Multi-Level Analysis of Memory Dissociations

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Abstract

Dissociations between explicit and implicit memory tests, between recollective and automatic retrieval processes, and between memorial states of awareness of past events all suggest that human memory is not a unitary faculty. Memory dissociations reflect the complex relationship between consciousness and memory. To understand such a complex relationship, any single level of analysis is not enough and may be misleading. A multi-level analysis was proposed. One of the most serious problems with the process-dissociation procedure is its failure to separate process level of analysis and memorial awareness level of analysis. One experiment was reported to support the above arguments.

Introduction

Explicit tests of memory refer to the tests in which subjects are explicitly told the relationship between the prior study and the following test. In this case, in order for subjects to perform the test, intentionally retrieving past events is necessary. In contrast to explicit tests of memory, implicit tests of memory refer to the tests in which subjects are simply told to perform a task as well as possible, without the mentioning of the prior study episode. A large body of data has shown that these two types of tests can be dissociated (for reviews, see Schacter, 1987; Richardson-Klavehn & Bjork, 1988). Dissociations between explicit and implicit tests of memory suggest that (a) human memory is not a unitary faculty and (b) consciousness plays an essential role in dissociable human memory.

A theoretical debate is concerned with whether memory systems or psychological processes are responsible for these task dissociations. Memory systems theories claim that there are distinct memory systems in the human brain and that implicit tests depend on the memory systems that are distinct from those that support explicit tests (e.g., Tulving & Schacter, 1990; Schacter, 1990, 1992). In contrast, processing theories claim that proposing distinct memory systems is neither necessary nor economic, and that dissociations between tests can be and should be understood in terms of the underlying perceptual and conceptual processing operations carried out during study and test phases (e.g., Roediger & McDemott, 1993).

While the theoretical debate remains to be resolved, several researchers have started to challenge the underlying *transparency* (Dunn & Kirsner, 1989) or *process-purity* (Jacoby, Toth, & Yonelinas, 1993) assumption on which several theoretical approaches are based. For example, they ask why explicit and implicit memory tests must tap distinct memory systems or different retrieval processes, why tests and memory systems must be "transparent", and why tests must be process-pure. These challenges have received some empirical support (e.g., Richardson-Klavehn, Lee, Joubran, & Bjork, 1994), which suggests that different retrieval processes might be involved in a single memory test and memory tests need not be process-pure.

The Process-Dissociation Procedure

The *process-dissociation procedure* (Jacoby, 1991; Jacoby, Toth, & Yonelinas, 1993) has been claimed to provide a general methodological framework for identifying the influences of recollective and automatic retrieval processes in a single memory test. It makes two critical assumptions. The first one is that recollective processes and automatic processes make independent contributions to the overall test performance (see Jacoby, Toth, Yonelinas, & Debner, 1994). The second one is that the difference between recollective and automatic retrieval processes can be considered as an issue of *control*. More specifically, recollective retrieval processes can not only voluntarily activate an action, but also "inhibit an action by opposing influences that would otherwise prevail" (Jacoby, Lindsay, & Toth, 1992, p. 804). In contrast, automatic retrieval processes have no control at all and always occur spontaneously and automatically.

Based on these two assumptions, Jacoby and colleagues claim that by adopting the method of *opposition*, it is possible to oppose the influences of two types of retrieval processes and let the two work in the opposite directions. They call the test in which both types of processes work in the same direction *an inclusion test*, and the test in which both types of processes work in the opposite directions *an exclusion test*. In a word-stem completion task, an inclusion test requires subjects to try to retrieve a previously studied word to complete a stem, while an exclusion test requires subjects to try not to use studied words as the completion (i.e., try to exclude studied words).

They further claim that in an inclusion test, the probability of responding with a studied word is the probability of recollection *(R)* plus the probability of the word automatically coming to mind when there is a failure of

recollection [$A(1-R)$]; and in an exclusion test, a studied word will be produced only when it comes to mind automatically and it is not recollected [$A(1-R)$]. That is,

$$I = R + A(1-R). \quad (1)$$

$$E = A(1-R). \quad (2)$$

where I is the inclusion test performance and E is the exclusion test performance. The influences of recollective processes and automatic processes can thus be easily calculated: $R = I - E$, and $A = E/(1-R)$.

