14

RECOGNITION MEMORY RESPONSE BIAS IS CONSERVATIVE FOR PAINTINGS AND WE DON'T KNOW WHY

D. Stephen Lindsay, Justin Kantner, and Kaitlyn M. Fallow

Foreword by Steve Lindsay

I became a Jacobean under the influence of Colleen M. Kelley, who had just returned to Williams College from a year's sabbatical with Larry (at McMaster) when I started at Williams in 1987. Colleen and I immediately began collaborating on research inspired by the ideas so beautifully articulated in Jacoby, Kelley, and Dywan's (1989) chapter on an attribution-making approach to the subjective experience of remembering. Subsequently, I followed in Colleen's footsteps and spent an extraordinary year in Larry's lab (1990–91, essentially a delayed postdoc). It was an intense and transformative experience. Larry was generous with me in every way, giving me lots of his time, feeding me research lines, offering me co-authorships, and writing very kind letters on my behalf that doubtless played a huge role in me landing the job at the University of Victoria that I continue to enjoy today. I am very greatly in Larry's debt.

Introduction

Our aims in this chapter are (a) to establish the empirical observation that undergraduate subjects tend to be conservative when recognizing colour digital reproductions of paintings and (b) to describe our efforts to discover the cause(s) of this bias. To anticipate, we have tested two explanations and found support for neither of them.

Background

On an old/new recognition memory test, subjects may demonstrate a liberal bias (higher false alarm than miss rate), a conservative bias (higher miss than false alarm rate), or no bias (equivalent false alarm and hit rates). The literature on response bias in recognition memory is not vast, but it is scattered across a number of decades and recently has begun to grow apace (see Hockley, 2011, for a brief yet thoughtful review). Due to space constraints, here we will restrict ourselves to the barest thumbnail sketch.

In early applications of signal detection theory (SDT) to recognition memory, response criterion was described in terms of the likelihood ratio (LR) of hits and false alarms; with equal old/new priors and equal payouts the optimal criterion is an LR of 1. Consistent with that approach, researchers demonstrated effects of payoff matrices and of the proportion of studied (old) versus nonstudied (new) test items on response bias (e.g., Thomas & Legge, 1970). More recently, Estes and Maddox (1995) offered a formal model of response bias (see also Starns, Ratcliff, & White, 2012). Watkins and Peynircioglu (1990) discovered a phenomenon they termed the revelation effect, in which requiring subjects to do extra cognitive work to reveal a test probe creates a liberal bias toward endorsing that probe, old or new. Response bias has also been invoked in explorations of mirror effects, in which manipulations that increase hit rates for a class of items also tend to reduce false alarm rates for items in that class (Glanzer & Adams, 1990). For example, compared to high-frequency words, low-frequency words produce higher hit rates and lower false alarm rates; according to one account the higher hit rate is due to deeper processing of low-frequency than high-frequency words at study and the lower false alarm rate is due to subjects having high expectations of the memorability of low-frequency words ("If I'd seen that odd word I'd surely have a clear memory of it") (but see Wixted, 1992). It is likely that recognition memory response bias arises from multiple processes and mechanisms.

Over the last decade or so there has been some debate about the extent to which subjects can shift response bias from trial to trial as a function of item differences. Some results suggest that subjects set a response criterion at the beginning of a recognition memory test and stick with that criterion throughout the test. For example, Morrell, Gaitan, and Wixted (2002) strengthened memory for exemplars of one category (e.g., professions) relative to another (e.g., locations). Strengthened category exemplars enjoyed a higher hit rate, but false alarm rates were equivalent for foils from the two categories, suggesting that subjects used the same response criterion for the two types of items. In contrast, some findings indicate that subjects can change response bias more flexibly. Rhodes and Jacoby (2007) found that when subjects received accuracy feedback on a yes/no recognition memory test they could shift criterion on an item-by-item basis. Items presented in one screen location had a high probability of being old, those in another had a high probability of being new, and subjects adjusted appropriately, although this depended on awareness of the difference in base rates by location and feedback; knowing about the base-rate manipulation without receiving feedback did not affect response bias. Han and Dobbins (2008) showed that false feedback during recognition tests can shift response criterion, and Kantner and Lindsay (2010) found effects of accuracy feedback on response criterion. Singer and colleagues reported several experiments in which subjects apparently modulated response criterion for items in different categories on an item-by-item basis at test. They also cited earlier evidence of "concordant" effects in which manipulations that increase hits also increase false alarms (Singer, 2009; Singer, Fazaluddin, & Andrew, 2013; Singer & Wixted, 2006; see also Dobbins & Kroll, 2005).

Lindsay and Kantner (2011) stumbled across an effect of materials on response bias while testing the hypothesis that giving subjects trial-by-trial accuracy feedback on a yes/no recognition memory test would enable them, over the course of the test, to become better at discriminating old items from new items. In our typical experiment, we presented words one at a time and later presented a 50/50 mix of old and new words one at a time for confidence-weighted recognition judgments. Half of the subjects were told, after each recognition response, the correct response to that item. To the extent that strategic processes contribute to a regulated recall-like process during recognition and/or to the evaluation of information that comes to mind in response to probes (e.g., Jacoby, 1972; Jacoby, Shimizu, Daniels, & Rhodes, 2005; Johnson, 2006; Lindsay, 2008), one might expect that subjects could use trial-by-trial accuracy feedback to fine-tune those strategic processes and inferences, such that they would gradually become more accurate. If so, then by the end of the test, subjects who received feedback would be more accurate than those who did not. We tried many different ways to obtain such an effect, without success (see Kantner & Lindsay, 2010, for a phalanx of null effects).

