Psychonomic Bulletin & Review
1998, 5 (4), 705-709

Two effects of repetition: Support for a dual-process model of know judgments and exclusion errors

LARRY L. JACOBY, TODD C. JONES, and PATRICK O. DOLAN
New York University, New York, New York

In three experiments, a *remember/know* recognition test (Experiments 1–2) and an exclusion test (Experiments 2–3) were used to examine effects of repeated study presentations. An effect of study repetition was obtained for remember but not know judgments, similar to results reported by Gardiner, Kaminska, Dixon, and Java (1996). Experiment 2 demonstrated the similarity between know responses and exclusion errors; neither was affected by repeated study presentations. In Experiment 3, a response deadline procedure was used to show that exclusion errors are the product of two opposing processes—recollection and familiarity—both of which are influenced by repetition. The interpretation of exclusion errors and know responses is shown to require a dual-process model that includes an assumption about the relationship between processes.

In the *remember/know* procedure, introduced by Tulving (1985) and further developed by Gardiner and his colleagues (Gardiner, 1988; Gardiner & Java, 1990, 1991; Gardiner & Parkin, 1990), subjects report on experiential states of memory. For a recognition memory test, subjects identify items as "old" or "new" and further classify items called "old" as remember (R) or know (K). Items are to be classified as R only if a detail of the study presentation is recollected. K judgments are given to items that are familiar but whose study presentation cannot be recollected. Gardiner and his colleagues (e.g., Gardiner, Kaminska, Dixon, & Java, 1996; Richardson-Klavehn, Gardiner, & Java, 1996) have advocated a state-of-awareness approach to analyzing R/K judgments. The approach is descriptive, in that emphasis is placed on differences in phenomenology rather than on underlying processes. The goal of their approach is to discover what factors influence states of awareness, and the attainment of that goal is said not to rely on the specification of underlying processes nor on an assumption about the relationships among underlying processes.

We (e.g., Jacoby, Yonelinas, & Jennings, 1997; Yonelinas & Jacoby, 1995) agree that it is important to investigate subjective experience, but we believe that interpreting and predicting the influence of factors on states of awareness does require the specification of underlying processes along with an assumption about their relationships. Our experiments illustrate the importance of an assumption about the relationship among underlying processes by examining the effect of repeated study presentation on the probability of a K response. The things—objects, words, people, places, situations—that are the most familiar are those that are encountered most frequently. By definition, K judgments reflect familiarity, and so one might expect the probability of a K judgment to increase with study repetitions. However, Gardiner et al. (1996) found that for pieces of classical music, study repetitions did not increase K responses; only R responses increased.

Experiment 1 was a conceptual replication of Gardiner et al. (1996), but with traditional verbal stimuli (words). We found that study repetitions increased the probability of an R response but left K responses unchanged, and the results illustrate how conclusions that are drawn change with the assumption that one makes about the relationship among underlying processes. The possible relationships of the underlying processes (familiarity and recollection) are exclusivity, redundancy, and independence (e.g., Jacoby et al., 1997; Joordens & Merikle, 1993; Yonelinas & Jacoby, 1995). Experiments 2 and 3 provided support for a dual-process model by showing that repetition increased familiarity and recollection, the process underlying the subjective state of remembering. The results from these experiments show that the probability of a K response relies as much on the absence of recollection as on the presence of familiarity. Accordingly, we conclude that a dual-process model that specifies the relation between processes is required for one to discover and predict effects on states of awareness.

This research was supported by grants to L.L.J. from the National Science Foundation (SBR-9596209) and the Natural Sciences and Engineering Research Council of Canada. The authors express appreciation to Jim Debner, Ann Hollingshead, and Tom Trainham for assistance during all phases of the research reported here. Additional thanks go to Wayne Donaldson, John Gardiner, Asher Koriat, and Johanna Nordlie for their helpful comments. Correspondence concerning this article should be addressed to L. L. Jacoby, Department of Psychology, New York University, New York, NY 10003-6634 (e-mail: larry@xp.psych.nyu.edu).