Although the process-dissociation procedure has resulted in several empirical findings (e.g., Jacoby, Toth, & Yonelinas, 1993; Toth, Reingold, & Jacoby , 1994), it has also been subject to several criticisms. For example, Joordens and Merikle (1993) argue that the independence assumption underlying the process-dissociation procedure is problematic because a redundancy relationship between the two types of processes is equally plausible. Richardson-Klavehn, Gardiner and Java (in press) even argued that the R and A in equation (1) need not to be equal to the R and A in equation (2). However, as we will show below, perhaps one of the most serious problems with the process-dissociation procedure is its failure to distinguish retrieval processes from memorial states of awareness. This problem is directly reflected in its control assumption.

Where Is Control?

The process-dissociation procedure defines control as the ability to inhibit an action that would otherwise be very likely to occur. It is assumed that recollective retrieval processes have control ability whereas automatic retrieval processes do not have it.

Let us consider how a studied word can be excluded from being used in an exclusion test. No matter how it is produced, whether it will be used as a response depends on how the subject thinks about it. Clearly, while retrieval processes are responsible for producing a word, or bringing a word to mind, it is the subject's memorial awareness about that word that serves as the control criterion for deciding using or excluding. A studied word will be excluded in an exclusion test if and only if subjects judge that it is a studied word. Such a judgment must be based on their subjective experience or memorial awareness of that word but not on the processes which bring that word back to mind.

From this perspective, control is not a function of retrieval processes but a function of memorial states of awareness. Since memorial states of awareness of past events are more likely to be a continuum, control is not an all-or-none but a continuous quantity. On the one hand, conscious recollection experience has absolute control power because once one has recollection experience about a word's earlier presence, this word will definitely be excluded in an exclusion test. On the other hand, different levels of feelings of familiarity may have different degrees of control power. That is, a word that looks more familiar is more likely to be excluded in an exclusion test than a word that looks less familiar.

Summary

Control is not a unique property of recollective retrieval processes. Instead, control is a continuous function of memorial states of awareness of past events. By using "control" as the key concept, what the process-dissociation procedure really dissociates is the conscious (controlled) and unconscious memorial awareness, but not the underlying recollective and automatic retrieval processes, which the process-dissociation procedure is designed to dissociate. In the next section we presents an experiment supporting the above arguments.

Experimental Study

The main hypothesis of this experiment is that automatic retrieval processes can also be associated with control. In this experiment, subjects performed a cued-recall test. In addition, they were asked to make a confidence judgment about each completion. The basic idea is as follows. If a studied word is produced by recollective retrieval processes, a subject should have absolute control and judge it as an old (studied) word with highest confidence. However, if a studied word comes to mind by automatic retrieval processes instead of recollective retrieval processes, how will a subject behave? Will the subject just make random confidence judgment and show no control, or will the subject show a certain predictable judgment pattern?

The independent variable manipulated in this experiment was the letter order of word-stems given as cues. In the normal-order condition, the letters of each word-stem were presented to subjects in the normal order, e.g., "mem___" for "memory". In the reversed-order condition, the positions of the initial two letters of each word-stem were switched, e.g., "emm___" for "memory". This manipulation was expected to influence automatic retrieval processes but not recollective retrieval processes. This is because automatic retrieval processes are usually based on data-driven processes or *perceptual fluency* (Jacoby, 1983), whereas recollective retrieval processes are usually based on conceptually driven processes. Changing the physical format of a cue might hurt the *fluency* of a studied word's coming to mind but should not hurt recollective retrieval processes.

Method

Subjects. Forty-four native English speakers participated in the experiment in return for credit in an introductory psychology course at The Ohio State University.

Materials. The stimulus set consisted of 120 five or six-letter words with average high frequency. 60 of them were used for study, and all 120 were used for test (thus equating the number of stems at test corresponding to old and new items). Normal-order word-stems consisted of the initial three letters of each word in correct order and 2 or 3 dashes, depending on the word-length. Reversed-order word-stems were created by switching the initial two letters of corresponding normal-order word-stems. Each word-stem could be completed by more than one word. Any two words in the stimulus set have different initial three letters.

Design and Procedure. The word-stem order manipulation is between-subjects design. Subjects were tested individually. The experiment was conducted in two phases, study and test. The study phase was identical for all subjects. Subjects were presented 60 words and were instructed to remember them. Each word was shown for two seconds with an inter-trial interval of one second.

