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The role of decision processes in remembering and knowing

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Participants in recognition memory studies are now often asked to partition recognized items into ones that are accompanied by some recollective experience (those they remember) and ones that are not so accompanied (but which they know were previously encountered). Rather than detecting separate memory systems, such attempts to distinguish between remembering and knowing are better understood as a division of positive recognition responses into those that lie above a second decision criterion (remember) and those that do not (know). As such, the amount of memory associated with knowing is strongly dependent on the placement of the decision criteria. A meta-analysis of published data and a simple experiment tested predictions from the decision process analysis of remember/know responses.

The standard recognition memory task is one in which participants are presented with a list of items to be remembered and then are given a longer list containing the original items and a number of distractors. They are asked to say "yes" to those items they remember from the initial list and "no" to those they do not remember seeing in the first list. Participants are often uncertain about whether an item is an old one they saw before or not. They can be induced to be more or less cautious in partitioning the items into old ones and new ones. They are more confident about responses to some items than others, and they can assign meaningful confidence ratings to their yes and no responses. Most researchers who use the recognition task now realize that the hit rate by itself, the proportion of times a participant says "yes" to old items, is not a good index of memory since it can be so easily influenced by the criterion the subject sets. One must combine the hit rate with the false-alarm rate, the proportion of times a participant says "yes" to new items, to calculate a measure of memory, such as d' or A', that is independent of a criterion or bias measure, such as C or B''_D. Snodgrass and Corwin (1988) reviewed a variety of such measures.

Recently, there has been an increased tendency to use the hit rate as if it adequately measures memory. This has occurred when experimenters have asked participants to provide additional information after they have identified an item as an old one. The additional information might be in the form of a source judgment (see Johnson, Hashtroudi, & Lindsay, 1993, for a review) or a recollective judgment (e.g., Gardiner, 1988). It also happens when experimenters make the yes/no decision more complex, as in the process dissociation procedure (Jacoby, 1991). Since we know that the original hit rate is so influenced by the participant's response criterion, it would be surprising if the subsequent judgments were not influenced.

Attempts are now beginning to be made to understand these follow-up responses. Batchelder and Riefer (1990) and Kinchla (1994) have examined source monitoring tasks. Banks and Prull (1994), Buchner, Erdfelder, and Vaterrodt-Plünnecke (1995), and Yonelinas (1994) have explored process dissociation tasks. Jacoby, Yonelinas, and Jennings (in press) have examined a variety of tasks, including that of recollective memory. Many of the models used by these researchers are versions of high-threshold theory; others go back to signal detection theory concepts (see Macmillan & Creelman, 1991). This article does the latter in a reanalysis of the data offered in support of the distinction between recollective and nonrecollective memory. Recollective memory is implicated when, after a positive recognition response, introspection leads a participant to say "I remember." Recognition in the absence of such recollection is labeled "know" or "familiar" by the participant.

The case presented in the literature is that being able to say "I remember" after a positive recognition response taps into a different type of memory than when the participant cannot say he or she remembers. The former is seen as being comparable to that operating in explicit or direct tasks, whereas the latter reflects that in implicit or indirect tasks (Richardson-Klavehn & Bjork, 1988). The former is seen as episodic in character, involving recollection and autonoetic consciousness, whereas the latter is semantic, nonrecollective, and anoetic (Tulving, 1985).

A preliminary version of this was presented at the Psychonomic Society 35th annual meeting in St. Louis in 1994, as Poster 154, *Non-Recollective Memory: Predicting Below Chance Performance.* The data in the experiment were collected by Andrew McNamara and Nancy Gallagher in undergraduate research apprenticeships under the supervision of the author. The author would like to thank Doug Hintzman, Joan Gay Snodgrass, John Wixted, and an anonymous reviewer, each of whom made thoughtful and extensive comments on an earlier version of this article. Correspondence should be addressed to W. Donaldson, Department of Psychology, University of New Brunswick, Fredericton, NB, Canada E3B 6E4 (e-mail: donaldsn@unb.ca).

The question is whether such a high-threshold interpretation is compatible with an initial recognition task that is known not to be well modeled by a high-threshold theory.

A simpler way to account for these data is to argue that there is a continuum of mnemonic information on which a person establishes a criterion. Items that lie above that criterion are identified as having previously occurred (i.e., are given a yes response). A second criterion is then established that divides the yes responses into those above the new criterion, which get labeled "remember," and those below it, which get labeled "know." Such a suggestion is made with full knowledge of claims, such as "the clear-cut nature of this dissociation argues against the possibility that remember and know responses simply reflect strong and weak traces" (Gardiner, 1988, p. 312), and that the "high level of recognition performance for know responses means that these responses cannot be equated with weak trace strength" (Gardiner & Java, 1990, p. 26). I will show that those claims are wrong. Dissociations such as those presented by Gardiner and others can be generated from a trace strength type of model in which participants simply divide their yes responses into strong remember responses and weak know ones. In addition, such a model predicts when dissociations of different types will and will not occur.

Each of the diagrams in Figure 1 represents a standard signal detection approach (Macmillan & Creelman, 1991), although none of the following arguments require any distributional assumptions about normality or equal variances. While the arguments are distribution free, the specific statistics used in testing the arguments are, of course, less so. The two distributions shown in Figure 1 are simply labeled A and B to allow discussion in two different ways. To begin with, one can think of Distribution A in the traditional way as the new-item distribution and Distribution B as the old-item distribution. When faced with deciding about the status of an item, an observer establishes a criterion; if an item falls above that criterion, it is identified as old (i.e., given a yes response). The vertical line to the left in each diagram represents that criterion. The top panel of Figure 1 shows a conservative criterion, the middle panel shows a neutral one, and the lower panel shows a liberal criterion. The area under Distribution A and to the right of the no/yes criterion represents the false-alarm rate; the area under Distribution B and to the right of that criterion represents the hit rate. Clearly, both the hit rate and the false-alarm rate increase as the no/yes criterion becomes more liberal, but statistics such as A' or d' provide criterion-free estimates of performance. The vertical line to the right of the no/yes criterion represents the criterion to subdivide the yes responses into remember responses and know responses. Items to the right of that line are identified as remembered. Thus, remember responses represent nothing more than conservative yes responses.

While the hit rates and false-alarm rates for remember responses will be lower than those for yes responses, the measure of memory, A' or d', calculated on remember responses should be no different from that calculated on the overall recognition yes responses. To avoid confusion, we need to be clear about which data are being used in calculations. Data may come from the overall recognition hit rates and false-alarm rates, from the hit and false-alarm rates associated with a remember response, or from the hit and false-alarm rates associated with a know response. The corresponding A' memory statistics will be reported as A'(recog), A'(rem), and A'(know), respectively. The same identifiers will be used with d', B''_D, and C.