EXPERIMENT 1

Method

In Experiment 1, we presented study words at a 2-sec rate and varied the number of presentations (3, 2, 1, or 0). Each presentation condition was represented by a set of 20 words, which were balanced for word length, word frequency, and concreteness, and were rotated through presentation conditions across the 24 University of Texas undergraduates who participated in the experiment. On a recognition test that immediately followed the study phase, subjects classified words as R, K, or new. The experiment was run using MEL software (Schneider, 1990) on IBM-compatible computers with VGA monitors.

Results and Discussion

The pattern of results produced by word repetition (see Table 1) was the same as that reported by Gardiner et al. (1996) for classical music.[1] An analysis of variance (ANOVA) of the overall hit rates revealed a significant effect of repetition [$F(2,46) = 34.48$, $MS_e = .01$]. Separate one-way ANOVAs showed an effect of repetition on R responses [$F(2,46) = 23.84$, $MS_e = .01$], but not on K responses [$F(2,46) = 0.04$, $MS_e = .01$].

If the probability of a K response were taken as a measure of familiarity, one would conclude that repetition did not influence familiarity. However, that conclusion can change if one adopts a dual-process account of K responses, along with a process relationship assumption, allowing the possibility that repetition influences both recollection and familiarity. The probability of recollection is important when one is using K responses to measure familiarity, because subjects are instructed to respond "know" if a word is familiar and they do *not* "remember" (recollect) its earlier presentation.

The use of the probability of a K response as a measure of familiarity relies on an assumption of exclusivity—familiarity is assumed to occur only in the absence of recollection, and vice versa. In contrast, a redundancy assumption holds that words whose study presentation can be recollected are a subset of those that are familiar, and the redundancy measure of familiarity is simply the overall hit rate (R+K). The use of a redundancy measure to interpret results of Experiment 1 would lead to the conclusion that repetition increased familiarity. For an independence assumption, the probability of a K response underestimates the degree to which familiarity has occurred. The measure of familiarity under independence is conditionalized on the opportunity to have a K judgment—the probability that an item is not remembered [$K/(1 - R)$; independence R/K procedure (IRK); Jacoby et al., 1997; Lindsay & Kelley, 1996; Yonelinas & Jacoby, 1995].[2] Under the IRK model (independence assumption), repetition in Experiment 1 increased familiarity ($F = K/1 - R$; see Table 1) [$F(2,46) = 16.56$, $MS_e = .02$].

The important finding of Experiment 1 is that repetition did not increase familiarity under a process assumption of exclusivity but did increase familiarity under an assumption of redundancy or independence. Equating K responses with familiarity, as is done by the exclusivity assumption, leads to the counterintuitive conclusion that repetition does not increase familiarity.

The arguments above concern the measurement of familiarity, an underlying process, and might seem irrelevant if one's primary interest were in phenomenology. Gardiner and his colleagues (Gardiner et al., 1996; Richardson-Klavehn et al., 1996) have stated that their approach allows relations between states of awareness to differ from the relations between underlying processes. Clearly, as responses, and perhaps as states of awareness, R and K are mutually exclusive—the subject is only allowed to say R or K, not both. That is, an exclusivity assumption holds at the level of responses. A relationship assumption about underlying processes is not required if one's only goal is to catalogue the probability of a K response under different combinations of conditions. However, an assumption about the relation between underlying processes is required if one wants to understand and predict the effects of repetition on states of awareness. Factors such as number of repetitions sometimes may not influence the probability of a K response because of offsetting (opposing) effects on recollection and familiarity. In Experiment 2, we examined the relation between cognitive control, as measured by an opposition procedure, and states of awareness, as measured by the R/K procedure.