In a conversation about those null results, Bruce Whittlesea speculated that undergrads may be optimized on old/new recognition for words. Bruce recommended that we try using richly complex and structured but very unfamiliar stimuli. He thought that with such materials subjects might find their responses to test probes ambiguous (e.g., is that music melodic, or is it familiar?) and consequently might benefit from feedback in tuning in on reliable indicators of oldness. The idea is that responses to test probes are multi-dimensional and complex, with some being more diagnostic of old/new status than others; thus with materials from an unfamiliar domain subjects may find their own responses to test probes ambiguous and therefore benefit from feedback. Lindsay and Kantner (2011) reported five experiments with traditional Korean melodies, five with snippets of poetry, and six with paintings. These were all of the experiments we had conducted with those three types of stimuli.[1] The Korean melodies were 10-s audio clips of music that, to Western ears, sounds oddly instrumented and structured. The poetry was snippets of poems by Rilke (e.g., "The walls, with their ancient portraits, glide away from us, cautiously, as though they weren't supposed to hear what we are saying."). The paintings were large, high-resolution digital scans of little-known masterwork paintings with a wide variety of subject matters and in a wide range of styles (portraits, landscapes, still-lifes, abstracts) selected from a large set created by Jeffrey P. Toth. In each experiment, subjects studied a set of items presented one at a time and later completed a recognition test in which equal numbers of studied and nonstudied items were presented one at a time in a random order for responses on a scale from 1 = "definitely new" to 6 = "definitely old."

The results of those experiments with regard to the anticipated effect of feedback on discrimination were inconsistent. Perhaps there is a small effect of feedback and our experiments lacked sufficient power to yield it consistently, or perhaps there is no effect and we just got a few Type-I errors.[2] A meta-analysis across the 16 experiments reported by Lindsay and Kantner (2011) yielded mean estimates of d' in the feedback and control conditions that differed by 1/1000th of a point.

Although our interest focused on sensitivity, for completeness' sake we also calculated C (a measure of response bias; values less than 0 represent liberal responding such that the false alarm rate exceeds the miss rate, whereas values greater than 0 indicate conservative responding such that the miss rate is greater than the false alarm rate).[3] Figure 14.1 displays three forest plots summarizing the data from Lindsay and Kantner (2011), one for each type of stimulus materials (Korean melodies, poetry, and paintings). These figures were made with Geoff Cumming's ESCI program.[4] The mean C for each group of subjects is represented by a square; higher power is represented by larger squares, and the error bars around each box represent the 95% confidence interval around the mean. Dark squares represent groups of subjects who received feedback, light squares those who did not receive feedback, and the grey diamond at the bottom of each plot represents the estimated mean from a meta-analysis of all of the groups tested with those materials (with the width of the diamond indicating the precision of the estimate, equivalent to a confidence interval). Subjects evidenced a striking tendency to be conservative. For Korean melodies and poetry, conservative response bias was observed only in the presence of accuracy feedback, whereas for paintings the tendency to be conservative was robust and sizeable regardless of the presence or absence of feedback. Subjects who had studied and were tested on paintings much more often erred by saying "No" when they should have said "Yes" than by saying "Yes" when they should have said "No." That is, miss rates tended to be higher than false alarm rates.

These observations inspired us to undertake head-to-head comparisons of response bias on paintings versus words. Figure 14.2 depicts the results of two between-subjects experiments. In these, some subjects studied and were tested on words, others on paintings. There were 96 studied items (plus two primacy and two recency buffers), presented one at a time. The test consisted of the studied items randomly intermixed with new items, presented one at a time for 6-point, confidence-weighted old/new judgments. Assignment of items to old/new status was randomized anew for each subject, as was stimulus order at study and test. As can be seen in Figure 14.2, on average subjects tested on words evidenced no response bias (as in Lindsay & Kantner's [2011] studies), whereas subjects tested on paintings tended to respond conservatively.

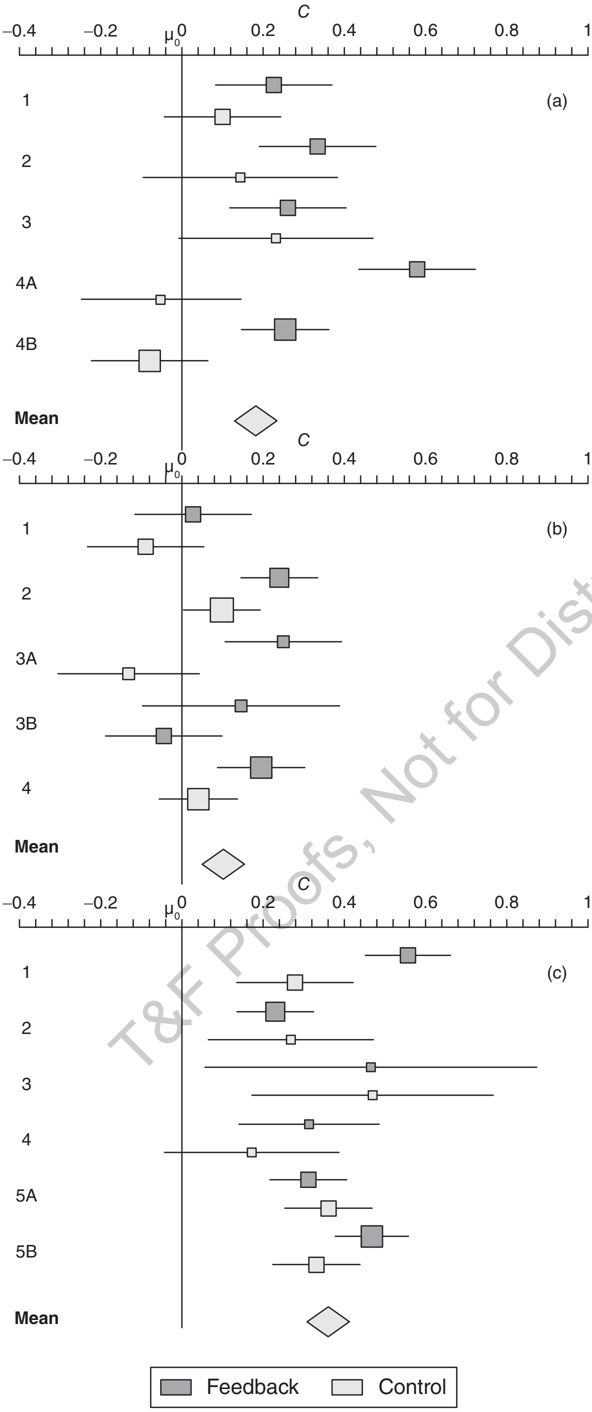

FIGURE 14.1 Forest plot of response bias (*C*) for Lindsay and Kantner's (2011) recognition memory experiments conducted with (a) poetry, (b) Korean melodies, and (c) paintings.

