8

CHAPTER

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Autobiographical Memory and Aging: Distributions of Memories Across the Life-Span and Their Implications for Survey Research

Autobiographical memory (Brewer, 1996; Conway, 1990; Conway & Rubin, 1993; Conway, Rubin, Spinnler, & Wagenaar, 1992; Neisser & Fivush, 1994; Rubin, 1986, 1996) and the interaction of autobiographical memory and survey research (Jobe, Tourangeau, & Smith, 1993; Schwarz & Sudman, 1994) have been fruitful areas of study over the last few decades. Because older adults have more life to remember, much of this work has been integrated into the study of cognitive aging. Rather than provide an overview of the field, I will concentrate on one aspect of interest to survey research: how autobiographical memories are distributed over the life-span.

The distribution of autobiographical memories is important for survey research because it indicates from where in the life-span memories are likely to come; that is, it indicates the relative availability of memories as a function of the age of those memories. If a respondent has a question on a survey to answer that depends on specific episodes, it suggests the range of ages of the episodes that the respondent will use. There is a second reason for concentrating on the temporal distribution of memories. It is one topic for which we have a good quantitative description, one that could be used to predict biases in responding.

Two issues need to be mentioned briefly. The first is the accuracy of the memories themselves. The second is the accuracy of the dates. If the autobiographical memories people report from their life are mostly confabulations, or if the dates given bear no direct relation to the actual dates, then the results reported here would be of little use for survey research. Neither condition appears to hold.

The issue of the accuracy of autobiographical memories is one of the most complex and heated in psychology (Brewer, 1996; Robinson, 1996; Schacter, 1996; Winograd & Neisser, 1992). After an extensive review of the philosophical and psychological literature, Brewer (1996, p. 61) comes to the following conclusion: "Recent recollective memories tend to be fairly veridical unless they are influenced by strong schema-based processes. Recollective memories give rise to high confidence in the accuracy of their contents and that confidence can frequently predict objective memory accuracy." Most of the time, people are mostly accurate unless there are biasing factors at work. This summary offers little comfort for individual courtroom cases, but is the best we have, and is less troubling for survey data that are to be aggregated. Depending on the goals of the survey, some of the biasing may not be a problem. People tend to keep their memories consistent with their current views of themselves (Robinson, 1996) and so may distort in ways that are useful for some, but not all purposes.

The question of the accuracy of the dating of memories is easier to discuss because the data are better (Friedman, 1993; Huttenlocher, Hedges, & Prohaska, 1988; Larsen, Thompson, & Hansen, 1996; Thompson, Skowronski, Larsen, & Betz, 1996). It is clear that people do not store the exact dates of most events (Brewer, 1996), but rather construct them using a cyclical time scale of years, seasons or months, and weeks. A person may know an event occurred on a Sunday in June but not know the year. Thus, there are a disproportionate number of events that have dating errors of approximately plus or minus one day, 7 days, 30 days, and 365 days. Nonetheless, the dates people give to events when temporal boundaries are not set are unbiased estimates of when the events actually occurred (Rubin, 1982; Rubin & Baddeley, 1989). There are some exceptions to this generalization (Brown, Rips, & Shevell, 1985; Kemp & Burt, in press), but they are not common.

With these preliminary considerations, we can turn to the distribution of autobiographical memories. The scientific beginnings of the study of autobiographical memory and of their distribution can be traced to Galton (1879; see Crovitz, 1970, and Crovitz & Schiffman, 1974, for an integration into modern cognitive psychology).

Galton (1879) studied his own memories by taking a "leisurely walk along Pall Mall" (p. 151) pausing at approximately 300 objects and using each one to cue a memory. To bring the study into the laboratory, he made a list of words, viewed the words one at a time, recorded the time it took for the word to elicit a memory, recorded a brief response, and noted the age of the memory. His distribution of memories was 39% from "boyhood and youth," 46% from "subsequent manhood," and 15% "quite recent events" (p. 157). This research can be seen as the foundation of two directions in research. The first is the free associations of Freud and Jung. The second is Crovitz and Schiffman's (1974) revival of the technique to study autobiographical memory. Whereas Galton accepted all memories as responses, Crovitz and Schiffman intended that their subjects' responses be episodic memories as defined by Tulving (1972, 1983); that is, memories for events that occurred at one specific time and place.