EXPERIMENT 2

The purpose of Experiment 2 was to relate the probability of a K response to that of exclusion errors on an opposition test (e.g., Jacoby, Woloshyn, & Kelley, 1989). For our exclusion test condition, subjects studied a visual word list, followed by an aural word list. Read and heard study words occurred on the exclusion test along with new words, and the task was to identify the study words that were *heard*. The exclusion test was designed to place effects of familiarity in opposition to those of recollection (Jacoby, 1991; Jacoby et al., 1989). Subjects were expected to fail to exclude a read word as heard if the study word was familiar but not recollected as read.

Opposition procedures are aimed at measuring cognitive control (e.g., ability to avoid exclusion errors), whereas the R/K procedure is aimed at investigating states of awareness. However, cognitive control depends on awareness (e.g., Jacoby et al., 1997). If one equates the

Table 1
Mean Proportion of Responses for Read Study Word Conditions by Experiment

	Remember			Know			Hit Rate			Familiarity (IRK)		
Experiment	1P	2P	3P	1P	2P	3P	1P	2P	3P	1P	2P	3P
1	.40	.52	.59	.35	.36	.35	.76	.88	.95	.58	.74	.83
2	.34	.52	.61	.34	.31	.29	.69	.84	.90	.53	.62	.73

Note—IRK, independence remember/know procedure; P, presentation(s).

failure to recollect reading a word with a failure to "remember," then the combination of outcomes required for a failure to exclude a read study word is the same as that required for a K response. We expected the rates for exclusion errors and K responses to be similar and to be unaffected by repetition. Invariance in the probabilities of K responses and exclusion errors across repetitions was expected to result from offsetting effects on recollection and familiarity.

Method

Subjects. The subjects were 48 different students from the same subject pool as in Experiment 1. Twenty-four students were randomly assigned to each of two test groups (R/K recognition or exclusion).

Materials and Design. The design was the same as for Experiment 1, except that a second list of words was heard at study (Phase 2) and an exclusion test group was added. An additional 108 words were drawn from the same word pool used in Experiment 1, with 68 words presented auditorily (once) in Phase 2 (8 of the words were buffer items). The 60 nonbuffer words appeared on the test, 20 of which were critical items. The test contained 40 new filler words to equate the number of read, heard, and new items, resulting in a 180-word test list. The heard items and new filler items were constant across all subjects.

Procedure. The R/K procedure was identical to that used for the study phase in Experiment 1. For the exclusion test, subjects responded "yes" (by a keystroke) if a word was recognized as heard but "no" if the item was not recognized as heard. They were told that if they remembered a word as having been read earlier, they could be certain that they had not heard the word. When subjects were unsure whether a word had been heard, they were told to respond "yes" because it was important to respond "'yes' to ALL of the heard words." These instructions encouraged subjects to mistakenly respond "yes" to read words that were familiar in the absence of recollection, much like words given a K response by subjects making R/K judgments.

Results and Discussion

Results for the R/K group (Table 1) replicated those found in Experiment 1. Repetition increased the overall hit rate [$F(2,46) = 44.51$, $MS_e = .01$], and this repetition effect was reflected entirely in the R responses [$F(2,46) = 45.66$, $MS_e = .01$]. Repetition did not significantly change the probability of a K response [$F(2,46) = 1.74$, $MS_e = .01$]. As in Experiment 1, however, analyzing the K data under an assumption of redundancy (R + K, the hit rate) or independence (IRK) revealed an effect of repetition on familiarity [$F(2,46) = 9.75$, $MS_e = .02$].

The R/K and exclusion test groups performed quite similarly in terms of the hits for the heard words (.63 and .61, respectively) and the false alarms for new items (.13 for both groups). Further, a group (exclusion "yes" vs. K responses) × repetition (1, 2, or 3 presentations) mixed ANOVA yielded no significant effects [group, $F(1,46) = 3.18$, $MS_e = .05$, $p = .08$; repetition and group × repetition interaction, $Fs < 1.50$], highlighting the similarity of K responses and exclusion errors. As with K responses, repetition did not change the probability of mistakenly responding "yes" to read study words (Table 2).