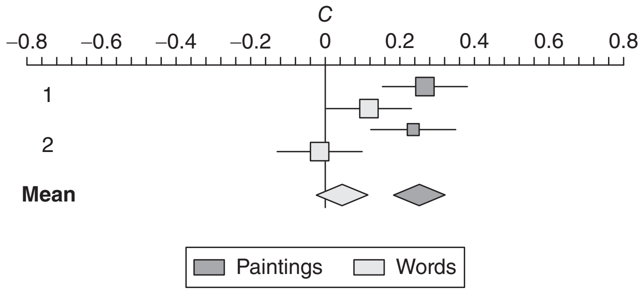

FIGURE 14.2 Forest plot of data from two between-subjects experiments estimating *C* for paintings versus words.

We also conducted nine experiments in which subjects studied a mixture of words and paintings (around 48 of each, presented one at a time in a newly randomized order for each subject), performed a brief filler task, and then completed a test in which equal numbers of studied and non-studied stimuli of each type were presented one at a time (in a newly randomized order) for confidence-weighted old/new judgments. Data from those studies are presented in Figure 14.3. Two findings are strikingly evident. Of primary interest, subjects tended to be conservative on paintings. That effect was statistically significant in every study. Secondarily, response bias on words tended to be liberal. That liberal tendency contrasts with the neutral response bias observed among subjects who studied and were tested on words in the between-subjects studies shown in Figure 14.2. We speculate that the tendency to be liberal on words in the within-subjects design is an artifact of subjects' reluctance to endorse paintings; that is, because they so often say "No" to paintings, they compensate by saying "Yes" to words more often than they otherwise would. Arguably consistent with that speculation, it appears that the tendency toward conservatism on paintings was even greater in the within-subjects design than when subjects studied and were tested on paintings alone. In any case, the main point for present purposes is that subjects were markedly conservative on paintings.

The tendency toward conservativeness on paintings was largely if not completely independent of accuracy on words versus paintings. For one thing, bias was conservative (i.e., more misses than false alarms) even when subjects studied and were tested on paintings alone, without any comparison set of stimuli (Figures 14.1 and 14.2). For another, as shown in Figure 14.4, the tendency toward conservativeness on paintings was observed in studies in which discrimination was better on paintings than on words, studies in which discrimination was better on words than on paintings, and studies in which discrimination was equivalent for the two types of stimuli. (We modulated discrimination on paintings versus words across studies in part via item selection and in part via orienting tasks.) The graphs in Figure 14.4 are receiver operating characteristics (ROCs). The left-most point in each function represents the hit and false alarm rates when restricted to the highest level of confidence (i.e., responses of 6 to old and

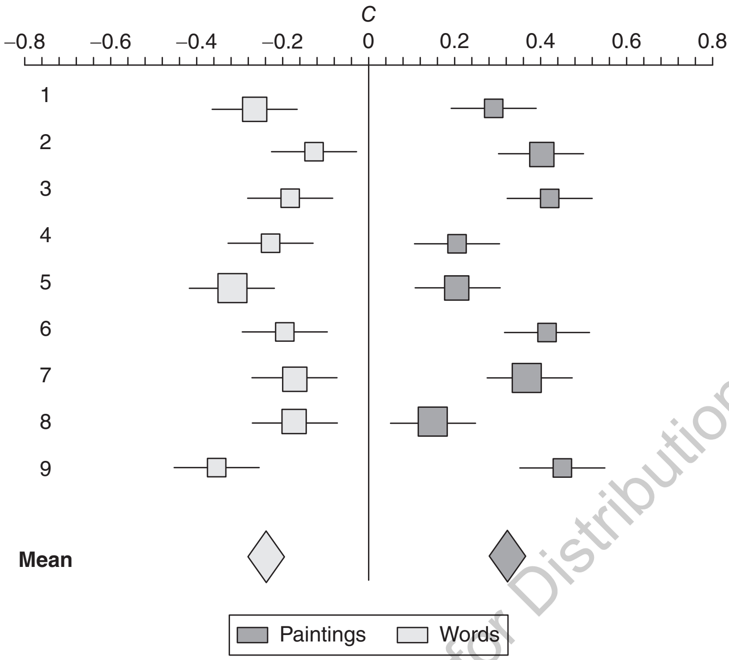

FIGURE 14.3 Forest plot of estimates of response bias (*C*) for recognition of paintings and words from nine within-subjects experiments in which subjects studied and were tested on mixtures of both types of items.

to new items); the next point represents the hit and false alarm rates when restricted to the two highest levels (5 or 6), and so on, such that the right-most point represents responses of 2, 3, 4, 5, or 6 (i.e., anything but "sure new") to old and new items. Curves farther above the diagonal represent better old/new discrimination. The important point to note is that, at each level of confidence, points are directionally lower and more leftward for paintings than for words. Finally, in the five studies with paintings reported by Lindsay and Kantner (2011), *C* and *d*′ were not significantly correlated across subjects in four of them, although they were in the fifth ($r(113) = .19$, $p = .045$) and in an analysis collapsing across the five experiments ($r(233) = .18$, $p = .006$). As shown in Figure 14.5, subjects with particularly high *d*′ scores were particularly likely to be conservative, but the more general point was that across the entire range of *d*′ values participants were much more likely to be conservative than to be neutral or liberal in their recognition of paintings.