In order to obtain a temporal distribution, Crovitz and Schiffman (1974) assumed that when a respondent reported that a memory occurred *n* time-units ago, the implied precision meant that the memory could be distributed evenly over ±½ of the time-unit. Thus, a memory that was reported as occurring 24 hours ago was assigned to a bin ranging from 23.5 to 24.5 hours ago, whereas a memory reported as occurring one day ago was assigned to a bin ranging from 12 to 36 hours ago. They plotted these densities at each time marker of English from 1 hour to 17 years ago using the time-units of hours, days, weeks, months, and years. Another technique (Rubin, 1982) asks for exact dates and times, rank-orders these, and forms bins of an odd number of reported memories using the range of each bin to determine the density and the median date of each bin to determine the time ago. The results are the same. A sample distribution (Rubin, 1982, Experiment 2) from 18-year-old undergraduates using the latter technique is shown in Figure 1. Each of the points in the figure is based on the median and range of 85 successively dated memories.

Several points are worthy of note. First, there is a large range of both times and densities—so large that logarithmic scales are used on both axes to allow all the data to be shown. Second, the data closely fit a smooth curve, even though there is no control at learning and little control at recall. Third, the data are close to linear on the log-log paper and thus fit a power function, $\ln(y) = \ln(a) - b \cdot \ln(t)$ or $y = at^{-b}$, with an exponent, b, of about .8. The power function is also a good fit to studies of laboratory learning (Anderson & Schooler, 1991; Rubin, 1982; Rubin & Wenzel, 1996; Wixted & Ebbesen, 1991). In a review of 210 data sets from the literature on human and animal memory, Rubin and Wenzel (1996) found that overall the power function fit as well as any of the 125 two-parameter functions they tested. The power function was clearly superior to the logarithmic and other two-parameter functions only for the autobiographical memory data sets. This difference could be due to

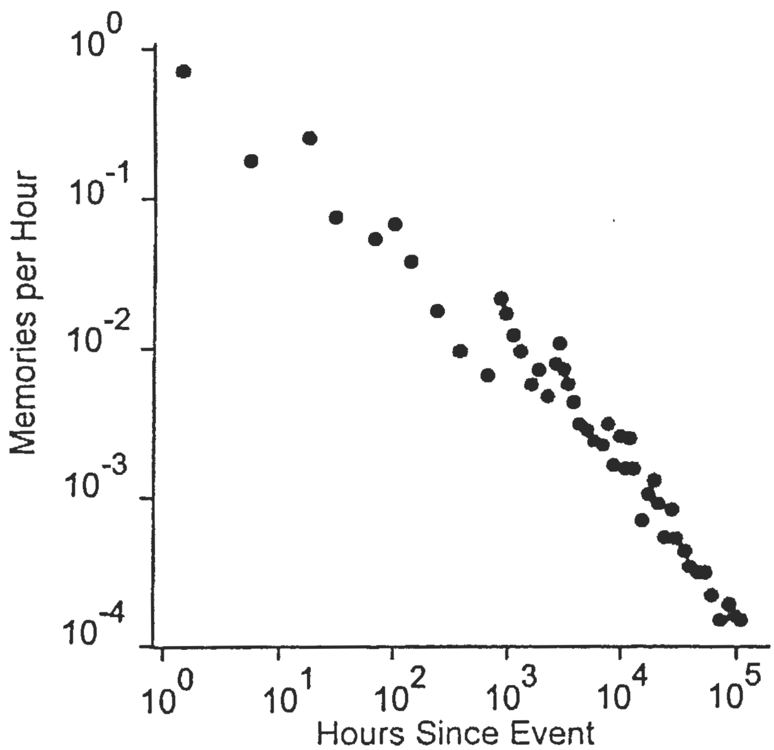

FIGURE 1. The relative number of autobiographical memories per hour reported by undergraduates as a function of the age of those memories. Both axes are logarithmic, so a straight line would be a power function. (Adapted from Rubin, 1982, Figure 2.)

autobiographical memory being different or to the much larger range of recall values present in the autobiographical memory data sets.

If the most recent 10 to 20 years of life of adults ranging in age from 12 to 70 are examined, similar results are obtained (Rubin & Schulkind, 1997b, 1997c; Rubin, Wetzler, & Nebes, 1986). A power function fits a collection of data sets with r^2's all over .95. The slopes vary between .69 and 1.07 across studies from laboratories using different subject populations, stimuli, and methods of aggregating the data, but the slopes did not differ systematically with the average age of the respondents. Thus, for adults of any age it appears that recent memories will be most available, with a monotonically decreasing retention function of the form at^{-b}, with b in the range of .7 to 1.1. The lack of a consistent difference in the slope parameter with the age of the respondent is consistent with the literature on other forms of retention (Giambra & Arenberg, 1993; Hulicka & Weiss, 1965; Rubin & Wenzel, 1996; Wickelgren, 1975). There are differences in learning with age, but once the level of learning is equated, there are at most small differences in the rate of retention with age.