Table 2
Mean Proportion of "Yes" Responses Across Item Types by Experiment

		False Alarms				
Experiment	Condition	1P	2P	3P	New	Hits: Heard
2	No deadline	.26	.25	.24	.13	.61
3	Deadline	.38	.43	.47	.36	.48
3	Wait	.32	.29	.23	.14	.59

Note—P, presentation(s).

EXPERIMENT 3

The results of Experiment 2 showed the equivalence of K responses and exclusion failures. Neither measure exhibited a repetition effect, presumably because effects of repetition on familiarity were successfully opposed by increased recollection, also produced by repetition. To show that the lack of a repetition effect did result from a balance between recollection and familiarity, we needed a manipulation that would selectively influence recollection, thus disrupting this balance.

Familiarity has been described as a faster basis for responding than recollection (e.g., Atkinson & Juola, 1974; Dosher, 1984; Hintzman & Curran, 1994; Yonelinas & Jacoby, 1994). Therefore, the amount of time that subjects were allowed to spend recollecting prior to responding on an exclusion test was varied in Experiment 3. In a deadline group, subjects were required to respond quickly. A short deadline afforded little time for recollective processes to occur, requiring responses to be based primarily on an assessment of familiarity. Repetition was predicted to increase familiarity, and accordingly, the false alarm rate. In a wait group, subjects were not allowed to respond until after a short delay, increasing the likelihood that they would engage in recollection. Since the probability of recollecting an item as having been read was predicted to increase with increased repetitions, the false alarm rate was expected to decrease to the extent that the influence from recollection was greater than that from familiarity.

In contrast to the null effect of repetition in Experiment 2, we expected that repetition would increase exclusion errors in the deadline group but decrease these errors in the wait group. A reason why exclusion errors did not decrease in Experiment 2 is that some subjects may have responded too rapidly, basing their decisions too much on the influence of familiarity, although they could have used recollection successfully had they spent more time trying to do so. In Experiment 2, the subjects were allowed to respond at their discretion. In Experiment 3, we controlled the opportunity for recollection more fully.

Method

Subjects. Two groups of 20 students from the same pool as in Experiment 1 were randomly assigned to two test groups (deadline or wait).

Design and procedure. The experimental design was the same as that for the exclusion test group in Experiment 2, but an additional between-subjects variable, response group (deadline or wait), was employed. For the deadline group, subjects had to respond within 700 msec after the test word appeared on the screen. For the wait group, subjects waited for 1,200 msec, and then they were signaled to respond within 500 msec. Each test word appeared on the screen until a response was made or until the trial timed out. If a response was not made within the time allotted, a beep sounded and the next test trial began.

Results and Discussion

The mean false alarm rates for read and new items and the hit rate for heard items are presented by group (deadline or wait) in Table 2. A 2 (group) × 2 (item type) mixed ANOVA of the hit rate for heard items and false alarms for new items revealed an interaction of group and item type [$F(1,38) = 53.83$, $MS_e = .01$]. The subjects in the wait group were better able to discriminate between old and new words than were those in the deadline group, demonstrated by a larger difference between hit and false alarm rates. Overall, there were few time-outs, but time-outs occurred more often for the deadline group (.08) than for the wait group (.05) [$t(38) = 2.52$, $SE = .01$].

Overall, false alarms to read words occurred more often than false alarms to new words for both groups [deadline, $t(19) = 2.43$, $SE = .03$; wait, $t(19) = 3.89$, $SE = .04$]. This outcome showed that the prior presentation of the words in the study phase increased their familiarity relative to that of new words. Most important, for the deadline group, the exclusion error rate *increased* as the number of study presentations increased. For the wait group, the opposite pattern emerged; the exclusion error rate *decreased* as the number of study presentations increased. A 2 (group) × 3 (repetition) mixed ANOVA provided statistical support for this interaction [$F(2,76) = 9.25$, $MS_e = .01$].