In the test phase, all subjects were presented 120 word-stems. Subjects receiving reversed-order word-stems were told the rule of how to get correct order stems. All subjects were instructed to try to use the studied words to complete each word-stem. If they could not think of a studied word, they were to use the first word that came to mind. If they could not figure out a completion, they could click on the "OK" button to pass the trial. If they got a completion, they were asked to further identify "How likely has this word been studied?" by choosing one of the five confidence levels (see Figure 1). Subjects were explicitly told that the 5th level referred to "conscious recollection" and "remembering", which was qualitatively different from the other 4 levels. If they could not consciously recollect or remember it, they could mark their confidence levels from 4 to 1. The test was self-paced.

Results and Discussion

Stem Completion Data. The test performance was indexed by the proportion of stems completed with studied words at each confidence level. The results are shown in Figure 2.

Statistical analyses show the follows results. First, when words were consciously recollected (the 5th level of confidence), stem order did not have effect. Second, when words were not consciously recollected (from the 1st to 4th level of confidence), stem order had effect ($F(1,42)=16.30$, $p< 0.01$): more studied words were produced with normal-order stems than with reversed-order stems. Third, when words were not consciously recollected, confidence judgment had effect ($F(3,126)=40.77$, $p< 0.01$): more studied words were given higher levels of confidence judgment.

This pattern of data suggests that when there was no conscious recollection, subjects did not randomly make a confidence judgment. Rather, they showed certain control ability and gave more studied words higher levels of confidence judgment.

Process-Dissociation Data. Now, let us consider a hypothetical situation. Suppose subjects were not asked to make confidence judgment. Instead, they were asked to exclude those completions which they thought were old words. It is easy to see that this hypothetical task was essentially identical to the confidence judgment task because subjects usually made their "exclusion or not" decisions based on their confidence about the "old-ness" of a word. Therefore, it was possible to use the stem completion data presented above to predict how subjects would behave in such an hypothetical exclusion test. For example, judging a word to the 5th confidence level would guarantee this word be excluded if the exclusion criterion is "excluding every word which is consciously recollected". Similarly, judging a word to be the 4th confidence level ("probably an old word") would guarantee this world be excluded if the exclusion criterion is "excluding every word which is probably an old world". Thus, a confidence level could be considered as an exclusion criterion; and based on the 5 levels of confidence judgment, 4 different exclusion criteria could be obtained. Thus, by subtracting the proportions excluded from the overall test performance, 4 different exclusion test scores could be predicted. Furthermore, 4 groups of recollective/automatic influences could be estimated by using the equations of the process-dissociation procedure. These estimates are shown in Figure 3.