Is it merely that subjects had rarely if ever seen these paintings before and hence the paintings were less familiar than the common words we used in these studies (cf. Hirshman, 1995)?[5] Lower familiarity of new and studied paintings relative to new and studied words could masquerade as conservativeness on paintings on a test of recognition of both kinds of stimuli if a common response

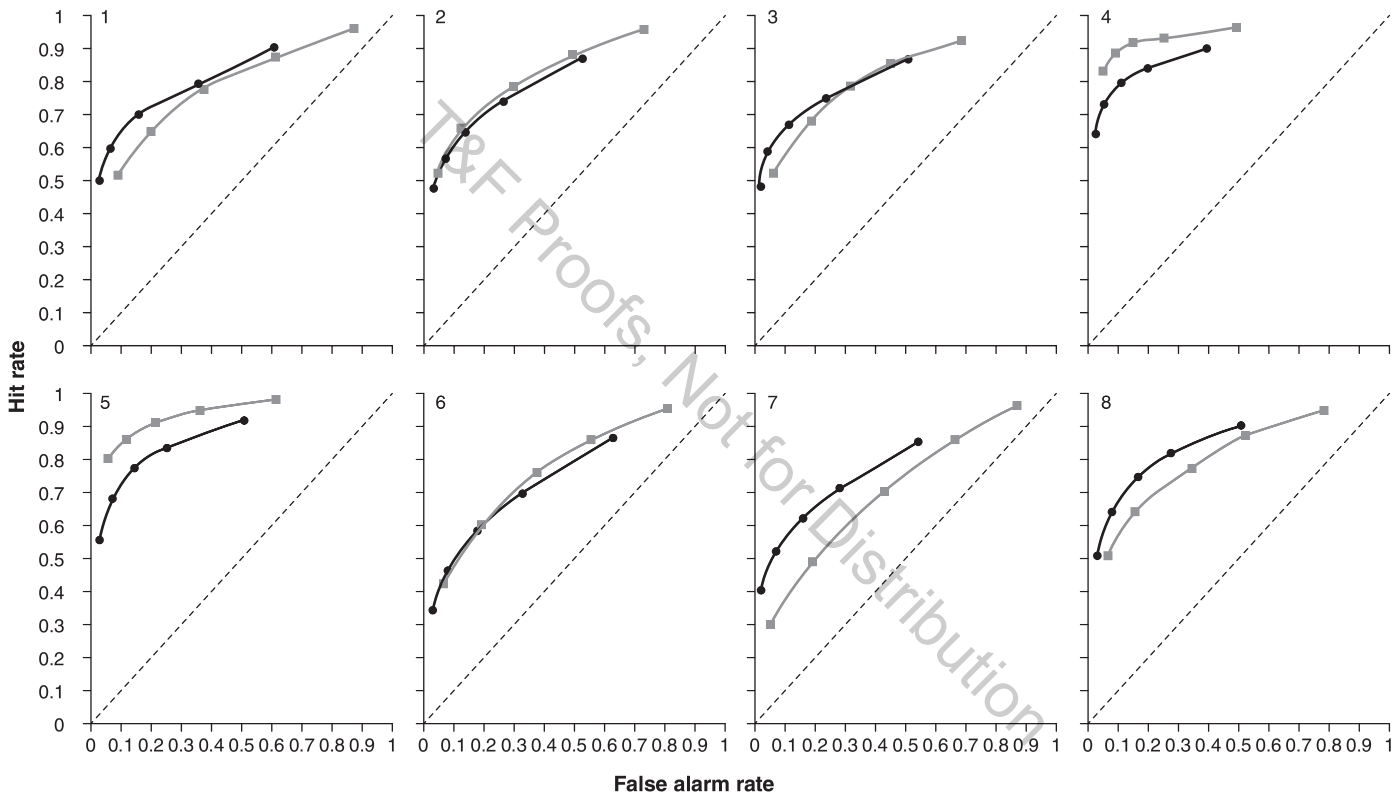

FIGURE 14.4 ROC curves from eight within-subjects comparisons of response bias on paintings (black) versus words (grey).

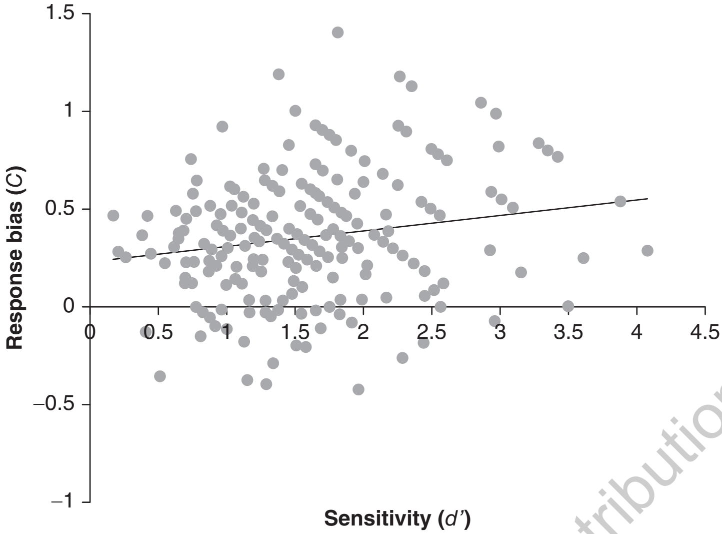

FIGURE 14.5 Scatterplot depicting the relationship between *C* and *d´* in the five studies of painting recognition reported by Lindsay and Kantner (2011).

criterion was used. That is, the presence of a higher-familiarity category of stimuli (words) might reasonably be expected to lead to a response criterion greater than the intersection of the new and old distributions of the lower-familiarity category of stimuli (paintings). But this account seems unsatisfactory for two reasons. First, conservativeness was observed on paintings even when they were the sole type of material, whereas low familiarity can masquerade as conservatism only when a higher-familiarity category of items are also present. Second (see note 1), Lindsay and Kantner (2011) conducted feedback-recognition experiments with other sorts of unfamiliar stimuli such as Chinese characters and faces, and we observed that average response bias was neutral on those stimuli (but conservative on one-liners). We have not undertaken a systematic review but informal forays into the published literature on recognition memory for richly complex and novel or very low-familiarity stimuli yielded some studies in which bias was conservative, some in which it was neutral, some in which it was conservative, and many in which bias was not reported. There is a large literature documenting an effect of word-frequency on recognition, but there the pattern is typically a mirror effect (i.e., compared to high-frequency words, low-frequency words have lower false alarm rates and lower miss rates), not a bias effect. Collectively, these considerations led us to reject the idea that the tendency to be conservative on paintings is caused by their low familiarity.