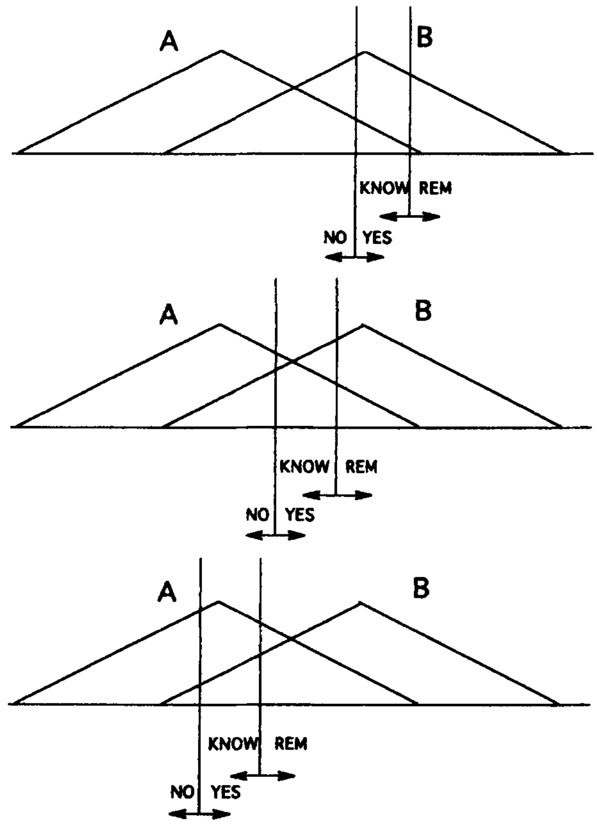

Figure 1. Schematic diagrams showing the effect of response criterion on remember and know responses when considered as stronger and weaker components of recognition. Criteria become more liberal as one moves from the top panel to the bottom. See text for details.

The first prediction, then, is that bias-free estimates of memory should produce equivalent values whether calculated on the overall hit-rate and false-alarm-rate data or only on the remember data. In other words, A'(recog) should equal A'(rem), and d'(recog) should equal d'(rem).

The critical areas of the two distributions are those *between* the two criteria, because those are the areas that represent the hit rate (under Distribution B) and false-alarm rate (under Distribution A) associated with responses of "know." Traditional signal detection analysis does not deal with areas between criteria. When more than one criterion is used, as with confidence ratings, data are always treated cumulatively. All of the research articles that present hit and false-alarm rates for know responses, however, are dealing with the areas between the criteria.

With conservative responding (top panel), the hit rate for know responses (the area between the two criteria and under Distribution B) is substantially larger than the false-alarm rate (the area between the two criteria and under Distribution A). Using those values to calculate either A'(know) or d'(know) will yield a relatively high measure of memory. While such a calculation does not make sense from the point of view of signal detection theory, predictions can be made about the behavior of the measures. With a more liberal criterion, as shown in the center panel of Figure 1, the hit and false-alarm rates associated with know responses (again, the areas under the two distributions between the criteria) are about equal and will produce an A'(know) value around 0.5 or d'(know) value around zero, chance performance. A correction such as hits minus false alarms will also produce a value around zero. Finally, with very liberal responding, as shown in the bottom panel, the Distribution B area between the criteria is *smaller* than the Distribution A area, the hit rate is *less* than the false-alarm rate, and *any* measure of mnemonic performance will be below chance.

The second prediction of the present model, then, is that memory based on knowing will not be independent of the no/yes response criterion, as is generally supposed to be the case with memory and bias measures. Rather than independence, the model predicts a positive correlation between the placement of the yes/no criterion and the amount of know memory. Buchner et al. (1995, Note 3) derive a similar prediction from a different perspective. Indeed, if the criterion is liberal enough, a higher proportion of new items than old ones will be labeled as know and memory measures will be below chance. These predictions were tested in a meta-analysis of published data and in a new study.

The distributions in Figure 1 may now be thought about in a different way, both of them representing old items in a recognition task. Distribution A represents the more difficult level of the variable in a simple experiment, and Distribution B represents the easier of the two levels. Thus, Distribution A might be the 8-day delay in Tulving (1985, Experiment 2), and Distribution B might represent the 1-day delay. Or, from Gardiner (1988, Experiment 1), Distribution A represents the rhyme condition, and Distribution B represents the associate condition. Now, the areas to the right of the no/yes criterion represent the overall recognition hit rates for the two conditions. The hit rate for the easier condition (B) is of course higher than that for the harder condition (A). The areas to the right of the more conservative criterion represent the hit rates associated with saying "remember" in each of the two conditions. In every case, regardless of where the criteria are placed, the remember hit rate for the condition that is overall easier (1-day delay or associative encoding), the area under Distribution B, will be larger than that under Distribution A. Thus, remember hit rates for the two conditions will always parallel overall recognition hit rates. Any variable that has an effect on overall recognition performance will have the same effect on remember performance.

The important changes again happen in the areas *between* the two criteria, in the areas that correspond to know judgments. When criteria are very conservative, as in the top panel, the area between the criteria under Distribution B is larger than the area under Distribution A. The effect of the variable on know responses will be in the same direction as that on remember responses. Thus, when overall responding is conservative, both remember and know responses can show generation effects, as in Wippich (1992). In that study, when participants said "I remember," the generate and read hit rates were 0.40 and 0.17, respectively. Responses of "know" were associated with hit rates of 0.31 and 0.24. The magnitude of the generation effect differs, but the direction is the same.

With a more liberal criterion, as in the center panel, the areas between the criteria underlying Distributions A and B are the same. The data then show that, while the variable had the expected effect on the remember data, it produced no effect on the know data. This is what happened in Gardiner (1988, Experiment 2), where overall hit rates of 0.60 and 0.46 were shown for the generate and read conditions, respectively. This effect of the variable was echoed in the remember responses (hit rates of 0.42 and 0.26) but disappeared in the know data (0.18 and 0.20). Thus, a dissociation occurs where the independent variable affects the remember responses but has no effect on the know responses.

Turning now to the bottom panel of Figure 1, where responding has become more liberal still, the areas *between* the criteria are now such that the area under Distribution A is larger than that under Distribution B. This is in contrast to the areas *above* the upper criterion, where the area under Distribution B continues to be larger than that under Distribution A. A full crossover interaction, a complete experimental dissociation, is thus demonstrated in a model based on a single underlying dimension. This models the effects found by Tulving (1985, Experiment 2). His overall hit rates for delays of 1 and 8 days were 0.86 and 0.62, respectively. His recollective hit rates parallel the overall effect with values of 0.67 and 0.47. Know hit rates show a reversed effect of the independent variable, being 0.15 and 0.28, respectively. This outcome is expected by the model when initial response criteria are liberal.

The simple model can generate data that show an independent variable to have the same effect on remember hit rates and know hit rates. It also can produce data where an independent variable has an effect on the remember hit rate but no effect on the know hit rate. Finally, it can generate a full crossover interaction where an independent variable has one effect on the remember hit rate and the opposite effect on the know hit rate. Finally, and importantly, it predicts when each type of outcome will occur in relation to the decision criteria adopted by the participants. This is important because interpretations that treat remember and know as indicative of separate memory systems have no way of predicting when dissociations will or will not occur.