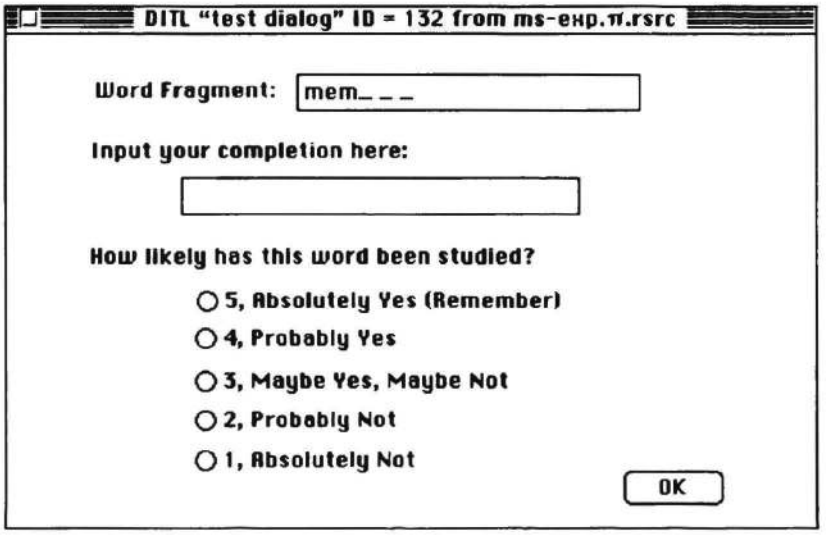

Figure 1: The Macintosh dialog box used in the experiment

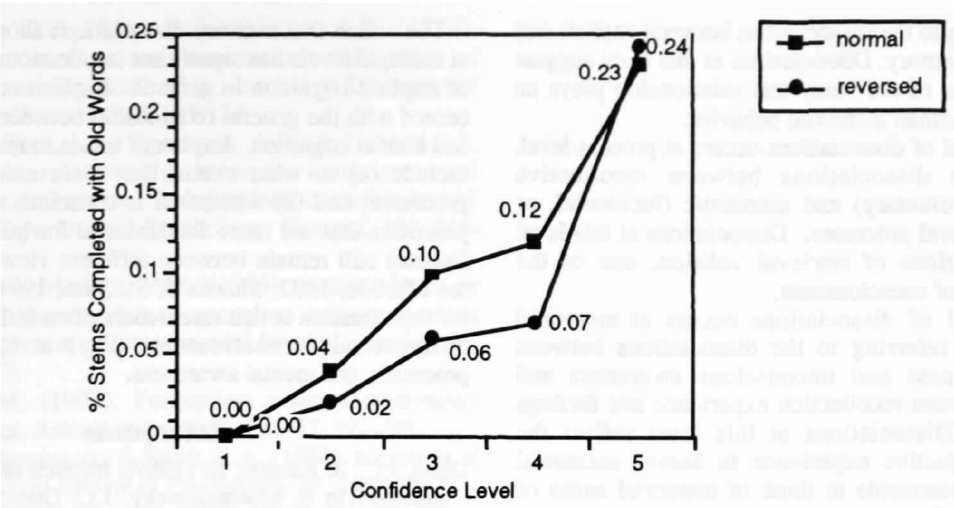

Figure 2: Cued-recall performance as a function of confidence levels for normal-order and reversed-order cues.

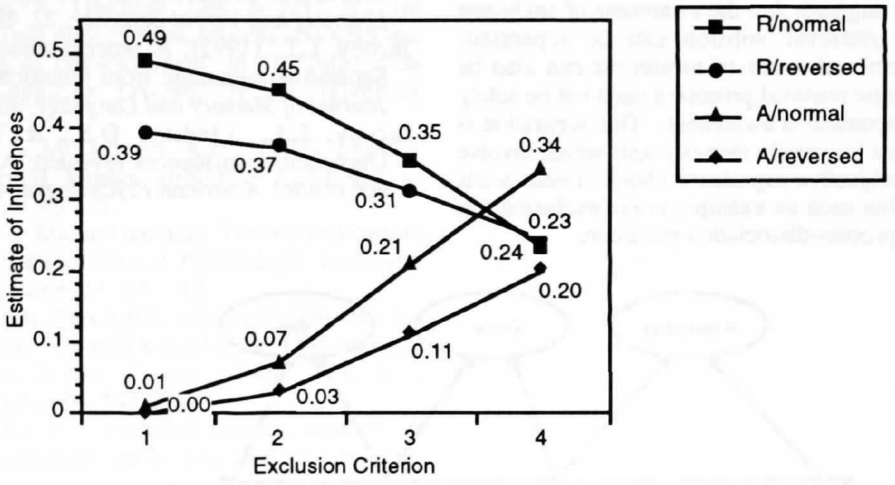

Figure 3: Influence estimates of recollective *(R)* and automatic *(A)* retrieval processes as a function of exclusion criteria for normal-order and reversed-order cues. Exclusion criteria 4, 3, 2, and 1 refer to excluding the performance at confidence levels 5, 5+4, 5+4+3, and 5+4+3+2, respectively.

Statistical analyses show that (a) stem order manipulation affected both recollective processes and automatic processes ($F(1,42)=3.63$, $p<0.07$; $F(1,42)=22.18$, $p<0.01$, respectively); and (b) if different exclusion criteria were adopted, different recollective and automatic influences would be estimated ($F(3,126)=151.81$, $p<0.01$; $F(3,126)=180.88$, $p<0.01$, respectively).

These results were ambiguous because (a) the stem order manipulation is expected to affect only automatic retrieval processes but not recollective retrieval processes, and estimates of recollective and automatic influences are expected to be stable across exclusion criteria; (b) Based on different exclusion criteria, different conclusions were obtained. One reason for these ambiguous results is that the process-dissociation procedure ignores the part of control power that is associated with automatic retrieval processes. It is this part of control power that produces predictable confidence judgment pattern and results in different exclusion criteria.