The opposite effects of repetition for the deadline and wait groups clearly show that exclusion performance reflected *both* recollection and familiarity. When subjects were required to wait prior to responding, effects of repetition on recollection more than offset effects on familiarity. In contrast, when fast responding was required, there was insufficient time for recollection, and effects of repetition on familiarity were largely unopposed.

This finding of opposite effects is important as support for a dual-process model, counter to the single-process model proposed by some researchers to account for R/K results. Donaldson and his colleagues (Donaldson, 1996; Donaldson, MacKenzie, & Underhill, 1996) and Hirshman and Master (1997) have argued that R and K responses reflect only a difference in memory strength rather than different underlying processes. They advocate a two-threshold model, with one criterion set to distinguish old from new items and a second, more stringent, criterion set to distinguish R from K judgments. In their view, R judgments are given to the most familiar items (above the second criterion), whereas K judgments are given to items whose familiarity falls between the two criteria. Shifts in the criteria account for various patterns of R/K results fairly well (Donaldson, 1996, notes exceptions; also, see Gardiner & Gregg, 1997).

Under a two-threshold strength model of recognition, giving subjects more or less time to respond should not result in opposite patterns of data across study repetitions; the two criteria cannot be shifted in a way that would produce the present data. If one uses a bias-free index of discriminability (A'', d'), the ordering of read item distributions *reverses* between the deadline and wait group ($1 > 2 > 3$ and $3 > 2 > 1$, respectively). A shift in overall discriminability or response criteria cannot account for this reversal. Jacoby (in press) has replicated the effect of response deadline and showed that age-related differences in memory produce the same pattern of results as response deadline. When an independence assumption was adopted, response deadline and aging were both found to influence only recollection, leaving familiarity unchanged. McElree, Dolan, and Jacoby (in press) used a speed–accuracy tradeoff procedure to more thoroughly examine the dynamics of recollection and familiarity and found results consistent with those reported here.

Of course, the results of the present experiment do not directly demonstrate that R/K judgments reflect two processes. Rather, the results show that exclusion performance is based on two processes. However, the parallel between effects on exclusion performance and K responses is sufficient to encourage the conclusion that a dual-process model is required for one to account for R/K results.

GENERAL DISCUSSION

Experiments 1 and 2 revealed effects like those found by Gardiner et al. (1996) for classical music: Repetition left the probability of a K response unchanged but increased the probability of a R response. However, treating the data under an independence or redundancy model did reveal an increase in familiarity due to study repetitions. The results of Experiments 2 and 3 showed that repeatedly reading words increases their familiarity, but that effects of increased familiarity can be masked by opposing effects of recollection. As in K responses, the probability of mistakenly accepting a read study word as heard was uninfluenced by repetition (Experiment 2). K responses and exclusion errors both reflect familiarity in the absence of recollection.

Like K judgments, exclusion errors resulted from subjects' "knowing" that words were old but being unable to recollect their study presentation. In Experiment 3, varying the amount of time that was allowed for responding selectively influenced recollection and revealed effects of repetition on familiarity. Requiring fast responding reduced the influence of a slower recollective process and revealed the predicted increase in familiarity with study repetitions, observed in exclusion errors. Requiring subjects to wait before responding allowed the slower recollective process to correctly assess whether an item was read or heard. Recollection increased with study repetitions and counteracted the influence of familiarity for read words, thus reducing exclusion errors across repetitions. Note that averaging the probability of exclusion failure in Experiment 3 (across deadlines) for each repetition condition (once = .35, twice = .36, thrice = .35) produces a pattern remarkably similar to that obtained in Experiment 2, in which no deadline on responding was imposed. Effects of repetition on the two processes—familiarity and recollection—can balance so that the two effects cancel out, producing no effect of repetition on exclusion errors.