So why did our subjects tend to be conservative when recognizing paintings? Our initial hunch was that they had unrealistic expectations as to the memorability of paintings (subjective memorability; Brown, Lewis, & Monk, 1977; Bruno, Higham, & Perfect, 2009; Zimmerman & Kelley, 2010; cf. Schacter, Israel, & Racine's, 1999, distinctiveness heuristic). The painting stimuli are impressively rich, distinctive, and evocative, and perhaps this led subjects to expect that they would have strong and clear recognition responses to studied paintings, stronger than in fact they had.

In four of the within-subjects experiments reported above (with *N*s from 38 to 84), subjects predicted, after the study phase, how well they would recognize paintings and how well they would recognize words on the forthcoming recognition test. The bottom line is depicted in Figure 14.6, a scatterplot collapsing across the four studies. The ordinate represents the difference in *C* for paintings versus words; points below the line represent subjects who were more conservative on words than paintings, whereas those above the line represent subjects who were more conservative on paintings than words. The abscissa indicates subjects' predicted recognition of paintings versus words; points to the right represent subjects who thought they would have better recognition memory for paintings, whereas those to the right represent those who predicted better recognition for words. As expected, most subjects were more

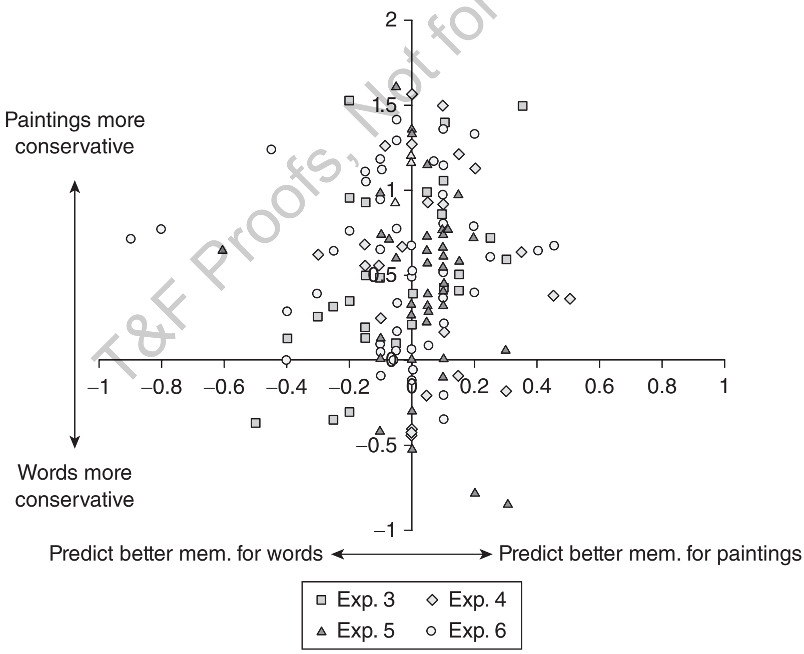

FIGURE 14.6 Scatterplot of the relationship between (a) the difference in subjects predictions, right before the test, as to their ability to recognize paintings versus words and (b) the difference in response bias (*C*) on paintings versus words. The figure depicts data from four experiments.

conservative on paintings than words. Contrary to our prediction, however, subjects did not consistently tend to predict better memory for paintings. Moreover, there was no relationship between the two measures; collapsing across the four studies, r = .037, 95% CI [−.095, .168].

Another speculation regarding the cause of conservativeness on paintings was that subjects may more often have noticed, during the study phase, that a painting reminded them of a previously studied painting than that a word reminded them of a previously studied word (Hintzman, 2011). Some paintings were related to other paintings in various ways (e.g., in some cases, there were two or three paintings by the same artist; in others, there were two or more paintings of highly similar subjects). Of course, some words were related to other words in various ways and so it is likely that reminding happened with words as well as with paintings, but we speculated that subjects were more likely to be aware of being reminded by paintings. That is, having a previously studied painting pop to mind in response to a study item is a salient experience. Perhaps noticing that paintings often reminded them of other paintings led subjects to think that the paintings were confusable and hence led them to be cautious about endorsing familiar paintings at test. To assess this idea, we presented a mixture of words and paintings for study and asked subjects to press the space bar if a study item reminded them of a previously presented study item. They were not prompted to make this judgment trial by trial (because we were attempting to index the occurrences of *spontaneous* reminding).

The data from the reminding experiment are presented in Figure 14.7. This scatterplot is laid out in the same way as Figure 14.6, except that the

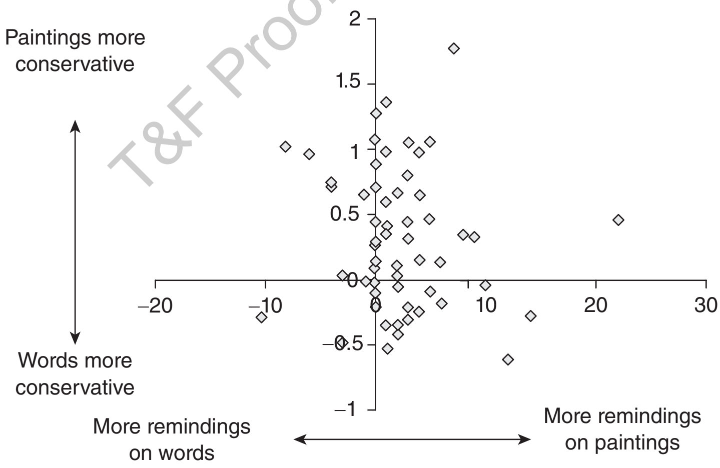

FIGURE 14.7 Scatterplot of the relationship between (a) the difference in subjects' rate of reporting that a study stimulus spontaneously reminded them of a prior study stimulus for paintings versus words and (b) the difference in response bias (C) on paintings versus words.