General Discussion

Memory dissociations are complex. This complexity may reflect the complex relationship between consciousness and memory. To explain such a complex relationship, any single level of analysis is not sufficient and will inevitably result in oversimplification and misleading conclusions. In order to better understand various memory dissociations, a multi-level analysis is necessary. Figure 4 shows such an attempt.

As shown in Figure 4, memory dissociations can occur at different levels. The first level of dissociations occurs at

test level, referring to the dissociations between explicit and implicit tests of memory. Dissociations at this level suggest that the awareness of the study-test relationship plays an important role in human memorial behavior.

The second level of dissociations occurs at process level, referring to the dissociations between recollective (intentional, or voluntary) and automatic (incidental, or involuntary) retrieval processes. Dissociations at this level reflect the operations of retrieval volition, one of the important aspects of consciousness.

The third level of dissociations occurs at memorial awareness level, referring to the dissociations between conscious awareness and unconscious awareness and dissociations between recollection experience and feelings of familiarity. Dissociations at this level reflect the functions of subjective experience in human memorial behavior. It is reasonable to think of memorial states of awareness as a continuum.

Tests and processes can be separated. An single test may involve both recollective and automatic retrieval processes. The fact that a single memory test might involve multiple types of processes suggests that the awareness of study-test relationship and retrieval volition can be separated. Processes and memorial states of awareness can also be separated. Automatic retrieval processes need not be solely associated with unconscious awareness. This separation is especially important for certain memory tests which involve a stage in which subjective experience about an item needs to be assessed. One such an example is the exclusion test introduced by the process-dissociation procedure.

The notion that memory dissociations should be analyzed at multiple levels has significant implications for the studies of implicit cognition in general. Implicit cognition is concerned with the general relationship between consciousness and human cognition. Important issues in implicit cognition include (a) to what extent that there exist unconscious processes; and (b) whether it is conscious or unconscious processes that are more fundamental for human cognition. Debates still remain between different views (for reviews, see Merikle, 1992; Shanks & St. John, 1994). One reason for this situation is that researchers often fail to separate the different roles consciousness plays at levels of tasks, processes, and mental awareness.

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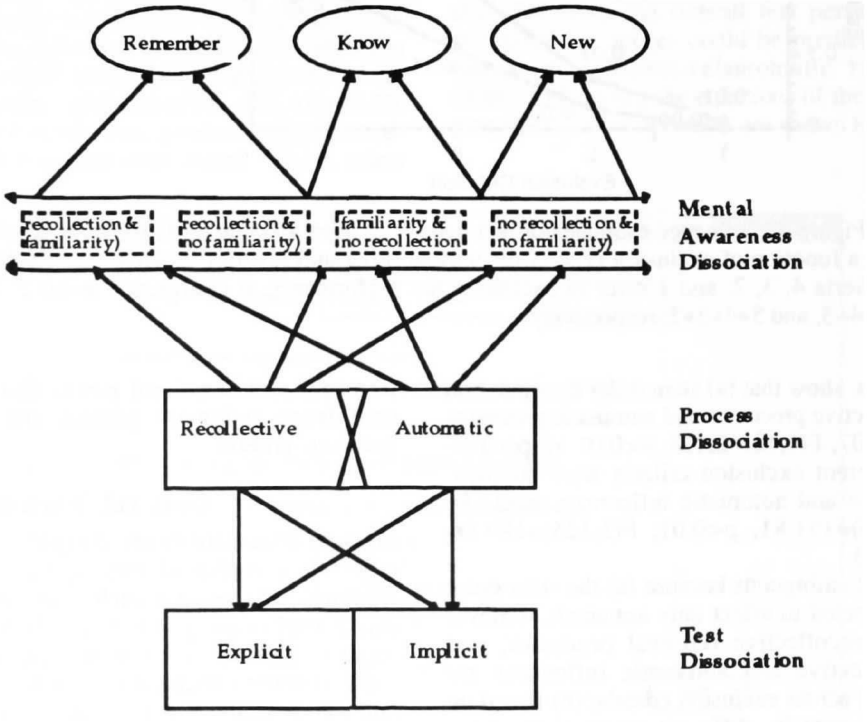

Figure 4: Multi-level analysis of memory dissociations.

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