The power function description of autobiographical memory has been shown to hold for individual people and individual cue words and for conditions in which people are asked to provide 50 autobiographical memories from their life without any cue words (Rubin, 1982). Different cues have different effects. For instance, concrete, easy-to-image words, such as fire, house, ship, and tree, which usually have objects as referents, produce older memories (i.e., shallower slopes) than hard-to-image words such as contents, context, memory, and time (Rubin, 1982). This may be one reason that odorants tend to produce old memories (Herz & Cupchik, 1992), though not older than words with the same referent (Rubin, Groth, & Goldsmith, 1984). Odors do, however, produce memories that were less often thought about. Nonetheless, the basic power function is maintained. In summary, there is a robust interpretable, quantitative description of the relative availability of autobiographical memories from the most recent decade or two of life.

We now turn briefly to people's early childhood memories. The retention function is expressed as a function of time ago (i.e., time measured from response). Another component is needed that is expressed as a function of age (i.e., time measured from birth). This is because people tend to recall fewer memories from the first few years of life and no memories from before birth. If the distribution of autobiographical memories of people of different ages are to be described, both a function of time ago, the t in at^{-b}, and a function of time since birth (age $- t$) is needed. Figure 2 shows distributions of early memories from several sources.

The left panel of Figure 2 shows results from three studies in which undergraduates were asked to provide memories from before the age of 8. For each study the percentage of memories at each year is shown. In the first study, Waldfogel (1948) had 124 undergraduates each spend two 85-minute sessions separated by 35 to 40 days recording experiences up to their 8th birthday. He then tabulated the number of unique, nonrepeated, memories for each person as a function of age. In the second study, Crovitz and Harvey (1979) collected memories of episodes from before age 8 from 17 undergraduates. Each student was instructed to spend 4 hours a week for each of 12 weeks. For these subjects there was a tendency to produce memories from later in the period between 0 and 8 years as the 12 weeks progressed, but this effect is ignored here. In the third study, Crovitz, Harvey, and McKee (1980) had 18 undergraduates spend up to 3 minutes trying to recall an

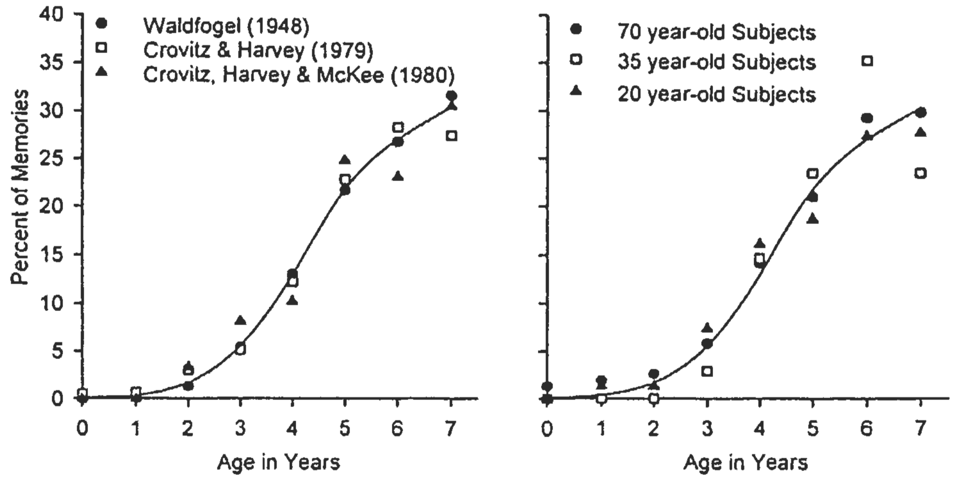

FIGURE 2. The distributions of early childhood memories from several published studies. Percentages of the total number of memories prior to age 8 in each distribution are used so that the plots can be easily compared. The curve fit to the data in both panels is the average distribution of the 8,610 early childhood memories from all studies combined.

autobiographical memory from before age 8 cued by each of 20 nouns. These nouns were drawn from words that described the memories produced in the earlier Crovitz and Harvey study. As can be seen in the left panel, the data are remarkably similar given the differences in procedures, and so one curve is drawn for all three data sets.