abscissa represents the difference in the frequency of reported remindings for paintings versus words. As in all of the preceding studies, response bias was more conservative on paintings than on words. As predicted, reports of reminding were substantially more common on paintings (mean frequency of 5.02, 95% CI [4.10, 5.94]) than on words (3.00, 95% CI [2.08, 3.92]). But, contrary to expectations, these two variables were not related, $r = -.108$, 95% CI [−.354, −.152]).

The reminding measure probably underestimates the frequency with which subjects noticed that one stimulus reminds them of another, because subjects must also be meta-aware of being reminded and remember that they are supposed to report the occurrence of such reminding (Smallwood & Schooler, 2006). In a final experiment, we took a different tack to assessing the idea that subjects believed the paintings to be more confusable with one another than the words. Subjects studied a mix of words and paintings (half of them were asked to report spontaneous reminding; as in the preceding experiment, those subjects much more often reported reminding on paintings than on words but the size of that difference was unrelated to response bias on the test so we combine those two groups here). At test, subjects selected from four response options for each test probe:

1 "This item was on the list."
2 "This or an item very much like this was on the study list, not sure which."
3 "An item very much like this was in the study list, but this item was not."
4 "Neither this nor an item very much like this was in the study list."

The data are shown in Figure 14.8. Once again, subjects were more conservative on paintings than on words, regardless of whether responses of "2" were categorized as "Yes" or "No." The new prediction was that the second and third response options (i.e., the options that refer to studied items similar to the test probe) would more often be used in response to paintings than words. No such tendency was observed. These results seem to us to conform with those of the preceding experiment in failing to support the hypothesis that conservative bias on paintings has to do with subjects perceiving the paintings as confusable.

Future Directions

When these experiments were presented at LarryFest, Janet Metcalfe proposed that it may be that paintings (and Korean melodies and poetry) engage "hot cognition" (Metcalfe & Jacobs, 1998) and that hot cognition may engender conservativeness in undergraduates. This is an interesting idea (and is consonant with our observation that low-familiarity, complex but seemingly rather "cool" stimuli such as Chinese characters do not appear to inspire conservative recognition response bias). There are a variety of ways this could be explored (e.g., physiological measures such as

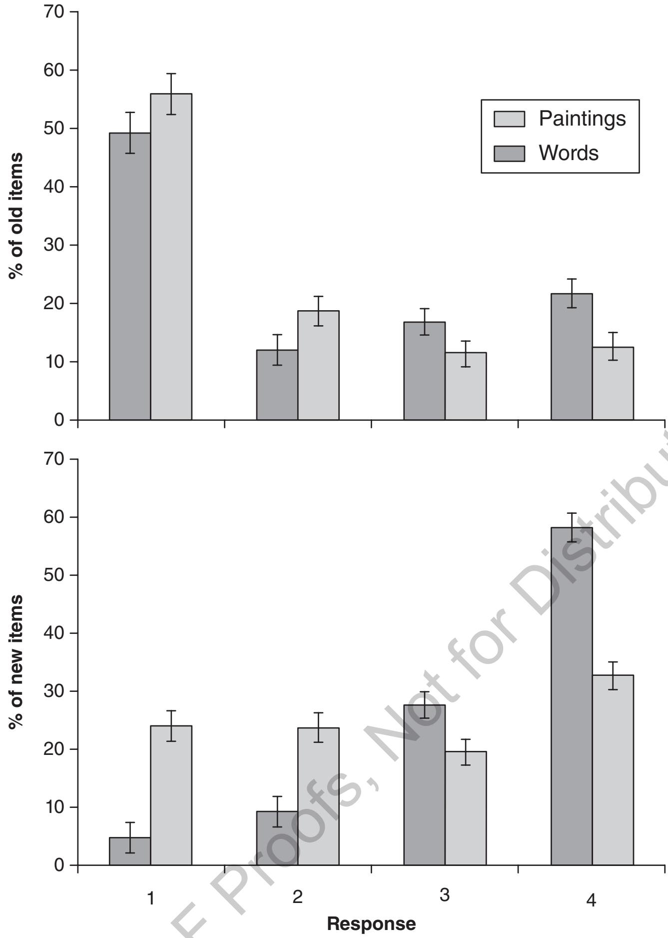

FIGURE 14.8 Bar graph of the percentages of paintings and of words on which subjects made each of the four recognition responses in Experiment 9: 1 = this item studied; 2 = either this item or a similar one studied; 3 = a similar item but not this item studied; 4 = neither this nor a similar item studied. The upper figure is for studied items, the lower figure is for new items. Error bars represent 95% within-subjects confidence intervals for the paintings versus words comparison, calculated as per Masson and Loftus (2003).

galvanic skin response or heart rate, ratings of arousal). But informal perusal of prior literature on recognition memory for stimuli that might be expected to inspire hot cognition does not seem to support this idea. Indeed, the studies we have come across suggest that, if anything, response bias tends to be liberal for emotional items. For emotionally negative stimuli, this liberal response bias is remarkably consistent among young adults. Dougal and Rotello (2007, p. 423) wrote "Our survey of the literature revealed that all studies show consistent changes in response bias with emotion." The picture looks less consistent for positive stimuli, but our impression is that those tend to come out neutral or slightly liberal, not conservative. These findings pour cold water on the hot cognition explanation of conservative response bias for paintings.