THE META-ANALYSIS

A search of what is called the *recollective memory literature* was carried out for recognition experiments in which participants were asked to partition their initial yes responses into those accompanied by some recollection of details of the initial presentation (in which case, they were to say they remembered) and those not so accompanied (which they identified as items they knew were on the list). To be included here, the published data had to report both hit rates and false-alarm rates subdivided into the remember and know components. The final analysis included data from 80 conditions in 28 experiments reported in 17 different publications (see Table 1).

For each condition in each experiment, the hit rates (HIT) and false-alarm rates (FA) were recorded for the overall recognition performance, the remember responses, and the know responses. The remember hit rate is the proportion of old items given a joint response of "yes" and "remember." The know hit rate is the proportion of old items given a response of "yes" and "know." The sum of the two equals the recognition hit rate. The comparable false-alarm rates are the proportions of new items given those responses. These data are reported in Table 1.

To compare data across different experiments, both A'(recog) and d'(recog) values were calculated. Similar values were also calculated for the two subcomponents from the separate remember and know hit rates and false-alarm rates. These are labeled A'(rem) or d'(rem), and A'(know) or d'(know), respectively. Both A' and d' are estimates of memory performance that are theoretically independent of response criterion. A' is an estimate of the area under the isomemory curve and is equivalent to the percent correct in a two-alternative forced-choice task. The computational formula when the hit rate is greater than the false-alarm rate (i.e., when performance is above chance) is:

$$A' = \frac{1}{2} + \frac{(\text{HIT} - \text{FA})(1 + \text{HIT} - \text{FA})}{4\text{HIT}(1 - \text{FA})}. \qquad (1)$$

It ranges between 0 and 1, with 0.50 representing chance performance. Below-chance performance requires a modified formula (Aaronson & Watts, 1987). Note that d' is the standardized difference between the means of the two underlying distributions.

Both A' and d' values were calculated on the suggestion of a reviewer of an earlier version of this article, but I prefer A'. Snodgrass and Corwin (1988) evaluated a variety of measures of memory and criterion in recognition memory tasks. A' did not fare well in their analysis because it was found not to be independent of either of the associated measures of response criterion available at the time. Since then, a measure of criterion has been developed that is independent of A' (Donaldson, 1992). The model being tested here is one in which criterion values are critical, and it has been demonstrated (Donaldson, 1993) that although d' tends to be a slightly better measure than A' when performance is unbiased, it is clearly less preferred when criterion changes occur. Since the present model makes predictions based on the establishment of different criteria, A' would seem to be more appropriate.

For each set of data, the overall recognition hit rate and false-alarm rate were also used to produce measures of where the recognition response criterion was placed, B''_D(recog) and C(recog). B''_D is the appropriate criterion measure associated with A', whereas C is that paired with d'. B''_D is given by the formula:

$$B''_D = \frac{(1 - \text{HIT})(1 - \text{FA}) - (\text{HIT})(\text{FA})}{(1 - \text{HIT})(1 - \text{FA}) + (\text{HIT})(\text{FA})}. \qquad (2)$$

It ranges between -1 and $+1$, with positive values reflecting conservative performance and negative values indicating liberal responding (Donaldson, 1992). The standard calculations of d' and C based on z-scores can be found in Macmillan and Creelman (1991). The memory and criterion measures are also presented in Table 1.

The first prediction was that estimates of memory should be the same whether calculated on recognition data or on remember data. The recognition performance average was A'(recog) = 0.86; remember performance was at A'(rem) = 0.83. Of the 80 comparisons, A'(recog) was higher than A'(rem) in 60 cases, lower in 12, and equal in 8. The comparable d' values were d'(recog) = 1.71 and d'(rem) = 1.80. Of the 80 comparisons, d'(recog) was higher than d'(rem) in 24 cases, lower in 53, and equal in 3. It is not immediately clear why these differences occur, but two possibilities suggest themselves. First, the prediction of equal values of d' assumes that the underlying isomemory curve has a slope of 1.0. If the slope is less than 1.0, as is usually the case, then calculations based on the more conservative remember responses would lead to higher estimates of d' than the overall response. The d' values are in the expected direction. Second, Macmillan and Creelman (1991, p. 108) indicated that an isomemory curve based on A' is slightly concave upward, so extreme values may be underestimates. There will be further discussion after the data from the experiment have been presented.

The second prediction was that there would be a positive correlation between the placement of the recognition criterion and the amount of memory associated with a response of "know." The correlation between A'(know) and B''_D(recog) was r = .57. The comparable value using d'(know) and C(recog) was r = .44. Figure 2 plots A'(rem) and A'(know) against B''_D(recog). The data in Figure 2 were deliberately plotted on axes that cover the full range of A' and B''_D in order to show the conservative bias in the placement of the yes/no criterion in published studies, where only 9 of 80 B''_D(recog) values were negative, and to make it comparable to Figure 3, where the data required the full ranges. Remember and know memory are related to response criterion in quite different ways. The correlation between A'(rem) and B''_D(recog) is $-.38$; that between A'(know) and B''_D(recog) is $+.57$. The comparable correlation between d'(rem) and C(recog) is $-.33$; that between d'(know) and C(recog) is $+.44$. The slope of the best-fitting A'(rem) data is $-.07$; that for the A'(know) function is $+.13$. The comparable values using d' are $-.86$ and $+.65$. In experiments where participants were very conservative in saying "yes," remember performance was slightly better than know performance. As the initial yes/no decisions become more liberal, moving from right to left in Figure 2, remember performance improves slightly, know performance declines substantially, and the difference between the two increases. Finally, it is worth reporting that there was no relationship between the remember and know memory values ($r = +.01$ with A', $r = +.15$ with d'). This is in contrast to a strong negative correlation ($r = -.53$) between remember and know hit rates, which replicates the finding of Parkin and Walter (1992), who reported correlations between hit rates of $-.70$ and $-.52$ for their young and old participants, respectively. The lack of a correlation between A' or d' values again emphasizes the importance of looking at memory measures that try to eliminate response bias (Snodgrass & Corwin, 1988).

THE EXPERIMENT

A simple recognition memory experiment was conducted to test the same predictions that were examined in the meta-analysis. Participants were presented a list of 100 common words under instructions simply to read each word out loud and to try to remember it. They were then tested on a recognition list of 200 words, all of the original ones plus 100 new ones. Since the model particularly implicates response criterion, and the meta-analysis suggests a tendency toward conservative responding in these kinds of studies, participants were induced to be liberal in their willingness to identify items as old ones. This was done by using a confidence rating scale that previous unpublished research had shown to effect this result. Participants simply said "no" to any items they thought were new; however, they were asked to give a confidence rating for each item they thought was old. This unbalanced rating scale (0, +1, +2, +3) produces data with increased hit rates and false-alarm rates (i.e., shifts the yes/no criterion) but leaves memory performance as measured by A' unaffected. After a nonzero response had been made to an item, a remember/know decision was required.

