The Foundations of Remembering

Essays in Honor of Henry L. Roediger, III

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The Effects of Attention and Emotion on Memory for Context

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It is a great pleasure to contribute a chapter to this volume honoring Roddy Roediger's many contributions to the field of human memory research. Roddy has not only provided influential theoretical analyses and striking empirical findings, but has also given his time generously to the organization and advancement of our discipline—his Presidency of the American Psychological Society and his Editorship of the *Journal of Experimental Psychology: Learning, Memory, and Cognition* are just two examples of many such contributions. Additionally, these obligations are always carried out in a relaxed and congenial manner, and with Roddy's wry humor. We look forward to many more years of excellent research and dubious Internet jokes!

Another more specific reason to be pleased to contribute to this Festschrift, is that Roddy has been very attentive over the years to the milestones passed by his friends in memory research. Among his many other activities, he has found the time to organize meetings and edit volumes in honor of Endel Tulving, Bob Crowder, and Gus Craik; it is therefore a particular pleasure to return the compliment.

We note that the organizers of the excellent meeting held in Roddy's honor at Purdue University entitled it somewhat cautiously "Roddyfest: Directions in Memory Research"—not "*Advances* in Memory Research" or even "*New* Directions in Memory Research," just "Directions!" So, freed from the obligation to contribute anything novel, we decided to look again at an experiment originally reported in the Festschrift for Endel Tulving edited by Roediger and Craik, and re-present it at the meeting. "After all," as the speaker remarked at the time, "it was good enough for Endel, so it should be good enough for Roddy!" The experiment (Craik, 1989) was part of a group of studies exploring the factors involved in associative binding, in particular the binding of item and contextual information. Emotion appears to be one such factor. There is good evidence that emotional events are not only well remembered in themselves, but that the context of occurrence is also well remembered. This is the essence of the "flashbulb memory"

effect reported originally by Brown and Kulik (1977) and reviewed by Conway (1995) and by Winograd and Neisser (1992). These classic studies document people's memories of highly dramatic and shocking public events such as the assassination of President Kennedy and the space shuttle *Challenger* disaster, and they show that contextual information is often well remembered even when it is irrelevant to the emotional event itself. The binding of item and context appears to happen spontaneously, and may have some survival value for animals and humans who should take care to avoid contexts associated with traumatic events.

EXPERIMENT 1

The purpose of Craik's (1989) experiment was to explore the effects of much weaker emotional stimuli on the integration of events and their contexts. The stimuli used were mildly emotional words, and the context in this case was the speaker's voice. Lists of 12 words (common concrete nouns) were prerecorded by four different speakers, each of whom had a marked regional accent, and then presented to participants to study and recall. After all lists had been presented and recalled, the participants were unexpectedly given a subset of the words on a preprinted sheet and asked to decide which speaker had presented each word. Embedded in each 12-word list was one "target" word that was either a mildly emotional word (e.g., breast, corpse, screw, lesbian, nipple, coffin) or a city name (e.g., Lisbon, Berlin, Dallas, Calgary). In addition, each list had a designated neutral control word positioned like the target word in the middle of the list, plus the first and last words to pick up any primacy and recency effects. The integration of item and context was thus indexed by the ability to identify the speaker of each word, and it was predicted that the level of identification would be higher for the emotional words. City names were included as they were expected to attract more attention than other list words, which were common nouns; it seemed possible that *any* somewhat anomalous word might attract attention, be well recalled, and its voice context well identified. On the other hand, if emotion plays a special role in binding events and their contexts it would be expected that although city words and emotional words would both be well recalled, the emotional words would be associated with superior voice identification.

Other details include the point that each of the four speakers recorded a brief biographical statement about their background and occupation. These biographies were played to participants before the lists were presented to enable them to form some kind of image of each speaker. The experiment involved 32 participants (mostly university students); the words in each list were presented at a 3-s rate, and presentation was followed immediately by a 1-min recall period. After the lists were presented and recalled, participants were given a typed list containing the four words of interest (primacy, neutral, target, and recency) from each of the 16 lists, and asked to make a forced-choice judgment as to which speaker had originally presented each word. In the 16 lists, half contained a city word and half contained an emotional word. The 64 words presented for the voice judgment test were scrambled with regard both to type of word and list of origin.