Andy Yonelinas (personal communication, April 2013) suggested that recollection may play a bigger role in recognition judgments for paintings than for words. That is, perhaps subjects are more willing to endorse word probes as old solely on the basis of familiarity, whereas they tend to require recollection to accept a painting as old. One question that we hope to explore further is the extent to which our data (e.g., shape of ROC and zROC functions) support that possibility. We are just now beginning studies to test the question empirically by asking subjects to follow their yes/no recognition judgments with remember/know judgments. If these efforts yield evidence that subjects do emphasize recollection as a basis for recognizing paintings over words, then another question is *why* recollection would play a bigger role in recognition decisions regarding paintings than for those regarding words (especially given that subjects did not predict better recollection for paintings than for words).

Informal comments subjects volunteered during debriefing suggest to us that, sensibly enough, recognition decisions about paintings often had to do with visual details (shapes, colours, objects), whereas recognition decisions about words usually had to do with semantics. It might also be that subjects sometimes used particular visual details as a basis for rejecting test probes (e.g., "I didn't think any of the paintings included an American flag like this one does, so I'll say 'No'."). Perhaps recognition judgments are better described by a two-high-threshold model of decision making rather than an SDT model (e.g., Bröder, Kellen, Shültz, & Rohrmeier, 2013), and maybe that is especially true when stimuli provide rich bases for rejecting (as well as for accepting) items (cf. Cox & Shiffrin, 2012; Mewhort & Johns, 2013). In future work we plan to use think-aloud protocols to explore the strategies subjects use to make recognition decisions about paintings and words.

Most subjects were conservative on paintings on average, but item analyses revealed considerable variability across paintings, with different paintings associated with more versus less conservative response bias and a minority of paintings giving rise to a liberal response bias. It seems likely that the response bias associated with a particular painting would be greatly affected by the nature of the other paintings in the set. Nonetheless, further analyses of these item effects may provide insight into the causes of the general tendency toward conservative responding when recognizing paintings. Kantner and Lindsay (2012) marshalled evidence that there are individual differences in response bias, a sort of cognitive trait, and there may also be individual differences in the effects of materials on recognition response bias. Inspired by a question of Jim Nairne's at LarryFest, we are also exploring changes in response bias for paintings as a function of position on the test.

Summary/Conclusion

Why our subjects have tended to be conservative when recognizing paintings is an engaging intellectual puzzle. So far the solution has eluded us, making it all the more fun. Of course, if materials-based bias effects were restricted to paintings, studying them would be a quixotic undertaking. But, as noted earlier, we observed conservative response bias on Korean melodies and on poetry clips (although only when trial-by-trial accuracy feedback was provided at test) and Singer et al. (2013) reviewed evidence for a number of concordant effects, in which manipulations of materials affected hits and false alarms in the same direction (i.e., affected response bias). Yet as we noted earlier there are other cases in which manipulations of materials produce mirror effects (i.e., have opposite effects on hits vs. false alarms). Understanding how and why response biases are affected by materials will help us understand the basic mechanisms underlying those biases. And recognition memory response biases matter—they have consequences for behaviour that can be life-altering (e.g., a security officer failing to recognize a known terrorist). Moreover, improved understanding of recognition memory response bias may also inform theorizing regarding other sorts of target-detection tasks (e.g., medical diagnosis).

Acknowledgment

We thank Ian Dobbins and Colleen M. Kelley for extremely thoughtful and helpful comments on an earlier version of this chapter.

Notes

1 We also did some feedback recognition experiments with Chinese characters, faces, and one-liners, but those never yielded significant effects of feedback so we did not pursue them. Looking back at those data sets, we see that response bias tended to be conservative for one-liners but roughly neutral for Chinese characters and faces.
2 To sharpen your intuitions of how wildly variable *p* values are when power is not high, watch Geoff Cumming's brilliant YouTube video, *Dance of the p values,* at tiny.cc/dancepvals.
3 We used *C* because it is easy to calculate and understand and is well known. *C* is imperfect, however, in that its calculation assumes that the old and new distributions have equal variances and typically the variance of the old distribution is greater than that of the new distribution (e.g., Ratcliff, Sheu, & Gronlund, 1992). As converging evidence for our claim that bias tends to be conservative on paintings, we provide ROC plots that show that with paintings the hit rates tend to be lower than the correct rejection rates.
4 Available free at http://www.latrobe.edu.au/psy/research/projects/esci.
5 Across these studies, we excluded data from a few subjects who reported having high expertise with paintings.

References

Bröder, A., Kellen, D., Schütz, J., & Rohrmeier, C. (2013). Validating a two-high-threshold measurement model for confidence rating data in recognition. *Memory, 21*(8), 916–944. doi: 10.1080/09658211.2013.767348

Brown, J. J., Lewis, V. J., & Monk, A. F. (1977). Memorability, word frequency and negative recognition. *The Quarterly Journal of Experimental Psychology, 29*, 461–473. doi:10.1080/14640747708400622

Bruno, D., Higham, P. A., & Perfect, T. J. (2009). Global subjective memorability and the strength-based mirror effect in recognition memory. *Memory & Cognition*, *37*, 807–818. doi:10.3758/MC.37.6.807

Cox, G. E., & Shiffrin, R. M. (2012). Criterion setting and the dynamics of recognition memory. *Topics in Cognitive Science*, *4*, 135–150. doi:10.1111/j.1756–8765.2011.01177.x

Dobbins, I. G., & Kroll, N. A. (2005). Distinctiveness and the recognition mirror effect: Evidence for an item-based criterion placement heuristic. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 31*, 1186–1198. doi:10.1037/0278–7393.31.6.1186

Dougal, S., & Rotello, C. M. (2007). "Remembering" emotional words is based on response bias, not recollection. *Psychonomic Bulletin & Review, 14*, 423–429. doi:10.3758/BF03194083

Glanzer, M., & Adams, J. K. (1990). The mirror effect in recognition memory: Data and theory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16*, 5–16. doi:10.1037/0278–7393.16.1.5

Han, S., & Dobbins, I. G. (2008). Examining recognition criterion rigidity during testing using a biased-feedback technique: Evidence for adaptive criterion learning. *Memory & Cognition, 36*, 703–715. doi:10.3758/MC.36.4.703

Hintzman, D. L. (2011). Research strategy in the study of memory: Fads, fallacies, and the search for the "coordinates of truth." *Perspectives on Psychological Science, 6*, 253–271. doi:10.1177/1745691611406924

Hirshman, E. (1995). Decision processes in recognition memory: Criterion shifts and the list-strength paradigm. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 21, 302–313. doi:10.1037/0278–7393.21.2.302

Hockley, W. E. (2011). Criterion changes: How flexible are recognition decision processes? In P. Higham & J. Leboe (Eds.), *Constructions of remembering and metacognition: Essays in honor of Bruce Whittlesea* (pp. 155–166). Houndmills, UK: Palgrave Macmillan.