Applying the IRK model to analyze R/K results in Experiments 1 and 2 revealed that repetition influenced both recollection and familiarity, in agreement with results from exclusion performance in Experiment 3. This parallel between exclusion performance and IRK model results supports similar findings (Jacoby, 1998; Jacoby et al., 1997). In contrast, analyzing the straight probability of a K response (e.g., Gardiner et al., 1996) and identifying K responses with familiarity led to the counterintuitive conclusion that repetition does not increase familiarity (for a description of other anomalies that arise from identifying K responses with familiarity, see Jacoby et al., 1997; Yonelinas & Jacoby, 1995; though see Richardson-Klavehn et al., 1996).

Although the stated goal of the R/K procedure has been descriptive and the procedure has been aimed at states of awareness rather than underlying processes (Gardiner et al., 1996; Richardson-Klavehn et al., 1996), there has been no shortage of attempts to relate remembering and knowing to underlying processes or forms of memory. While R judgments have been equated with an episodic memory system, K judgments have been equated with a semantic memory system (Tulving, 1985; Wheeler, Stuss, & Tulving, 1997). Gardiner and Parkin (1990) suggested that R judgments reflect conceptual processing but that K judgments reflect prior perceptual processing. Rajaram (1996) reported results not easily accommodated by the contrast between perceptual and conceptual processing and offered a distinctiveness-fluency account of R and K responses.

Each of the accounts above postulates a one-to-one mapping between type of response (R or K) and type of processing or memory system. To do so represents an attempt to explain K responses as reflecting a single underlying process or memory structure. However, exclusion errors and K responses are as much influenced by differences in recollection (or episodic memory, or distinctiveness, etc.) as by differences in familiarity (or semantic memory, or fluency, etc.). Recollection opposes familiarity at an item-by-item level to allow exclusion errors to be avoided or K responses to be made. Consequently, a one-to-one mapping of type of response (K response or exclusion error) onto a single underlying process cannot work. Understanding and predicting how factors influence states of awareness requires a dual-process model that includes an assumption about the relation between processes.

REFERENCES

Atkinson, R. C., & Juola, J. F. (1974). Search and decision processes in recognition memory. In D. H. Krantz, R. C. Atkinson, R. D. Luce, & P. Suppes (Eds.), *Contemporary developments in mathematical psychology: Vol 1. Learning, memory, and thinking* (pp. 243-293). San Francisco: Freeman.

Donaldson, W. (1996). The role of decision processes in remembering and knowing. *Memory & Cognition*, **24**, 523-533.

Donaldson, W., MacKenzie, T. M., & Underhill, C. F. (1996). A comparison of recollective memory and source monitoring. *Psychonomic Bulletin & Review*, **3**, 486-490.

Dosher, B. A. (1984). Discriminating preexperimental (semantic) from learned (episodic) associations: A speed–accuracy study. *Cognitive Psychology*, **16**, 519-555.

Gardiner, J. M. (1988). Functional aspects of recollective experience. *Memory & Cognition*, **16**, 309-313.

Gardiner, J. M., & Gregg, V. H. (1997). Recognition memory with little or no remembering: Implications for a detection model. *Psychonomic Bulletin & Review*, **4**, 474-479.

Gardiner, J. M., & Java, R. I. (1990). Recollective experience in word and nonword recognition. *Memory & Cognition*, **18**, 23-30.

Gardiner, J. M., & Java, R. I. (1991). Forgetting in recognition memory with and without recollective experience. *Memory & Cognition*, **19**, 617-623.

Gardiner, J. M., Kaminska, Z., Dixon, M., & Java, R. I. (1996). Repetition of previously novel melodies sometimes increases both remember and know responses in recognition memory. *Psychonomic Bulletin & Review*, **3**, 366-371.

Gardiner, J. M., & Parkin, A. J. (1990). Attention and recollective experience in recognition memory. *Memory & Cognition*, **18**, 579-583.