Liberal responding was desired for three reasons. First, with a higher proportion of yes responses, more opportunities exist to collect remember/know data, increasing the reliability of the observations. Second, with the model predicting, and the meta-analysis showing, that know performance declines as performance becomes more liberal, there is the question of how much more it might decline. Indeed, the model predicts that know memory performance will drop below chance when recognition responding becomes liberal enough. Third, if initial responding is liberal, one can explore more conservative behavior within subjects by examining only confident (+2 and +3) and high confident (+3) responses. This would allow one to test the prediction that recognition memory (A') will be the same whether measured on the yes data, the sure yes data, the very sure yes data, the overall remember data, the sure remember data, or the very sure remember data. In contrast, A'(know) calculated on all of the know data should be lower than that calculated on the sure data (+2 and +3), which in turn should be lower than that calculated on only the very sure (+3) know data.

Method

Subjects and Design. Forty students from an introductory psychology class participated in the study for course credit. Each individually tested participant was presented with a list of words with instructions simply to read each word and to try to remember it. Immediately following the presentation, a second list of words was presented. The participants were asked to make a recognition decision, including a confidence rating, and then to indicate which of their yes responses were accompanied by some recollective experience.

Procedure. All participants responded to the same 200-word recognition test list. The 200 words were randomly divided into two sets of 100 words each, and half of the participants were presented with each of the sets so that, across participants, all tested words were equally often old and new.

Each participant began by seeing a list of 110 common words, 100 critical items plus 5 primacy and 5 recency buffers. The words were presented one at a time on a computer screen. Each word appeared for 2.5 sec, with 0.5 sec between words. The participants were asked to read each word out loud as it was presented and to try to remember it. They were advised that the list was long and that they were not to worry if, during the presentation, they began to feel that they were not remembering. No mention was made of the type of memory test to be administered.

Following list presentation, the participants were informed that they would be shown a second list that would include the words they had just seen plus an equal number of new words. They were told that the words would appear on the computer screen one at a time and, as in the first list, they were to read each word out loud when it appeared. After the word had been read, the participant was asked to report a number. A report of 3 indicated that he or she was very sure that the word had occurred in the first list. A report of 2 indicated that the respondent was sure that it was there. A response of 1 indicated that the word was thought to be an old one but the person was unsure. A response of zero meant that the word was not thought to have been in the first list. The confidence scale, with both numbers and descriptions, was displayed at the bottom of the computer screen throughout the entire test. Finally, after each nonzero response, a recollective judgment was requested. The participants were asked to respond either "remember" or "familiar."

The response of "familiar" was used rather than the more traditional know response or Horton, Pavlick, and Moulin-Julian's (1993) "must" response, because pilot work found both of these to be very uncomfortably given after an initial unsure response on the old/new status of the word. Both know and must carry a con-

Table 1
Remember/Know Studies and Basic Data

			Recognition Performance						Response: Remember						Response: Know			
Study	Experiment	Level	HIT	FA	A'	B''_D	d'	C	HIT	FA	A'	B''_D	d'	C	HIT	FA	A'	d'
Conway & Dewhurst (1995)	1	PERFORM	0.74	0.09	0.90	0.54	1.98	0.35	0.48	0.01	0.87	0.99	2.53	1.31	0.26	0.09	0.71	0.70
		WATCH	0.62	0.09	0.86	0.71	1.65	0.52	0.36	0.01	0.84	0.99	2.22	1.47	0.26	0.09	0.71	0.70
		IMAGINE	0.51	0.09	0.82	0.80	1.37	0.66	0.24	0.01	0.80	1.00	1.87	1.64	0.27	0.09	0.72	0.73
	2	PERFORM	0.68	0.12	0.86	0.55	1.62	0.32	0.46	0.03	0.84	0.95	1.78	0.99	0.22	0.09	0.68	0.57
		WATCH	0.60	0.12	0.84	0.66	1.38	0.44	0.30	0.03	0.79	0.97	1.36	1.20	0.30	0.09	0.73	0.82
		IMAGINE	0.56	0.12	0.82	0.70	1.28	0.49	0.29	0.03	0.79	0.98	1.33	1.22	0.27	0.09	0.72	0.73
Curran, Gardiner, Java, & Allen (1993)		PRE	0.83	0.11	0.92	0.25	2.18	0.14	0.64	0.03	0.90	0.90	2.24	0.76	0.19	0.08	0.67	0.53
		POST1	0.62	0.11	0.85	0.66	1.54	0.46	0.39	0.03	0.82	0.96	1.60	1.08	0.23	0.08	0.70	0.67
		POST3	0.70	0.11	0.88	0.55	1.75	0.36	0.45	0.03	0.84	0.95	1.75	1.01	0.25	0.08	0.72	0.74
		POST5	0.77	0.11	0.90	0.41	1.97	0.25	0.48	0.03	0.85	0.94	1.83	0.97	0.29	0.08	0.74	0.86
		PRE	0.76	0.11	0.90	0.44	1.94	0.26	0.58	0.03	0.88	0.92	2.08	0.84	0.18	0.08	0.67	0.49
		POST1	0.79	0.11	0.91	0.37	2.04	0.21	0.68	0.03	0.91	0.88	2.35	0.71	0.11	0.08	0.58	0.18
		POST3	0.83	0.11	0.92	0.25	2.18	0.14	0.66	0.03	0.90	0.89	2.29	0.94	0.17	0.08	0.66	0.46
		POST5	0.88	0.11	0.94	0.05	2.41	0.03	0.71	0.03	0.91	0.86	2.43	0.67	0.17	0.08	0.66	0.46
Dewhurst & Conway (1994)	1	PICTURES	0.92	0.12	0.94	−0.22	2.59	−0.12	0.77	0.02	0.93	0.87	2.79	0.66	0.15	0.10	0.60	0.24
		WORDS	0.59	0.12	0.83	0.67	1.41	0.48	0.31	0.02	0.81	0.98	1.55	1.28	0.28	0.10	0.71	0.70
	2	PICTURES	0.79	0.08	0.92	0.51	2.22	0.30	0.58	0.01	0.89	0.97	2.53	1.07	0.21	0.07	0.70	0.67
		WORDS	0.93	0.08	0.96	−0.07	2.89	−0.04	0.76	0.01	0.94	0.94	3.04	0.81	0.17	0.07	0.67	0.52
	3	PICTURES	0.93	0.02	0.98	0.57	3.53	0.29	0.79	0.00	0.95	1.00	3.39	0.89	0.14	0.02	0.74	0.97
		WORDS	0.93	0.02	0.98	0.57	3.53	0.29	0.64	0.00	0.91	1.00	2.94	1.11	0.29	0.02	0.80	1.50
	4	W-WRITE	0.72	0.21	0.84	0.19	1.39	0.12	0.39	0.04	0.82	0.95	1.47	1.02	0.33	0.17	0.67	0.51
		P-WRITE	0.81	0.08	0.92	0.46	2.29	0.27	0.59	0.02	0.89	0.94	2.28	0.91	0.22	0.06	0.72	0.79
		W-RATE	0.91	0.06	0.96	0.22	2.90	0.11	0.71	0.00	0.93	1.00	3.13	1.02	0.20	0.06	0.71	0.72
		P-RATE	0.81	0.08	0.92	0.46	2.29	0.27	0.53	0.02	0.87	0.96	2.13	0.99	0.28	0.06	0.75	0.98
	5	HIGH	0.70	0.08	0.89	0.66	1.93	0.45	0.55	0.02	0.88	0.95	2.18	0.96	0.15	0.06	0.67	0.52
		LOW	0.60	0.10	0.85	0.71	1.53	0.52	0.33	0.02	0.81	0.98	1.61	1.25	0.27	0.08	0.73	0.80
Gardiner (1988)	1	ASSOC	0.85	0.02	0.96	0.79	3.09	0.51	0.67	0.01	0.91	0.96	2.77	0.95	0.18	0.01	0.78	1.41
		RHYME	0.63	0.03	0.89	0.90	2.21	0.78	0.47	0.02	0.85	0.96	1.97	1.07	0.16	0.01	0.77	1.34
	2	GEN1h	0.83	0.08	0.93	0.40	2.36	0.23	0.68	0.05	0.90	0.80	2.12	0.59	0.15	0.03	0.73	0.84
		READ1h	0.50	0.08	0.82	0.84	1.41	0.71	0.36	0.05	0.80	0.94	1.29	1.01	0.14	0.03	0.72	0.80
		GEN1w	0.60	0.27	0.75	0.29	0.86	0.18	0.42	0.10	0.78	0.85	1.08	0.74	0.18	0.17	0.52	0.03
		READ1w	0.46	0.27	0.67	0.52	0.51	0.36	0.26	0.10	0.70	0.92	0.64	0.96	0.20	0.17	0.55	0.11
Gardiner, Gawlik, & Richardson-Klavehn (1994)		LEARN	0.68	0.13	0.86	0.52	1.60	0.33	0.50	0.03	0.86	0.94	1.88	0.94	0.18	0.10	0.63	0.36
		FORGET	0.43	0.13	0.76	0.80	0.95	0.66	0.23	0.03	0.77	0.98	1.14	1.31	0.20	0.10	0.65	0.44
		LEARN	0.67	0.13	0.86	0.53	1.57	0.35	0.40	0.03	0.83	0.96	1.63	1.07	0.27	0.10	0.70	0.67
		FORGET	0.55	0.13	0.81	0.69	1.26	0.50	0.26	0.03	0.78	0.98	1.24	1.26	0.29	0.10	0.72	0.73
Gardiner & Java (1990)	1	LOW	0.60	0.11	0.84	0.69	1.48	0.49	0.43	0.04	0.83	0.94	1.57	0.97	0.17	0.07	0.67	0.53
		HIGH	0.47	0.14	0.77	0.75	1.00	0.58	0.31	0.05	0.78	0.95	1.15	1.08	0.16	0.09	0.63	0.35
	2	WORD	0.44	0.15	0.75	0.76	0.89	0.60	0.28	0.04	0.78	0.97	1.17	1.17	0.16	0.11	0.59	0.24
		NONWD	0.48	0.14	0.78	0.74	1.03	0.57	0.18	0.03	0.75	0.99	0.96	1.40	0.30	0.11	0.71	0.71