The basic results are shown in Table 10.1. The neutral words from the middle of the list were recalled with a probability of .48, and the table shows that the experiment yielded the classic serial position curve with enhanced recall of the first word (primacy = .62) and last word (recency = .96). Of greater interest, there was also enhanced recall of city words (.70) and emotional words (.69), with no difference in the recall probabilities of these two types of target. Chance performance for voice identification is .25, and Table 10.1 shows that all four types of words exceeded that value. The probabilities of voice identification for neutral and recency words were almost identical (.36 and .35 respectively), but voice identification was superior for the other three word types (.49, .44, and .52 for primacy, city, and emotional words, respectively). There is thus some evidence that even mildly emotional events—in this case words in a list to be learned and recalled—are not only well recalled in themselves, but also strengthen the link between the event and its context. The difference in voice identification between city and emotional words was not statistically significant, but nonetheless there is some indication that emotionality has some effect on context integration over and above the effects of attention. On the other hand, voice identification performance for primacy words was surprisingly high despite the absence of emotionality in this case.

The first experiment thus gave results suggesting that even mildly emotional events can increase the binding of experienced events to their contexts of occurrence—a kind of "mini flashbulb effect!" But the results also left many unanswered questions; is the effect essentially due to the greater attention paid to any anomalous item, for example, or does emotionality confer some special benefit? A related question concerns the role of intentionality in this paradigm; participants were not explicitly told that they would be asked to recall the voice of presentation in the present study, but they were instructed to pay attention to the voice "as it might help them to remember the words." If emotion (or attention) truly acts in a flashbulb manner, recall of context should be facilitated regardless of any intention to associate specific words and voices. Recall should also be facilitated regardless of any pre-existing association between the item and its context; a less extreme view might be that emotion acts to amplify existing associations. If attention is the mediating factor, is the effect of emotion on item and context recall reduced systematically as attention is withdrawn in a dual-task paradigm? Also, does such a reduction in attention affect item and context information differentially? One possibility is that associative information is more vulnerable to the withdrawal of processing resources (Craik, 1989). Finally, there are many interesting questions concerning the neural bases of the effects of emotion on memory (Cahill & McGaugh, 1998).

TABLE 10.1 Probability of Free Recall and Voice Identification as a Function of Word Type

	Primacy	Control	City	Emotional	Recency
Free recall	.62	.48	.70	.69	.96
Voice ID	.49	.36	.44	.52	.35

FURTHER BACKGROUND ON EMOTION AND CONTEXT

Interest in the topic of emotion and memory has grown exponentially in the last 15 years in fact, with reviews of the area provided by Cahill and McGaugh (1998), Christianson (1992), McGaugh (2004), and Reisberg and Heuer (2004). There is general agreement that emotional stimuli are better remembered than neutral stimuli, and that one reason for this effect is the involvement of the amygdala, which serves to modulate the processes of encoding and consolidation in the hippocampus, caudate nucleus and other structures (Cahill & McGaugh, 1998). There is still a great deal of debate about the cognitive factors underlying the effect, however. Does emotionality act directly on memory, for example, or is it simply that emotional events attract attention and therefore receive greater amounts of processing—which in turn enhance memory? Emotional events are also distinctive and significant, and it is well known that these features confer a benefit on later remembering (Hunt & Worthen, 2006; Schmidt, chapter 9, this volume). Finally, Talmi and Moscovitch (2004) pointed out that emotional stimuli in a laboratory setting are often related (e.g., words like pain and torture, or like corpse, death, coffin), and that this factor also contributes to the overall effect. These components of the effect of emotion on memory are still under active debate (see for example Schmidt, chapter 9, this volume).