Hintzman, D. L., & Curran, T. (1994). Retrieval dynamics of recognition and frequency judgments: Evidence for separate processes of familiarity and recall. *Journal of Memory & Language*, **33**, 1-18.

Hirshman, E., & Master, S. (1997). Modeling the conscious correlates of recognition memory: Reflections on the remember–know paradigm. *Memory & Cognition*, **25**, 345-351.

Jacoby, L. L. (1991). A process dissociation framework: Separating automatic from intentional uses of memory. *Journal of Memory & Language*, **30**, 513-541.

Jacoby, L. L. (1998). Invariance in automatic influences of memory: Toward a user's guide for the process-dissociation procedure. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, **24**, 3-26.

Jacoby, L. L. (in press). Ironic effects of repetition: Measuring age-related differences in memory. *Journal of Experimental Psychology: Learning, Memory, & Cognition*.

Jacoby, L. L., Woloshyn, V., & Kelley, C. M. (1989). Becoming famous without being recognized: Unconscious influences of memory produced by dividing attention. *Journal of Experimental Psychology: General*, **118**, 115-125.

Jacoby, L. L., Yonelinas, A. P., & Jennings, J. (1997). The relation between conscious and unconscious (automatic) influences: A declaration of independence. In J. Cohen & J. W. Schooler (Eds.), *Scientific approaches to consciousness* (pp. 13-47). Mahwah, NJ: Erlbaum.

Joordens, S., & Merikle, P. M. (1993). Independence or redundancy? Two models of conscious and unconscious influences. *Journal of Experimental Psychology: General*, **112**, 462-467.

Knowlton, B. J., & Squire, L. R. (1995). Remembering and knowing: Two different expressions of declarative memory. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, **21**, 699-710.

Lindsay, D. S., & Kelley, C. M. (1996). Creating illusions of knowing in a cued recall remember/know paradigm. *Journal of Memory & Language*, **35**, 197-211.

McElree, B., Dolan, P. O., & Jacoby, L. L. (in press). Isolating the contributions of familiarity and source information to item recognition: A time-course analysis. *Journal of Experimental Psychology: Learning, Memory, & Cognition*.

Rajaram, S. (1996). Perceptual effects on remembering: Recollective processes in picture recognition memory. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, **22**, 365-378.

Richardson-Klavehn, A., Gardiner, J. M., & Java, R. I. (1996). Memory: Task dissociations, process dissociations, and dissociations of consciousness. In G. Underwood (Ed.), *Implicit cognition* (pp. 85-158). Oxford: Oxford University Press.

Schneider, W. (1990). *Micro Experimental Laboratory* (Version 1.0) [Computer program]. Pittsburgh, PA: Psychology Software Tools.

Tulving, E. (1985). Memory and consciousness. *Canadian Psychologist*, **26**, 1-12.

Wheeler, M. A., Stuss, D. T., & Tulving, E. (1997). Toward a theory of episodic memory: The frontal lobes and autonoetic consciousness. *Psychological Bulletin*, **121**, 331-354.

Yonelinas, A. P., & Jacoby, L. L. (1994). Dissociations of processes in recognition memory: Effects of interference and of response speed. *Canadian Journal of Experimental Psychology*, **48**, 516-534.

Yonelinas, A. P., & Jacoby, L. L. (1995). The relation between remembering and knowing as bases for recognition: Effects of size congruency. *Journal of Memory & Language*, **34**, 622-643.

NOTES

1. It is important to note that our proposal of independence is different from that of Knowlton and Squire (1995). In their view, two processes may occur independently, but both processes must occur to elicit an R response. In our proposal, an R response can be based on the occurrence of a single process, recollection.

2. A programming error was discovered after all three experiments were run. Thus, two of items from the twice-presented condition for one of the counterbalancing schemes were eliminated. For those 6 subjects, the proportion of responses for the twice-presented condition was calculated out of a total of 18 items rather than 20.

(Manuscript received August 8, 1997;
revision accepted for publication February 16, 1998.)