Gardiner & Java (1991)	1	10m	0.75	0.05	0.92	0.73	2.32	0.49	0.49	0.00	0.87	1.00	2.55	1.31	0.26	0.05	0.76	1.01
		1h	0.66	0.07	0.88	0.75	1.89	0.54	0.42	0.01	0.85	0.99	2.13	1.27	0.24	0.06	0.74	0.85
		1d	0.54	0.09	0.83	0.79	1.44	0.62	0.27	0.03	0.78	0.98	1.72	1.47	0.27	0.06	0.75	0.95
		1w	0.48	0.13	0.78	0.76	1.08	0.59	0.25	0.05	0.75	0.97	0.98	1.16	0.23	0.08	0.70	0.67
	2	1w	0.49	0.15	0.77	0.71	1.01	0.54	0.24	0.05	0.75	0.97	0.94	1.18	0.25	0.10	0.69	0.61
		4w	0.40	0.11	0.76	0.85	0.98	0.74	0.19	0.02	0.77	0.99	1.17	1.47	0.21	0.09	0.68	0.53
		6m	0.32	0.14	0.69	0.86	0.61	0.78	0.15	0.05	0.69	0.98	0.61	1.35	0.17	0.09	0.64	0.39
Gardiner & Parkin (1990)		UNDIV	0.70	0.05	0.90	0.78	2.17	0.57	0.50	0.01	0.87	0.98	2.33	1.17	0.20	0.04	0.74	0.91
		DIV1	0.58	0.08	0.85	0.79	1.61	0.61	0.38	0.01	0.84	0.99	2.02	1.32	0.20	0.07	0.70	0.64
		DIV2	0.49	0.10	0.81	0.81	1.31	0.66	0.27	0.01	0.81	0.99	1.72	1.47	0.22	0.09	0.68	0.57
Gregg & Gardiner (1991)		SPOKEN	0.86	0.21	0.89	−0.24	1.89	−0.14	0.58	0.02	0.88	0.95	2.25	0.93	0.28	0.19	0.61	0.30
		SILENT	0.64	0.21	0.80	0.36	1.17	0.23	0.32	0.02	0.81	0.98	1.58	1.26	0.32	0.19	0.64	0.41
		SPOKEN	0.81	0.22	0.87	−0.09	1.65	−0.06	0.49	0.03	0.85	0.94	1.85	0.96	0.32	0.19	0.64	0.41
		SILENT	0.63	0.22	0.79	0.35	1.10	0.22	0.29	0.03	0.79	0.98	1.33	1.22	0.34	0.19	0.66	0.47
LeCompte (1995)	2	NORM	0.70	0.34	0.76	−0.09	0.94	−0.06	0.45	0.14	0.76	0.76	0.96	0.60	0.25	0.20	0.57	0.17
		REVL	0.70	0.44	0.71	−0.29	0.68	−0.19	0.39	0.16	0.72	0.78	0.72	0.64	0.31	0.28	0.53	0.09
Mogg, Gardiner, Stavron, & Golombok (1992)		THREAT	0.56	0.10	0.83	0.76	1.43	0.57	0.27	0.03	0.78	0.96	1.27	1.25	0.29	0.07	0.75	0.93
		NONTHREAT	0.62	0.07	0.87	0.79	1.79	0.59	0.36	0.01	0.83	0.99	1.97	1.35	0.26	0.06	0.75	0.92
		THREAT	0.57	0.12	0.82	0.68	1.36	0.50	0.24	0.03	0.77	0.98	1.17	1.30	0.33	0.09	0.74	0.90
		NONTHREAT	0.61	0.05	0.88	0.85	1.93	0.69	0.36	0.02	0.82	0.98	1.69	1.21	0.25	0.03	0.78	1.21
Parkin & Russo (1993)		LAG 0	0.77	0.23	0.85	0.00	1.48	0.00	0.51	0.06	0.84	0.88	1.59	0.77	0.26	0.17	0.61	0.31
		LAG 6	0.85	0.23	0.88	−0.26	1.78	−0.15	0.66	0.06	0.89	0.78	1.97	0.58	0.19	0.17	0.53	0.07
Parkin & Walter (1992)	1	YOUNG	0.77	0.05	0.92	0.70	2.39	0.46	0.52	0.01	0.87	0.98	2.38	1.14	0.25	0.04	0.76	1.08
		OLD	0.66	0.10	0.87	0.65	1.69	0.44	0.20	0.01	0.79	0.99	1.49	1.59	0.46	0.09	0.80	1.24
	2	YOUNG	0.80	0.07	0.92	0.54	2.32	0.32	0.37	0.02	0.83	0.98	1.72	1.19	0.43	0.05	0.82	1.47
		MIDDLE	0.68	0.09	0.88	0.65	1.81	0.44	0.19	0.02	0.77	0.99	1.17	1.47	0.49	0.07	0.83	1.45
		OLD	0.67	0.09	0.88	0.67	1.78	0.45	0.12	0.02	0.73	0.99	0.87	1.62	0.55	0.07	0.85	1.61
Rajaram (1993)	1	ASSOC	0.86	0.16	0.91	−0.08	2.07	−0.05	0.66	0.02	0.91	0.92	2.46	0.82	0.20	0.14	0.59	0.24
		RHYME	0.62	0.16	0.82	0.53	1.30	0.34	0.32	0.02	0.81	0.98	1.58	1.26	0.30	0.14	0.68	0.56
		VISUAL	0.74	0.16	0.87	0.30	1.63	0.18	0.49	0.02	0.86	0.96	2.02	1.04	0.25	0.14	0.64	0.41
		AUDITORY	0.74	0.16	0.87	0.30	1.63	0.18	0.49	0.02	0.86	0.96	2.02	1.04	0.25	0.14	0.64	0.41
	2	PICTURES	0.90	0.09	0.95	0.06	2.62	0.03	0.81	0.01	0.95	0.92	3.21	0.73	0.09	0.08	0.53	0.07
		WORDS	0.69	0.09	0.88	0.64	1.84	0.42	0.51	0.01	0.87	0.98	2.36	1.15	0.18	0.08	0.67	0.49
	3	REP	0.67	0.23	0.81	0.24	1.18	0.15	0.43	0.05	0.82	0.92	1.47	0.92	0.24	0.18	0.58	0.21
		UNREL	0.60	0.18	0.80	0.50	1.17	0.34	0.42	0.05	0.82	0.93	1.45	0.93	0.18	0.13	0.58	0.21
Smith (1993)			0.91	0.09	0.95	0.00	2.68	0.00	0.52	0.01	0.87	0.98	2.38	1.14	0.39	0.08	0.78	1.13
Tulving (1985)	2	1D	0.86	0.17	0.91	−0.11	2.03	−0.07	0.71	0.08	0.89	0.65	1.96	0.43	0.15	0.09	0.62	0.30
		8D	0.62	0.27	0.76	0.25	0.92	0.15	0.34	0.11	0.73	0.88	0.82	0.82	0.28	0.16	0.64	0.41
Wippich (1992)	1	READ	0.41	0.14	0.74	0.80	0.85	0.66	0.17	0.02	0.76	0.99	1.10	1.50	0.24	0.12	0.66	0.47
		GEN	0.71	0.14	0.87	0.43	1.63	0.27	0.40	0.02	0.83	0.97	1.80	1.15	0.31	0.12	0.71	0.68