The effects of emotionality on memory for *context* is another lively area of research. Doerkson and Shimamura (2001) presented lists of neutral and emotionally valenced words (e.g., glory, sunrise, emergency, slaughter) for participants to study; half of the words were colored yellow and the other half were colored blue. Participants were instructed to remember the color in which each word appeared. After list presentation, participants were first asked to recall as many words as possible and were then given a recognition test in which they judged words to be old/yellow, old/blue, or new. The results showed that emotional words were recalled at a much higher level than neutral words, and that source memory for the associated color was also enhanced for the emotional words. Donald MacKay has also published two studies that are highly relevant to the present concerns. In the first of these (Mackay et al., 2004) the investigators presented a series of words in different colors for participants to name: The words were either neutral emotionally or were obscene taboo words. Color-naming took longer for the taboo words, and they were also better recalled than the neutral words despite the fact that participants did not expect the recall test. In Experiment 3, the color-naming phase was followed by a surprise color-recognition test, which resulted in better color recognition of the emotional words. In a further study, MacKay and Ahmetzanov (2005) replicated this result and also found that the original word location was better recognized for taboo than for neutral words. MacKay and colleagues have suggested that emotion acts to bind emotional events to their contexts of occurrence, and also that this binding process occurs automatically; in the MacKay and Ahmetzanov study there was no difference in location recognition between cases in which participants were aware or unaware that some words always occurred in the same location. In greater detail, MacKay and colleagues (2004) hypothesized that there is an emotional binding mechanism that operates to link salient features of the context to specific emotional events. This mechanism works in a parallel way to an attentional-binding mechanism, which again acts to bind attended features of events to salient aspect of the context.

EXPERIMENT 2

The second experiment to be reported was designed and carried out essentially to replicate and extend the results of Craik (1989) rather than to endorse or rebut the ideas and findings of MacKay and colleagues (2004; MacKay & Ahmetzanov, 2005), although many of the issues are similar. We discuss the relations between the two sets of studies later in the chapter.

The experiment used the paradigm reported earlier; that is, four lists of 12 words were spoken by each of four different speakers, with each list followed by immediate free recall. The presentation and recall of all lists was followed in turn by a voice identification test, in which four words from each of the 16 lists were presented visually; the participant's task was to decide which of the four speakers had presented each word.

As in the study by Craik (1989), each list contained four words of interest, the first and last words (primacy and recency, respectively), a neutral control word positioned in the middle of the list, and either a city name or a mildly emotional word, also in the middle of the list. The exact positions of these three middle-of-list items were counterbalanced across lists and participants. Before the lists were presented, participants listened to each speaker present a brief biography from a tape-recorder; a photograph of the speaker was also presented. These preliminaries allowed participants to form some impression of the speakers, who in this case were a female staff member of the Rotman Institute who came originally from Hong Kong, a female postdoctoral fellow from Quebec, a male postdoctoral fellow from Israel, and a (late) middle-aged semi-retired male Scottish professor.

The words used were common two-syllable concrete nouns, apart from the city and emotional words; they were presented at a 3-s rate, and presentation was followed by a 1-min period for free recall. Four different formats were recorded, with the result that each 12-word list was spoken by all four speakers across the experiment. The order of the lists was also counterbalanced. Eight of the lists (two per speaker) contained a city name, and the remaining eight contained an emotional word. The experiment was described as one investigating the effect of different speakers' accents on memory; participants were instructed to associate each word with that particular speaker, but were not told that they would be tested for that information. Following presentation and recall of all lists, a typed sheet containing the 64 critical words was presented, and participants were asked to make a forced-choice decision as to which speaker had presented each word.

Three groups of 32 participants performed the experiment; a group of young adults (mostly university students), a group of older adults aged between 60 and 80, and a second group of young adults who listened to the original list presentations under divided-attention (DA) conditions. The purpose of including the older

group was to check whether the effects of emotionality on memory were attenuated by aging. It has been suggested that older adults are less emotionally labile and have "flattened affect;" if this is so it might be expected that the effect of emotionality on memory from context would be reduced. The purpose of including the divided-attention group was primarily to check the idea that the effects of emotionality are essentially due to a greater allocation of attention to the emotional event. If this is so, the divided-attention condition should presumably show attenuated effects of emotionality and perhaps also of city names and primacy. Participants in this group answered simple addition questions presented visually on a computer screen during list presentation. They performed the recall test and the voice-identification test under full attention (FA) conditions.