Jacoby, L. L. (1972). Effects of organization on recognition memory. *Journal of Experimental Psychology, 92*, 325–331. doi:10.1037/h0032275

Jacoby, L. L., Kelley, C. M., & Dywan, J. (1989). Memory attributions. In H. L. Roediger & F. I. M. Craik (Eds.), *Varieties of memory and consciousness: Essays in honour of Endel Tulving* (pp. 391–422). Hillsdale, NJ: Erlbaum.

Jacoby, L. L., Shimizu, Y., Daniels, K. A., & Rhodes, M. G. (2005). Modes of cognitive control in recognition and source memory: Depth of retrieval. *Psychonomic Bulletin & Review, 12*, 852–857. doi:10.3758/BF03196776

Johnson, M. K. (2006). Memory and reality. *American Psychologist, 61*, 760–771. doi:10.1037/0003–066X.61.8.760

Kantner, J., & Lindsay, D. (2010). Can corrective feedback improve recognition memory?. *Memory & Cognition, 38*, 389–406. doi:10.3758/MC.38.4.389

Kantner, J., & Lindsay, D. (2012). Response bias in recognition memory as a cognitive trait. *Memory & Cognition, 40*, 1163–1177. doi:10.3758/s13421–012–0226–0

Lindsay, D. S. (2008). Source monitoring. In H. L. Roediger, III (Ed.), *Cognitive psychology of memory. Vol. 2 of Learning and memory: A comprehensive reference*, 4 vols. (J. Byrne, Editor) (pp. 325–347). Oxford: Elsevier.

Lindsay, D. S., & Kantner, J. (2011). A search for influences of feedback on recognition of music, poetry, and art. In P. Higham & J. Leboe (Eds.), *Constructions of remembering and metacognition: Essays in honor of Bruce Whittlesea* (pp. 137–154). Houndmills, UK: Palgrave Macmillan.

Masson, M. E. J., & Loftus, G. R. (2003). Using confidence intervals for graphically based data interpretation. *Canadian Journal of Experimental Psychology, 57*, 203–220.

Metcalfe, J., & Jacobs, W. (1998). Emotional memory: The effects of stress on 'cool' and 'hot' memory systems. In D. L. Medin (Ed.), *The psychology of learning and motivation: Advances in research and theory, Vol. 38* (pp. 187–222). San Diego, CA US: Academic Press.

Mewhort, D. J. K, & Johns, E. (2013, June). Forced-choice recognition: Processes and strategies. Paper presented at the annual meeting of the Canadian Society for Brain, Behavioural, and Cognitive Science, Calgary, Alberta.

Morrell, H. R., Gaitan, S., & Wixted, J. T. (2002). On the nature of the decision axis in signal-detection-based models of recognition memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 28*, 1095–1110. doi:10.1037/0278–7393.28.6.1095

Ratcliff, R., Sheu, C.-F., & Gronlund, S. D. (1992). Testing global memory models using ROC curves. *Psychological Review, 99*, 518–535.

Rhodes, M. G., & Jacoby, L. L. (2007). On the dynamic nature of response criterion in recognition memory: Effects of base rate, awareness, and feedback. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33*, 305–320. doi:10.1037/0278–7393.33.2.305

Schacter, D. L., Israel, L., & Racine, C. (1999). Suppressing false recognition in younger and older adults: The distinctiveness heuristic. *Journal of Memory and Language, 40*, 1–24. doi:10.1006/jmla.1998.2611

Singer, M. (2009). Strength-based criterion shifts in recognition memory. *Memory & Cognition, 37*, 976–984. doi:10.3758/MC.37.7.976

Singer, M., Fazaluddin, A., & Andrew. K. N. (2013). Recognition of categorised words: Repetition effects in rote study. *Memory*, *21*(4), 467–481. doi:10.1080/09658211.2012.739625

Singer, M., & Wixted, J. T. (2006). Effect of delay on recognition decisions: Evidence for a criterion shift. *Memory & Cognition, 34*, 125–137. doi:10.3758/BF03193392

Smallwood, J., & Schooler, J. W. (2006). The restless mind. *Psychological Bulletin, 136*, 946–958.

Starns, J. J., Ratcliff, R., & White, C. N. (2012). Diffusion model drift rates can be influenced by decision processes: An analysis of the strength-based mirror effect. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 38*, 1137–1151. doi:10.1037/a0028151

Thomas, E. A., & Legge, D. (1970). Probability matching as a basis for detection and recognition decisions. *Psychological Review,* 77, 65–72. doi:10.1037/h0028579

Watkins, M. J., & Peynircioglu, Z. F. (1990). The revelation effect: When disguising test items induces recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16*, 1012–1020. doi:10.1037/0278–7393.16.6.1012

Wixted, J. T. (1992). Subjective memorability and the mirror effect. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 18*, 681–690. doi:10.1037/0278–7393.18.4.681

Zimmerman, C. A., & Kelley, C. M. (2010). "I'll remember this!" Effects of emotionality on memory predictions versus memory performance. *Journal of Memory and Language, 62*, 240–253. doi:10.1016/j.jml.2009.11.004