Note—The "Experiment" column indicates the experiments from the studies listed in the left column. The "Level" column identifies the levels of independent variable. See text for the definitions and formulas of the data presented.

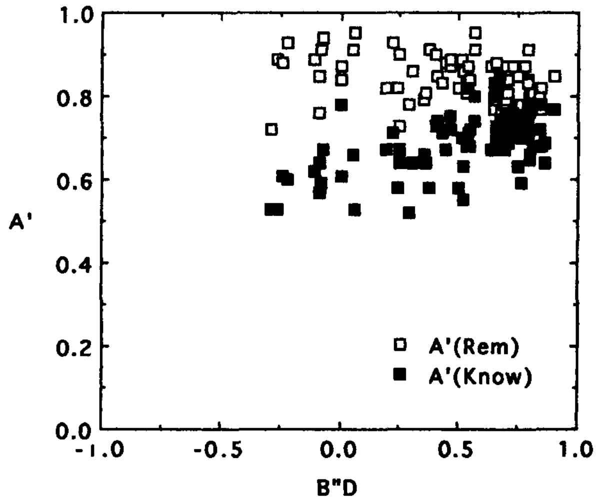

Figure 2. A'(rem) and A'(know) as a function of recognition response criterion (B''_D) for the 80 conditions in the meta-analysis (Table 1).

notation of certainty that is at odds with having just indicated a lack of certainty by saying "unsure." The response of "familiar" to designate recognition in the absence of any recollective experience seemed to be more neutral in that regard. The participants were given extensive instructions as to the use of "remember" and "familiar," including the types of examples used by Gardiner (1988). Each person was also asked to generate examples of her or his own to describe the difference, and testing did not begin until it was clear that the difference was understood. The recognition test was self-paced. A new word would appear, the participant would read it, and give a number response. If the response was zero, a touch of the space bar would clear the screen and present the next word. Any other response had to be followed by a response of either "remember" or "familiar," and then the participant pressed the space bar for the next word. Both the number response and the recollective response were recorded by the experimenter. Although participants in this study said "familiar," that category of response will continue to be identified as "know" rather than change terms in midarticle.

Results

Overall, the participants produced a hit rate of .819 (SE = .016) and a false-alarm rate of .348 (SE = .027). The hit rate was then partitioned into a remember hit rate of .523 and a know hit rate of .296. The corresponding false-alarm rates were .077 and .271.

The predictions were then examined. All the statistics are based on the yes data (i.e., combined over the three levels of confidence). The sure (+2 and +3) and very sure (+3) data will be discussed later. Furthermore, the descriptive statistics A', B''_D, d', and C were all calculated on the individual participant's hit rates and false-alarm rates and then averaged.