The main results are shown in Figures 10.1a (word recall) and 10.1b (voice identification). Relative to the control words, recall was somewhat higher for the first words in each list (primacy), and this effect was similar for all three groups. As expected, all groups also showed strong recency effects. Recall levels for the city and emotional words were substantially above those for the respective control words in all groups, with equivalent recall of emotional and city words in the case of young adults under FA conditions, but superior recall of city words for the older group and young adults under DA conditions. However, an analysis of variance on these data showed main effects of word type and of group only; the interaction was not statistically significant. Figure 10.1b shows first that voice identification (voice ID) was greater than chance (.25) in all cases. Word type had comparatively small effects on voice ID in the older group, varying only from .34 and .33 for the control and recency words, respectively, to .36, .41, and .38 for primacy, city, and emotional words respectively. Figure 10.1b shows that the two young adult groups had similar patterns of voice ID, with control and recency words yielding comparably low levels of identification, and emotional words yielding the highest level. Voice ID ranged between .44 (recency) and .59 (emotional) for the young-FA group, and between .31 (control) and .51 (emotional) for the young-DA group. Thus there is graphic support for the prediction that older adults would show only a small effect of emotionality on voice ID, whereas young adults would show strong effects. Surprisingly, a comparatively strong effect of emotionality was also shown by the young-DA group. Despite the graphic evidence, however, an ANOVA again showed no interaction between word type and group.

A comparison of Figures 10.1a and 10.1b shows that the young-DA participants mimic the recall pattern of the older group (Figure 10a), yet resemble the young-FA group more closely in their voice-ID performance (Figure 10b). The first result is a further illustration of the point that withdrawal of processing resources by dividing attention between memory encoding and a secondary task in young adults reduces their subsequent recall levels to those of older adults under full attention (Craik, 1982). Figure 10.1a shows a particularly striking example of this effect given first that recall levels of the old group vary between .24 and .69, and second that the corresponding levels for the young-DA group are between .04 and .06 higher across all cases. That is, the effect of DA is not simply to lower performance, but to lower it in a way that exactly matches the pattern shown by older adults. The strong implication is that at least one major cause of memory