The right panel of Figure 2 shows data from Rubin and Schulkind (1997c) for subjects of three different ages: 40 undergraduates who were 20 years old, 20 adults who were 35 years old, and 60 adults who were 70 or 73 years old. The task for these subjects was to produce an autobiographical memory for each of 124 cue words. In contrast, to the left panel just discussed, in the right panel, memories were requested from anywhere in the life-span, not just from the first 8 years; however, only the data from the first 8 years are analyzed here. For each group the number of memories dated as occurring before the 8th birthday was set equal to 100% in the figure. As will be discussed later, some subjects were biased toward earlier memories, and although they did produce more early memories, the shape of their distributions did not differ. Similarly the 20-, 35-, and 70-year-old subjects varied widely in the percentage of the 124 cue words memories that were from before age 8 (6.0, 1.4, and 4.2%, respectively), but the relative distributions from the three age groups are remarkably similar, with the obvious exception that data from groups with more subjects are more regular. The curve fit to the data is the same as that in the left panel. Thus, it appears that, independent of the age of the adult and independent of whether all episodic memories or just those from early childhood are to be retrieved, the same distribution is obtained.

Averaging over all the data shown in Figure 2, by summing the total number of memories produced in each year independent of the study in which the memory was collected, and then dividing by the total number of memories, yields the following percentages for ages 0 through 7: 0.13, 0.38, 1.68, 5.54, 12.96, 21.80, 27.05, and 30.45. This set of values, to which the curves in Figure 2 are fit, provides my best estimate of the relative frequency of childhood memories by age. It is based on a total of 8,610 memories from before age 8.

The discussion so far is sufficient to describe the distribution of autobiographical memories of 20-year-old respondents. However, most of the lives of older adults has not been considered. When the total distribution of older adults is considered, a third component is needed: a *bump*, or increase in memories, from the period after the childhood decline to about age 30. Figure 3 shows a distribution for 70-year-old respondents from several laboratories.

The third component could be termed reminiscence, but the term bump is used to stress the empirical nature of the finding because all

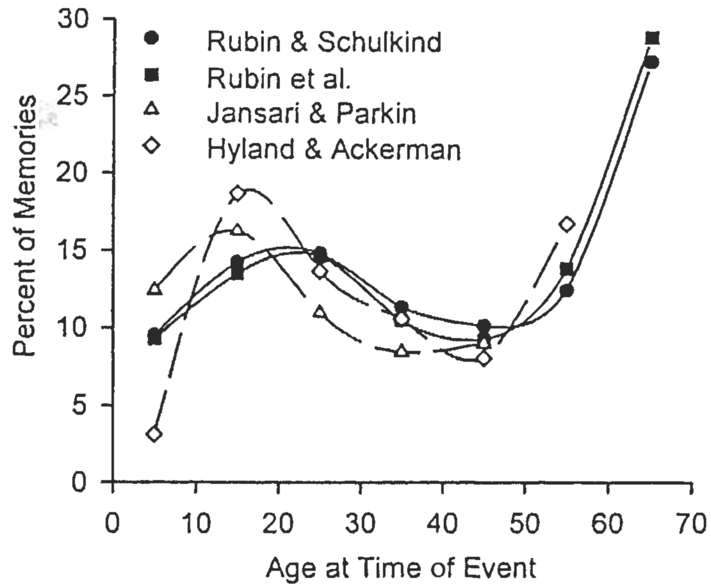

FIGURE 3. The distribution of autobiographical memories over the life-span for older adults from several published studies. The data are normalized so that the area under each curve is approximately the same.

that is implied is that more autobiographical memories are recalled from when a person is between 10 and 30 years old than would be expected from the other two components. The term bump also serves to highlight the lack of a suitable theoretical framework. Reminiscence, while usually lacking the kind of explicit quantitative definition provided here for the bump, has been a topic of great interest in the aging literature (e.g., Butler, 1964; Costa & Kastenbaum, 1967; Havighurst & Glasser, 1972; Romaniuk, 1981). For integrations of studies of the distribution of autobiographical memory with studies of the theoretically richer term reminiscence, see Fitzgerald (1996) and Webster and Cappeliez (1993). Additionally, people with many forms of amnesia often have better memory for older than for more recent events (Butters & Cermak, 1986; Squire, Chace & Slater, 1975; Ribot, 1882), and the description of the bump provides a comparison measure of the extent to which such a pattern occurs in nonclinical populations.