The first prediction was that estimates of memory should be the same whether calculated on recognition data or on remember data. The overall performance yielded A'(recog) = 0.825, and A'(rem) = 0.837. These values do not differ significantly [$t(39) = 1.484$]. The comparable d' values were d'(recog) = 1.447, and d'(rem) = 1.741, which do differ significantly [$t(39) = 4.134$, $p < .01$]. As in the meta-analysis, the d'(rem) is higher than the d'(recog), as expected if the slope of the isomemory curve is less than unity. From the confidence rating data combined over participants, a three-point isomemory curve was plotted. On a normal–normal plot, the three points fall on a straight line with a slope of 0.784. The lack of a difference in the A' values, where one was found in the meta-analysis, may be because the three points span the neutral point, thus reducing any effect that might be due to curvature of the isomemory curve.

The second prediction was that there would be a positive correlation between the placement of the recognition criterion and the amount of know memory. The correlation between A'(know) and B''_D(recog) was $r = .77$. The comparable value using d'(know) and C(recog) was $r = .81$. In contrast, the correlation between A'(rem) and B''_D(recog) was $r = -.06$; the similar value based on d'(rem) and C(recog) was $r = +.14$. Figure 3 plots A'(rem) and A'(know) against B''_D(recog). Again, recollective and nonrecollective memory performances are related to response criterion in quite different ways. The slope of the best-fitting A'(rem) relationship is -0.01; that for the A'(know) function is +0.24. The comparable values using d' are +0.20 and +1.03. Clearly, as the placement of the yes/no criterion became more liberal, A'(know) declined. Indeed, for 12 of the 40 individual subjects, the hit rate associated with a response of "know" was actually lower than the accompanying false-alarm rate. The individual A'(know) values for those below chance performances were, of course, calculated using the Aaronson and Watts (1987) formula rather than the above-chance formula.

There seems to be no question that the individual subject data show similar relationships to those in the meta-

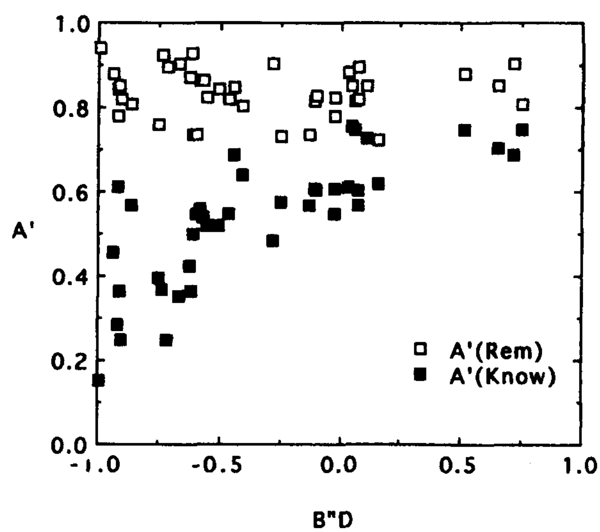

Figure 3. A'(rem) and A'(know) as a function of recognition response criterion (B''_D) for each of the 40 participants in the experiment.

analysis. Indeed, an overlay plot of Figures 2 and 3 shows those relationships to be indistinguishable. Also replicating the meta-analysis data, there was a strong correlation between remember and know hit rates (−0.84) and a nonsignificant one between remember and know A' values (−0.29). Using d' values, the correlation was −0.02.

Finally, the relationship between A'(know) and response criterion can be examined in a third way. The data of the present study included confidence ratings. While the overall yes/no data reported above show liberal responding on the part of the participants, more conservative data can be explored by looking only at responses given a confidence rating of +2 or +3. Then, even more conservative responding can be examined with only the +3 confidence rating data. A response of "very sure" is comparable to a very conservative "yes." One might then expect an examination of conservative and very conservative responding to produce A'(rem) or d'(rem) values that are unchanged from A'(recog) or d'(recog). A'(know) or d'(know) values, however, should increase from the overall recognition data to the more conservative data (+2 and +3) and then to the very conservative data (+3).

A comment is necessary before the data are presented. The A'(recog) and d'(recog) values about to be reported are slightly different from those reported earlier. This is because these values were calculated on the average hit and false-alarm rates, whereas the previous values were averages of individual subject A' and d' values. The method of calculation makes very little difference in the outcome. The overall average A'(recog), as reported earlier, was 0.825. Using the mean hit and false-alarm rates, the A'(recog) was 0.824. This is a useful comparison to have since it supports previous arguments (Donaldson, 1992) that the calculation of A' using the average hit and false-alarm rates, as was done in compiling the meta-analysis data, does not produce any serious distortion. One would prefer to calculate individual participant statistics because they then yield standard errors; however, this was not possible in examining the very confident data, because 15 of the 40 participants never used a rating of +3 in combination with a response of "know." Thus, with both a hit rate and a false-alarm rate of zero, A'(know) is undefined for those individuals, and one has to resort to using average hit and false-alarm rates to calculate the statistics.

Moving from all the yes data to sure (+2 and +3) to very sure (+3 only), A'(recog) values were 0.824, 0.840, and 0.835. Comparable A'(rem) values were 0.834, 0.835, and 0.832. No systematic differences are apparent. In contrast, A'(know) moves from 0.528 to 0.625 to 0.674 as one moves from all the data to sure to very sure responding. Confirming the relationship shown between subjects in Figure 3, more conservative within-subject responding produced higher values of A'(know). Similar comparisons using d' values are a little less convincing. As predicted, d'(know) values increase from 0.069 to 0.331 to 0.473 as the criterion becomes more conservative. However, the d'(recog) and d'(rem) values show a similar pattern. The d'(recog) values increase from 1.301 to 1.434 to 1.566, and the d'(rem) values increase from 1.488 to 1.529 to 1.602. This parallels the relationship found with the individual subject calculations as well and is presumably because the slope of the isomemory curve is less than unity.

Thus, the different relationships between yes/no response criterion and remember and know memory performance have been demonstrated in three very different ways. The meta-analysis shows the different effects across experiments. The present data replicate the meta-analysis effects between participants who adopted different criteria. And finally, the present data show the same effects within participants as each adopted different criteria through the use of confidence ratings.

The simple model accounts for the broad characteristics of the data well. The critical factor in the model is the placement of the decision criterion for responding "yes" or "no." But if the analysis is correct, the distinction between remember responses and know responses simply involves a second decision criterion. The model can gain considerably more power if the placement of that second criterion is also considered. Just as the yes/no criterion can range from conservative to liberal, so too can the remember/know criterion, at least above its lower bound set by the yes/no criterion. Thus, if the yes/no criterion is a conservative one, as in the top panel of Figure 1, there is little freedom of movement for the remember/know criterion since it must remain to the right of the yes/no criterion. If the yes/no criterion is very liberal, however, the remember/know criterion can range from liberal to conservative. In the liberal case, a person would identify more of their yes responses as remember; in the conservative situation, more yes responses would be classified as know. Just as people can be more or less willing to say that they recognize a word, so they can be more or less willing to say that they remember it.