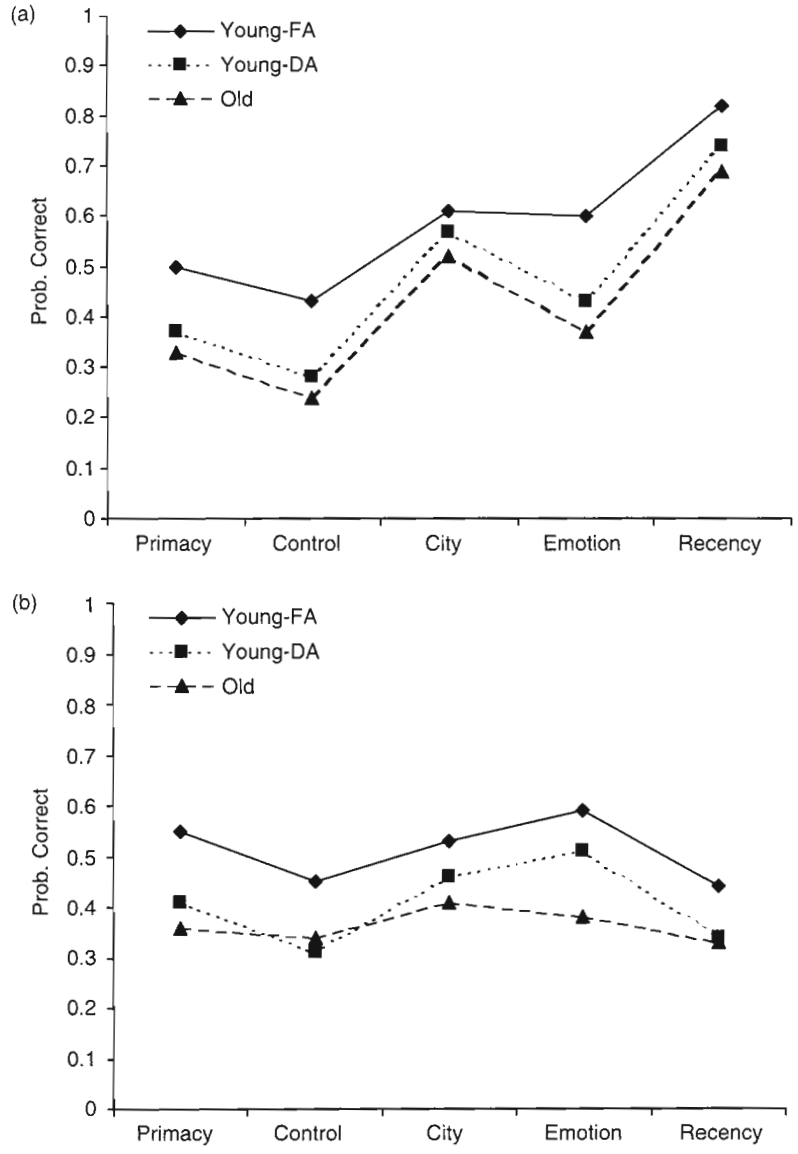

FIGURE 10.1 Probabilities of (a) word recall and (b) voice identification as a function of participant group and word type.

impairment in older adults is a reduction in available processing resources. The finding that recall of city words is approximately 15% higher than recall of emotional words for both young-DA and older adults may reflect the point that a city name embedded in a list of nouns is more immediately noticeable and salient than are mildly emotional words such as those used in the a present study. Taboo words might yield a different result, however. Despite their similarity to older adults in

recall, the young-DA group performs more like the young-FA group in the Voice-ID task (Figure 10b). Thus, although the young-DA participants recalled relatively few emotional words, their voice-ID scores for these words were relatively high.

A second way to look at these data is to conditionalize on recall; given correct recall, what is the probability that the voice is correctly identified? These data are shown in Figure 10.2. Values for recency items are understandably low; these words were well recalled (Figure 10a), yet their voice-ID scores are approximately the same as control words, yielding a low conditionalized score. For the remaining four word types, older adults had quite similar conditionalized scores, varying between .46 and .51. For this older adult group, primacy scores are .05 points above control, and emotional words are .04 points above control. The pattern is different in both young groups. In the case of primacy scores, the advantage relative to control is .14 for young-FA and .09 for young-DA. For emotional scores, the advantage relative to control is even greater; .15 for young-FA and .22 for young-DA participants. There is thus some evidence that words with emotional impact (including primacy words possibly) have a stronger likelihood of binding to their perceptual qualities—in younger adults at least.

DISCUSSION AND CONCLUSIONS

The two experiments are consistent in showing that for young adults working under full attention conditions, emotional words enhance the later identification

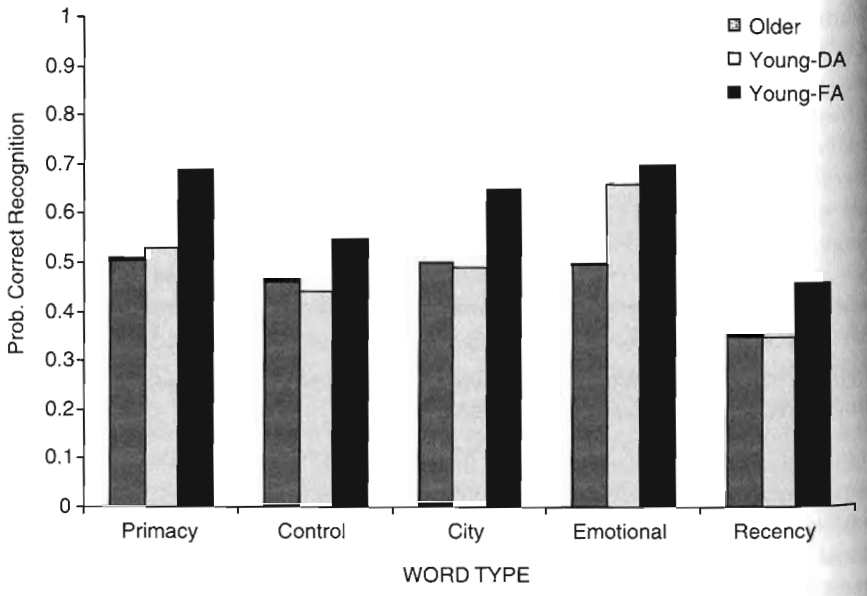

FIGURE 10.2 Probability of voice identification conditionalized on correct word recall, as a function of participant group and word type.