The definition of the bump used here was derived from empirical studies of autobiographical memory that used the cue-word technique. The oldest plot in Figure 3 was taken from Rubin et al. (1986) and is a summary of 1,373 memories of 70 adults sorted into the decades in which the individuals reported that the remembered event had occurred. The subjects, who were about 70 years old, were tested in three different laboratories under slightly different conditions (Fitzgerald & Lawrence, 1984; Franklin & Holding, 1977; Rubin et al., 1986). At the time of data collection, none of the laboratories were expecting a bump, which only appeared on reanalysis of the data in Rubin et al. (1986). In all cases, the subjects were asked to provide an autobiographical memory for each cue word. There were between 20 and 50 cue words per subject. On completing this task, the subjects were asked to date each memory. Roughly half the memories produced by these subjects are not in Figure 3. Memories that occurred within the most recent year of life were not included because doing so would have required extending the vertical axis, making the rest of the curve less visible. Data from 50- and 60-year-olds from the same three and one additional laboratory (Zola-Morgan, Cohen, & Squire, 1983) yielded similar curves. Data from 40-year-olds did not show a clear bump.

The second plot in Figure 3 is a combination of the twenty 70- and twenty 73-year-old subjects from Rubin and Schulkind (1997c) who each provided autobiographical memories to 124 cue words. Again, all memories from the most recent year were eliminated and the area under the curve set to 100%.

The third plot is from Hyland and Ackerman (1988). Subjects were cued with object nouns, activity verbs, and feeling terms from Robinson (1976). Older volunteers showed a clear increase in memories, which peaked in their teens and early 20s. In Figure 3, we plot the data from 12 volunteers with a mean age of 70. Hyland and Ackerman did not exclude recent memories, but report that 47% of the 70-year-old subjects' memories occurred within the subject's most recent decade. In order to make their data comparable with the first two studies, the area under the first six decades of the Hyland and Ackerman data and the Rubin et al. (1986) plot were set equal to each other. Adults in their 60s also showed a clear reminiscence effect. Adults in their 50s showed a possible reminiscence effect, whereas those in their 40s had a nearly equal number of memories from their teens, 20s, and 30s, with 80% of their reports falling in the most recent decade of life. For these adults, as well as the 40-year-old subjects analyzed by Rubin et al. (1986), it is likely that any reminiscence effect was overshadowed by memories for recent events.

Jansari and Parkin (1996) also asked adults to provide autobiographical memories to each of Robinson's (1976) cue words. Half of the subjects were under normal instructions and half had the added requirement that all memories had to be older than 2.5 years. Independent of these instructions, for reasons that are not clear, the data differ slightly from the other data sets in that they have fewer recent memories and more memories from childhood. Nonetheless, if the area under the curves from both of Jansari and Parkin's conditions are equated, the two conditions show patterns similar to each other and to the other data sets. The data for the average of their two conditions for their oldest group, who were between 56 and 60 years old, are plotted in Figure 3, with the area under the curve up to age 50 set equal to that of the Rubin et al. (1986) data set up to age 50.

Thus the bump is a robust and substantial effect. When older adults are asked to provide autobiographical memories from their lives without restrictions to the content or time period, they show a marked increase in memories for events that occurred in adolescence and early adulthood. The only way not to get this result seems to be to ask adults to recall events from individual thirds, quarters, or fifths of their lifespan for 5 or 10 minutes and to then see if some periods have more memories than others (Howes & Katz, 1992; Rabbitt & Winthorpe, 1988).

One question that remains with a method that lets people select whatever memory comes to mind is the role of demand characteristics. The cue-word procedure used is among the most open ended in cognitive psychology, and so exactly what the subject takes the experimental task to be is not clear. The method produces reliable findings, but there are differences in distributions that have no clear cause. Thus, for instance, Jansari and Parkin's (1996) results, which are shown in

Figure 3, have more early memories than other studies. To pursue this issue, a modification, or bias, in the standard instructions was made to favor earlier memories. Instead of asking for *events in a memory experiment*, Rubin and Schulkind (1997c) asked for *memories in an autobiographical memory experiment*. They also changed the content of their one example from a recent event to a childhood event. Figure 4 compares two groups of twenty 73-year-old subjects who, except for the differences just noted, performed the same task with the same 124 cue words. As can be seen, although the bump remains, the effects of such subtle biasing can be substantial. Thus, it appears that slight changes in the framing of a question in a survey of the order just noted, which could bias recalls from early to later periods, could change the autobiographical memories accessed to formulate a response.