The bottom panel of Figure 1 shows a liberal placement of both criteria. With the criteria in those positions, the know hit rate would be lower than the false-alarm rate, and A'(know) would be below chance. Were the no/yes criterion to remain in its liberal position and the remember/know criterion to be shifted to the right (i.e., made more conservative), the values of both the know hit rate and false-alarm rate would rise, though the hit rate would rise more rapidly, and A'(know) based on those values would rise as the remember/know criterion became more conservative.

Such a result can be seen in the present data. On the left side of Figure 3, there are data points from 7 people with very liberal yes/no criteria. These are the 7 black squares for A'(know) that are approximately in a column, all having B''_D(recog) values more extreme than −0.85. The A'(know) values themselves, however, range widely from 0.15 to 0.61. A measure of the remember/know criterion placement, B''_D(rem) can be calculated for each of those 7 participants by using each person's remember hit rate and remember false-alarm rate, in the B''_D Formula 2. Those values for the 7 people range from a liberal value of B''_D(rem) = −0.13 up to a fairly conservative B''_D(rem) =

0.73. While those 7 people were all very liberal in their yes/no decisions, they varied tremendously in their willingness to say "I remember." The correlation between each person's B''_D(rem) value and his or her A'(know) value was +0.77. Thus, A'(know) is heavily dependent on the placement of the remember/know criterion as well as on the yes/no criteria.

Discussion

Two issues need to be raised in discussion, and both concern what is *not* intended in this article. First, I am not suggesting that the use of appropriate measures, such as A', saves the remember/know paradigm as generally useful for exploring recollective and nonrecollective memory. I do not believe it is useful. Second, I am not claiming that there is no distinction to be made between recollective and nonrecollective memory, only that this introspective technique fails to capture the distinction. These points will be discussed in turn.

Many of the characteristics of the data obtained in experiments where participants are asked to introspect about whether they can recollect encoding details appear to be well handled by a signal detection type of model. I would suggest that such an analysis is necessary since hit rates alone are not good measures of memory (Snodgrass & Corwin, 1988). But just as hit rates based on knowing must be rejected as good measures of nonrecollective memory, so too must values such as A'(know) or d'(know). A' based on know responses as plotted in Figure 3 and shown in Table 1 is not a measure of nonrecollective memory. Indeed, it is not a measure of memory at all. The logic of signal detection theory does not handle areas between different criteria in this way. In the context of such a model, it is clearly inappropriate to identify nonrecollective memory with the hit rates or the A' or the d' values associated with a response of "know." The data clearly show that such measures are not independent of response criteria. It makes no sense to talk about nonrecollective memory that is below chance. To borrow an understatement from Jacoby et al. (in press), the demonstration that new items are more familiar than old items is not a very reasonable pattern of results.

The analyses presented here assume only a single underlying mnemonic continuum and, thus, do not include any distinction between recollective and nonrecollective memory states. But to deny that people can sometimes recollect encoding details, or that there are occasions when they cannot, would be silly. It is the case, however, that many of our experiments are ones in which nondistinctive material is presented quickly under shallow encoding instructions, all conditions that minimize the chances of encoding rich, recollectible details. The present experiment was certainly of that sort, and if recollection is a relatively rare, or weak, event in our experiments, then it is not surprising that a model that ignores recollection fits well.

There are, however, some findings in the literature that the model cannot handle, and these outcomes may point to situations where the remember/know task does detect real recollection rather than just variations in response criteria. For example, Parkin and Walter (1992) reported data on the recollective experiences of older participants (see Table 1). The anomaly here, particularly noticeable in Experiment 2, is that the middle-aged and older participants show higher values of A'(know) than of A'(rem). Even noting the extremely conservative placement of the remember/know criterion (i.e., the unwillingness of these people to say "remember"), there is no obvious way for the model to account for the lower values of A'(rem). If these values really do reflect recollection, however, it is also unclear why they are so very much lower than the overall recognition performance. The first prediction of the model was that measures based on remembering and those based on overall recognition should not differ. If this is a case where saying "remember" is really restricted to recollective experiences, one might expect memory to be better than the composite rather than worse.

As a second example, Dewhurst and Conway (1995, Experiment 3; see Table 1) show identical overall performance on pictures and words but different recollective hit rates and, consequently, different A' values for recollective memory. If the overall old-item distributions for pictures and words do not differ, how can a criterion be set to partition them differently? There is no obvious way for the model to handle different recollective hit rates derived from overall recognition performances that do not differ. The elaborate encoding processes required in that experiment may have produced a substantial proportion of items that could be recollected. On the other hand (and I thank Doug Hintzman for this observation), the elaborate encoding has produced performance that is almost perfect, and, with hit rates at the ceiling and false-alarm rates on the floor, the data may not be useful for testing any model.

So we are left with the idea that the distinction between recollective and nonrecollective memory may be worth preserving but that it is not captured with the remember/know procedure. How might the distinction be measured? Jacoby et al. (in press) suggest that remember/know responses might be more reasonably handled under what they identify as an independence assumption. An analysis of their procedures is beyond the scope of this paper, but the relationship between their analysis and this one is worth noting. By their procedure, familiarity-based hit rates and false-alarm rates must be adjusted to take into account the likelihood that items given a remember response are also familiar. Thus, they are adjusted by dividing each by one minus the proportion of items assigned a remember response. Figuratively, memory based on knowing is handled as in Figure 4. The remember portions of the distributions are eliminated and the remaining distributions are "rescaled" so that the area remaining under each distribution is unity. The area under the truncated Distribution A is unity, as is that under the truncated Distribution B. Thus, the nonrecollec-

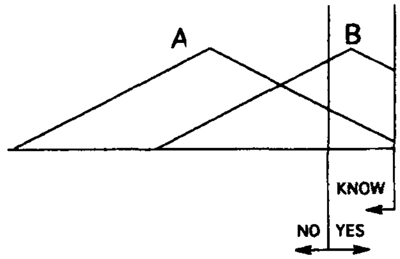

Figure 4. Schematic diagram showing the reanalysis of know responses under the Jacoby et al. (in press) independence assumption. See text for details.

tive hit rate (Jacoby's IRK hit rate, IRK standing for *independent remember know*) becomes the area to the right of the no/yes criterion under Distribution B, and the nonrecollective false-alarm rate becomes the area to the right of the criterion under Distribution A. Those two values can then be combined into an A'(know) or a d'(know) value.

For the record, the know data from the present experiment were reanalyzed in that way. Whereas the A'(know) values calculated on raw know data were significantly correlated with both the no/yes and the familiar/remember criteria, the A'(know) values calculated on the hit and false-alarm rates corrected on the independence assumption were not significantly correlated with either. The lack of significant correlations is the first step toward the suggestion that the memory and criterion measures are independent. Finally, the mean IRK corrected A'(know) was 0.750, to be compared with the A'(recog) of 0.825 and the A'(rem) of 0.837. It remains for more extensive analyses to determine whether it is necessary to consider recollective memory as a separate, suprathreshold state, whereas nonrecollective memory functions on a familiarity continuum with decision criteria.

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