of the voice presenting the word. This improvement in the binding between an item and its perceptual qualities (or "context" or "source") is substantial; .52 compared to .36 for control words in Experiment 1 and .59 compared to .45 for control items in Experiment 2. These results thus confirm and extend the findings that emotional words enhance source memory for their presentation color (Doerkson & Shimamura, 2001) and that highly emotional words enhance later recognition of location (MacKay & Ahmetzanov, 2005). The enhancement of binding triggered by emotion appears to happen automatically, given that participants were not instructed to learn the association between words and their context in either the current experiments or those of MacKay and Ahmetzanov (2005).

The present experiment can also give at least tentative answers to other questions posed in the introduction. First, the differences between the young-FA group and the other two groups were less dramatic than expected; essentially, all three groups showed the same patterns (as indicated by the absence of Group × Word type interactions) although unsurprisingly the young-DA and older groups performed at lower levels than those shown by the young-FA group. Nonetheless, the older group showed a smaller range of voice-ID scores (.08) than either the young-FA group (.15) or the young-DA group (.20), giving some support to the idea that aging is associated with flattened affect, and that this reduction in emotional activity is one factor underlying the reduction in source memory observed in older participants (Hashtroudi, Johnson, & Chrosniak, 1989; McIntyre & Craik, 1987; Spencer & Raz, 1995). Of course, there is no guarantee that the words have the same emotional impact on older and younger participants, but one reassuring aspect of the data is that (as shown in Figure 10.1a) the recall advantage of emotional over control words is very similar in the older group (.13) and the young-DA group (.15). With regard to the young-DA group, withdrawal of attentional resources reduced their word recall levels to that of older participants (Figure 10.1a), but interestingly their voice-ID scores tended to follow the pattern of the young-FA group rather than that of the older adults (Figure 10.1b). When voice-ID scores were conditionalized on correct recall (Figure 10.2), the young-DA group showed similar performance levels to those of older adults except for emotional words, where there was a tendency for their scores to approach those of the young-FA group. This trend was entirely absent for city words, however, suggesting that salience is not enough, that some emotional content is necessary to enhance the binding of item and context information, that primacy items have this quality as well as overtly emotional words, and that young adults show the effect of emotionality despite a reduction in processing resources under divided attention conditions. For the young groups, the emotional words may capture attention in an obligatory fashion (cf. the "rubbernecking" effect reported by Most, Chun, Widders, & Zald, 2005).

One important question in this area is whether the boosting effects of emotionality on memory for context are essentially attributable to the increased *attention* paid to emotional stimuli. The present experiments attempted to answer this question by comparing performance on emotional words with performance on city names, which are at least as salient and are probably more easily segregated into a distinctive group than are the mildly emotional words used here. The city names

were recalled at least as well as the emotional words (Figure 10.1a), but the emotional words were slightly superior with regard to voice ID, in the two younger groups at least (Figures 10.1b and 10.2). The tentative conclusion is that the affective impact of mildly emotional words (or taboo words in the case of MacKay & Ahmetzanov, 2005) and even of the first (primacy) words in a list to be learned, appears to be equivalent to the effects of attention with respect to later *recall* of the words themselves, but has an effect beyond that of attention with respect to later recollection of source and context. A related question is whether emotionality and other forms of salience simply amplify existing relations between items and their contexts, or whether such effects are independent of previous relations, as the original work on the flashbulb effect suggests. In this latter case, the effects of emotionality would be to "glue" together events and contexts regardless of their associative compatibility. The present data do not address this issue, but it would be an interesting topic for investigation—to vary the prior congruity between events and contexts, and then examine the effects of salience and emotionality on later memory for the contexts.