Rubin and Schulkind (1997c) measured a host of other properties of autobiographical memories in the hope of distinguishing memories from the bump from memories from other periods. When memories for events from between 10 years old and 30 years old were compared with memories from other periods, there were no differences in reaction time, the properties of the cue words that evoked the memories

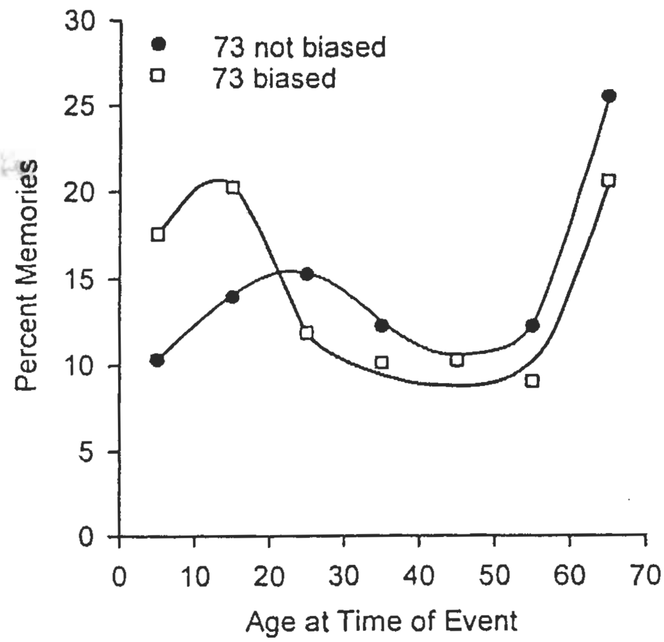

FIGURE 4. The distribution of autobiographical memories over the life-span for older adults, half of whom were biased to have earlier memories. (Adapted from Rubin & Schulkind, 1997c.)

(Rubin & Schulkind, 1997a), and rating scale measures including importance, vividness, emotionality, novelty, and number of times the memory was rehearsed. Because there are no simple obvious measures that distinguish memories in the bump from surrounding memories, it is difficult to know how, why, or even if memories from the bump differ from other memories.

In addition to the studies finding a bump when autobiographical memories were cued by words, several researchers found the bump when older adults were requested to provide either "important" or "vivid" autobiographical memories. Such findings are included here because important memories are more likely to be the basis of answers to some survey questions, whereas the more general word-cued memories are likely to be the basis of others. Instead of cuing each memory with a single word as in the studies just reviewed, Fromholt and Larsen's (1991, 1992) 30 subjects were asked to spend 15 minutes recalling events that had been important in their lives. The volunteers were between the ages of 71 and 89 and had an average of 7 years of education. For their important memories, the bump occurred at the same general place and shape as it did in the studies just reviewed. The change in procedure, however, increased the bump at the expense of memories from the most recent decade of life. In addition, there were slightly more memories in the 10–19-year-old decade than the 20–29-year-old decade. Thus, Fromholt and Larsen demonstrated that, at least for important memories, the bump's existence does not depend on the cuing technique or any details of its procedure and that the request for important memories produces relatively more bump memories. Similar results have been obtained with age-matched adults in the early stages of Alzheimer's dementia and with adults suffering from their first major depression (Fromholt, Larsen, & Larsen, 1995).

Fitzgerald (1988) asked individuals with an average age of almost 70 and an average of 12 years of education to record three "vivid" memories. The plots of the vivid memories correspond more closely to Fromholt and Larsen's (1991, 1992) important memories than to the cue-word studies just reviewed: the bump increased at the expense of recent memories. The bump peaked in the 16–20-year-old five-year period with fewer memories from the two surrounding five-year periods and still fewer from the 2 five-year periods surrounding them. In a later study, Fitzgerald (1996) found that adults between the ages of 31 and 46 produced a clear peak in their distribution of vivid memories between the ages of 16 and 25. Fitzgerald (1996) also demonstrated that younger and older adults both show a clear peak between the ages of 6 and 25 in the distribution of memories that would go into a book about their lives. The inclusion of younger groups demonstrates that the bump for vivid and important memories exists fairly early in life and that the lack of a clear bump in 40-year-old subjects with word-cued memories may be due to the overshadowing by recent memories.

