Between-subjects effects			
	Attention (A)	1	3.00
	Response Alternatives (B)	1	43.06***
	A x B	1	2.38
	Within-group Error	41	(38916.62)
Within-subjects effects of Fame (C)			
	Fame (C)	1	75.10***
	A x C	1	0.31
	B x C	1	1.87
	A x B x C	1	0.08
	Within-group Error	41	(8701.37)
Within-subjects effects of Prior Occurrence (D)			
	Prior Occurrence (D)	1	37.39***
	A x D	1	0.97
	B x D	1	4.17*
	A x B x D	1	0.28
	Within-group Error	41	(8747.39)
Within-subjects effects of Instruction (E)			
	Instruction (E)	1	3.76
	A x E	1	2.04
	B x E	1	54.71***
	A x B x E	1	0.00
	Within-group Error	41	(6406.49)
Within-subjects effects of Fame (C) by Prior Occurrence (D)			
	C x D	1	49.49***
	A x C x D	1	0.45
	B x C x D	1	2.69
	A x B x C x D	1	1.56
	Within-group Error	41	(6026.59)
Within-subjects effects of Fame (C) by Instruction (E)			
	C x E	1	39.07***
	A x C x E	1	0.60
	B x C x E	1	7.25**
	A x B x C x E	1	6.89*
	Within-group Error	41	(5734.96)
Within-subjects effects of Prior Occurrence (D) by Instruction (E)			
	D x E	1	24.82***
	A x D x E	1	1.89
	B x D x E	1	10.35**
	A x B x D x E	1	0.37
	Within-group Error	41	(4516.42)
Within-subjects effects of Fame (C) by Prior Occurrence (D) by Instruction (E)			
	C x D x E	1	52.22***
	A x C x D x E	1	0.51
	B x C x D x E	1	2.57
	A x B x C x D x E	1	0.00
	Within-group Error	41	(5671.39)

Note. Values enclosed in parenthese represent mean square errors. * $p<0.05$. ** $p<0.01$. *** $p<0.0001$.

Footnotes

[1] Taken from Hayman & Tulving, 1989

[2] These factors were also entered into a 2x2x2x2x2 mixed ANOVA, which included examination of within-subject factors of prior occurance, instruction and fame. The source table is located in Appendix F. The results were not analyzed as no predictions were made about reaction times and the significant effects did not aid interpretation of the experimental results.

[3] These factors were also entered into a 2x2x2x2x2 mixed ANOVA, which included examination of within-subject factors of prior occurance, instruction and fame. The source table is located in Appendix H. The results were not analyzed as no predictions were made about reaction times and the significant effects did not aid interpretation of the experimental results.

[4] This instruction was given only to subjects in experiment 2, to try to increase their efficacy.

[5] Taken from Jennings and Jacoby (1993).

[6] Taken from Jennings and Jacoby (1993).

[7] Taken from Jennings and Jacoby (1993).

Table 1 The 4-Alternative Forced-choice Paradigm.

	Judged Famous (FA)	Judged Not Famous	
Presented in the Study Phase	Cell (A) The name is famous and in the study list	Cell (B) The name is not famous but in the study list	P(R)
Not Presented in the Study Phase	Cell (C) The name is famous but not in the study list	Cell (D) The name is not famous and not in the study list	1-P(R)

Table 2 Mean probabilities of rating studied and nonstudied nonfamous-names as famous in Experiment 1.

	Test Condition							
	Inclusion				Exclusion			
	Studied		Nonstudied		Studied		Nonstudied	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Full Attention								
Separate Judgements	.604	.040	.183	.034	.148	.031	.152	.051
Simultaneous Judgements	.687	.025	.209	.031	.082	.017	.069	.017
Total	.646	.024	.196	.023	.115	.018	.110	.028
Divided Attention								
Separate Judgements	.502	.031	.194	.042	.175	.028	.156	.025
Simultaneous Judgements	.588	.029	.242	.026	.100	.011	.057	.013
Total	.529	.021	.218	.025	.137	.016	.107	.017
Overall Total	.588	.018	.207	.017	.126	.012	.109	.016

Table 3 Estimated mean probabilities of rating studied and nonstudied nonfamous-names as famous on the basis of recollective and automatic memory in Experiment 1.

	Recollective				Automatic			
	Studied		Nonstudied		Studied		Nonstudied	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Full Attention								
Separate Judgements	.456	.052	.031	.056	.249	.041	.136	.036
Simultaneous Judgements	.605	.028	.141	.024	.159	.034	.083	.022
Total	.531	.032	.086	.032	.204	.027	.110	.021
Divided Attention								
Separate Judgements	.327	.035	.038	.037	.256	.035	.166	.026
Simultaneous Judgements	.456	.029	.184	.020	.152	.022	.069	.015
Total	.392	.025	.111	.025	.204	.022	.118	.017
Overall Mean Total	.462	.022	.098	.020	.204	.018	.114	.014

Table 4 Dependence between fame judgements and recollection as a function of attention for the simultaneous response procedure in Experiment 1.