The data from Experiment 2 also address the issue of similarities and dissimilarities between divided attention in young adults and the effects of aging (Craik, 1982, 1983; Naveh-Benjamin, 2000, 2002). Naveh-Benjamin (2002) has argued that the effects are different in that aging is associated with a specific deficit in associative binding that is absent in DA manipulations on young adults. The relative effects of aging and DA on item and associative information can be assessed from the data shown in Figures 10.1a and 10.1b. The effects are best estimated from the primacy and control words, as these items are neither "contaminated" by special qualities (city and emotional words) nor involve different encoding and retrieval mechanisms (recency words). For young-DA participants, the drop in performance levels from those of the young-FA group (averaged over primacy and control words) was .14 for recall and also .14 for voice-ID. The corresponding values for the older adults were .18 and .15, respectively. Thus although it might have been expected that aging and DA would affect the encoding of associative information more than the encoding of item information and that such an effect would be greater in the old group, in fact the present data show that item and associative information were negatively affected to the same degree by both aging and divided attention.

In the course of editing this chapter, Jim Nairne pointed out that episodic recall of events (illustrated, for example, by the free recall of words in lists) *also* involves "binding"—in this case the binding of words to the temporal and other contextual features of the list and the experimental situation. So why should recall—involving binding of an item to its episodic context—differ from voice identification—also involving binding of an item to its episodic context? This is an interesting puzzle. We agree with Nairne that the two measures (recall and voice ID) logically tap the same type of associative process; nonetheless, the present data show some differences. One example is the 15% advantage of city recall over emotional recall for the old and young-DA groups, compared with the roughly equivalent voice-ID scores for city and emotional words in these two groups (Figures 10.1a and 10.1b). Another example is provided by the conditionalized voice-ID scores shown in Figure 10.2. It seems to us that if "list binding" and "voice binding" are equivalent processes, then the conditionalized scores should also be equivalent (apart from recency, which taps a different recall process). That is, subject and material differences should be "absorbed" in the recall data. The finding that some differences are apparent among the conditions shown in Figure 10.2 may reflect differences in what may be termed "levels of binding" (Craik, 2006). That is, there may be important differences between binding items to general contextual aspects and binding of inherent features such as voice and handwriting. This is the distinction between "extrinsic" and "intrinsic" context made by Baddeley (1990) and others. One final point in this connection is that the distinction between "remember" and "know" items is also a distinction between two levels of contextual association, in that "know" items lack episodic detail, but the subject clearly knows that the item occurred in the experimental list (Craik, 2003).

In conclusion, we have presented some preliminary data on the effects of stimulus salience and emotionality on the associative binding between events and their contexts. We see no traces of Roddy Roediger exhibiting signs of flattened affect, and trust that he will remember both the events and the context of his Festschrift conference for many years to come.

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11

Putting Context in Context

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Roediger and McDermott's comprehensive review of the implicit memory literature (1993) included a puzzling pair of findings: If a prime item is studied in massed fashion (i.e., longer study or successive presentations), the prime benefit on a later perceptual-implicit memory test (e.g., lexical decision) does not increase beyond that provided by a brief or single presentation. However, if the prime item is repeated in spaced fashion, the prime benefit increases with the number of presentations (see Jacoby & Dallas, 1981; Roediger & Challis, 1992). These findings are puzzling because explicit memory tests show that performance increases with the number of both massed and spaced presentations (albeit more so for spaced presentations). Starting with Shiffrin and Steyvers (1997) we had been developing a theory that included a key role for context to account for implicit and explicit memory and the relation between these. Long-term priming, for example, was explained in large part by the assumption that event-study produced not only an explicit trace (incomplete and noisy), but also additional context storage in that event's knowledge trace (if one existed; see Schooler, Shiffrin, & Raaijmakers, 2001). However, the findings highlighted by Roediger and McDermott did not fit that developing model, and led us to look deeper into the role of context and the mechanisms by which it affected memory. Now a decade and more after Roediger and McDermott put implicit memory in context, we believe it fitting to report our subsequent attempts to place context in context.

WHAT IS CONTEXT?

The idea of "context" is at once the bane and boon of those aiming to understand memory. Although context has been employed almost universally as an explanatory construct, in such areas as classical conditioning (Gantt, 1940), motor learning (Wright & Shea, 1991), recall (Anderson & Bower, 1972; Dulsky, 1935; Raaijmakers & Shiffrin, 1981; Strand, 1970), recognition (Criss & Shiffrin, 2004a; Dennis