Two additional studies of vivid memories with older adults provide similar results. Benson, Jarvi, Arai, Thielbar, Frye, and McDonald (1992) report on studies in which 10 vivid memories were requested from Japanese and rural Midwestern American subjects. Both groups showed a bump: the Japanese in the 21–30-year-old decade of their lives, the Americans in the 11–20-year-old decade. Cohen and Faulkner (1988) requested 6 vivid memories from adults ranging from 20 to 87. The bump was observed with the following exception. Subjects in the 40–59 and in the 60–87 age ranges recalled the most memories from when they were 0–10 years old.

In general, requests for vivid or important memories produce the bump in older adults, but with a reduction of recent memories compared with the word-cued distribution. Rubin and Schulkind (1997c) had the same forty 70- and 73-year-old subjects perform both tasks producing five important memories and approximately 124 word-cued memories each. The distribution of those subjects, who were not biased toward older memories, is shown in Figure 5. Here memories

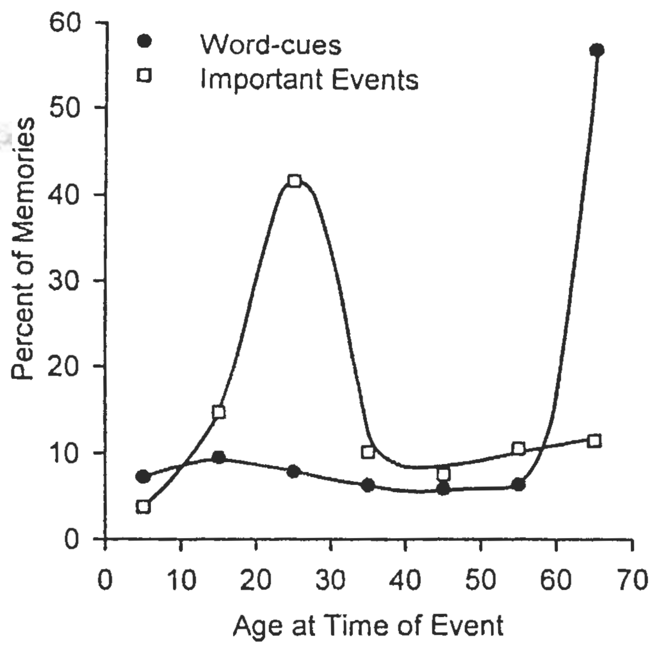

FIGURE 5. A comparison of word-cued and important memories obtained from the same older adults. (Adapted from Rubin & Schulkind, 1997c.)

from the last year are included to allow for a clearer comparison between important and word-cued memories. Consistent with the other studies, the request for important memories produced fewer recent memories. In addition, for the highly educated volunteers, who had an average of 16 years of education, the important memories are reported as falling heavily in the single decade when the subjects were in their twenties. Thus the important memories have a different, narrower, distribution than the word-cued memories. Comparisons with the other distributions of important memories indicate that the location and width of the peak changes with different populations and procedures, with a tendency for groups with less education to have earlier peaks. Nonetheless, the within-group comparison shown in Figure 5 clearly indicates that requests for memories of one kind or another can affect the period of the life-span from which the memories originate. Thus, questions whose answers are based on a different aspect of autobiographical memory may rely on different distributions.

The results reported so far are all from psychological laboratories, though not especially well controlled ones. Similar results appear outside the lab. Figure 6 presents the distribution of episodic and more