	Rec	Fa	FaRec	Fa*Rec	Yules *Q*	χ^2
Studied Nonfamous-names						
Full Attention	0.605	0.156	0.074	0.094	- 0.306	4.97*
Divided Attention	0.456	0.151	0.051	0.069	- 0.283	2.19
Overall Mean	0.531	0.154	0.063	0.082	- 0.283	9.61**
Nonstudied Nonfamous-names						
Full Attention	0.141	0.083	0.015	0.011	0.172	0.313
Divided Attention	0.184	0.069	0.012	0.013	-0.060	0.030
Overall Mean	0.163	0.076	.014	0.012	0.056	0.004

Note: Fa = famous; Rec = recollection observed; FaRec = famous and recollected, observed; Fa*Rec = expected famous and recollected when independent.
* $p<0.05$. ** $p<0.01$.

Table 5 Mean probabilities of rating studied and nonstudied Nonfamous-names as famous in Experiment 2.

	Test Condition							
	Inclusion				Exclusion			
	Studied		Nonstudied		Studied		Nonstudied	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Full Attention								
Separate Judgements	.634	.034	.115	.032	.110	.027	.118	.033
Simultaneous Judgements	.616	.044	.167	.029	.030	.006	.040	.008
Total	.625	.027	.141	.022	.070	.015	.079	.018
Divided Attention								
Separate Judgements	.481	.040	.142	.019	.135	.030	.129	.054
Simultaneous Judgements	.573	.051	.220	.034	.084	.023	.081	.018
Total	.527	.033	.181	.020	.110	.019	.105	.028
Overall Total	.576	.022	.161	.015	.090	.012	.092	.017

Table 6 Estimated mean probabilities of rating studied and nonstudied Nonfamous-names as famous on the basis of recollective and automatic memory in Experiment 2.

	Recollective				Automatic			
	Studied		Nonstudied		Studied		Nonstudied	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Full Attention								
Separate Judgements	.524	.040	-.004	.031	.211	.045	.111	.030
Simultaneous Judgements	.585	.042	.127	.027	.090	.021	.047	.009
Total	.555	.029	.062	.023	.110	.027	.079	.017
Divided Attention								
Separate Judgements	.346	.043	.012	.053	.206	.039	.107	.035
Simultaneous Judgements	.488	.048	.139	.024	.176	.043	.098	.023
Total	.417	.034	.076	.031	.191	.029	.103	.020
Overall Mean Total	.486	.024	.069	.019	.171	.020	.091	.013

Table 7 Dependence between fame judgements and recollection as a function of attention for the simultaneous response procedure in Experiment 2.

	Rec	Fa	FaRec	Fa*Rec	Yules *Q*	χ^2
Studied Nonfamous-names						
Full Attention	.585	.083	.053	.047	.170	.469
Divided Attention	.488	.156	.072	.078	-.097	.302
Overall Mean	.537	.120	.063	.059	.065	.203
Nonstudied Nonfamous-names						
Full Attention	.127	.047	.007	.007	.079	.036
Divided Attention	.139	.093	.012	.013	-.052	.024
Overall Mean	.133	.070	.010	.009	.027	.010
Studied Famous-names						
Full Attention	.743	.623	.502	.459	.435	9.88**
Divided Attention	.573	.758	.473	.433	.416	8.46**
Overall Mean	.658	.691	.488	.434	.482	27.03**
Nonstudied Famous-names						
Full Attention	.178	.525	.058	.095	-.477	9.04**
Divided Attention	.145	.698	.080	.098	-.314	2.97
Overall Mean	.162	.612	.069	.098	-.406	12.02**

Note: Fa = famous; Rec = recollection observed; FaRec = famous and recollected, observed; Fa*Rec = expected famous and recollected when independent.
* $p<0.05$. ** $p<0.01$

Table 8 Mean probabilities of rating studied and nonstudied Famous-Names as famous in Experiment 2.

	Test Condition							
	Inclusion				Exclusion			
	Studied		Nonstudied		Studied		Nonstudied	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Full Attention								
Separate Judgements	.942	.011	.746	.046	.260	.031	.683	.036
Simultaneous Judgements	.864	.027	.645	.057	.121	.019	.467	.072
Total	.903	.016	.695	.037	.191	.022	.575	.044
Divided Attention								
Separate Judgements	.910	.021	.781	.029	.406	.029	.687	.041
Simultaneous Judgements	.858	.053	.763	.055	.286	.040	.618	.066
Total	.884	.028	.772	.031	.346	.027	.653	.039
Overall Total	.894	.016	.734	.024	.268	.020	.614	.030

Table 9 Estimated mean probabilities of correctly rating studied and nonstudied Famous-names as famous on the basis of recollective and automatic memory in Experiment 2.

	Recollective				Automatic			
	Studied		Nonstudied		Studied		Nonstudied	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Full Attention								
Separate Judgements	.681	.033	.063	.041	.809	.034	.742	.041
Simultaneous Judgements	.743	.033	.178	.045	.496	.052	.541	.071
Total	.712	.024	.121	.032	.653	.042	.642	.044
Divided Attention								
Separate Judgements	.504	.037	.094	.028	.835	.031	.755	.035
Simultaneous Judgements	.573	.053	.145	.031	.723	.063	.711	.067
Total	.539	.032	.120	.021	.779	.036	.733	.037
Overall Mean Total	.625	.023	.120	.019	.716	.028	.687	.029