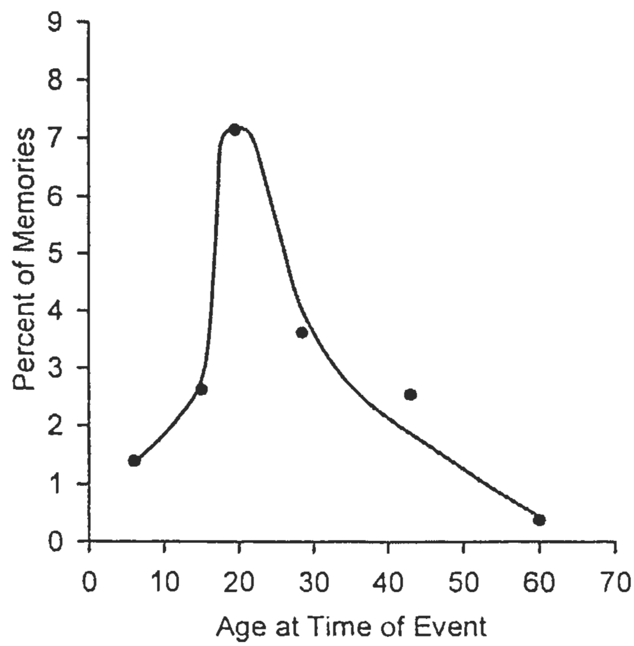

FIGURE 6. The distribution of memories recorded in published autobiographical sketches by famous psychologists. Memories for specific events and those extended over time were combined, weighted by their relative frequency. (Adapted from Mackavey, Malley, & Stewart, 1991, Table 2.)

extended events from the published intellectual autobiographies of famous psychologists (Mackavey, Malley, & Stewart, 1991). The same bump appears here as in the request for important memories from less famous subjects.

The bump also appears when one asks for public, as opposed to private, events. Using telephone surveys, Schuman and his colleagues have shown that when people are asked for the most important event or change in the last half-century, they tend to report events or changes from when they were 10–30 years old (Belli, Schuman, & Jackson, 1997; Schuman, Akiyama, & Knäuper, 1997; Schuman, Belli, & Bischoping, 1997; Schuman & Rieger, 1992; Schuman, Rieger, & Gaidys, 1994; Schuman & Scott, 1989). Figure 7 shows the percentage of responses given as the most important public event of the last 50 years that were either World War II, John F. Kennedy's assassination, or the Vietnam War as a function of the age of the respondent at the time of the event. In the

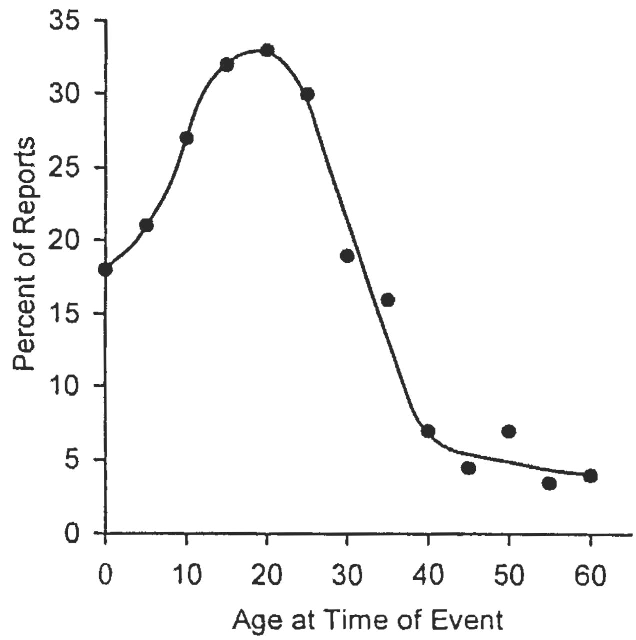

FIGURE 7. The percentage of people who judged either World War II, the assassination of John F. Kennedy, or the Vietnam War to be the most important public event of the last 50 years as a function of the age of the person at the time of the event. The values reported are the average percentages of these three events for each five-year period. For the first periods and the periods over 40 years, the averages are based on less than three events because there were no respondents who were of that age at the time of the event. (Adapted from Schuman & Scott, 1989.)

original studies, numerous plots of individual events show the same pattern. The questions and methodology in the work of Schuman and his colleagues are different from the other work reviewed here, but the basic results are the same, indicating that survey and experimental methods lead to the same results. Events judged as important by people are more likely to happen when those people are between 10 and 30 years old. Neisser (1982), in his discussion of flashbulb memories, notes that the recall of one's personal circumstances at the time of an historical event ties one's autobiography to history. Having important personal and public memories peak at the same period of the life-span makes this more likely to occur.

Having dealt at length with the distribution of episodic, autobiographical memories, the relation of such memories to more semantic memories should be considered. There are no studies for such semantic memories, or laboratory studies of any kind, that show the several-order-of-magnitude drop shown in Figure 1, but it will be argued here that for the limited range the data available, such memories follow the same pattern as that already presented. The most well known studies of very-long-term memory for factual material have been done by Bahrick and his colleagues (Bahrick, 1983, 1984; Bahrick, Bahrick, & Wittlinger, 1975). In these studies, there is a rapid drop in memory after initial learning followed by a steady period of little observable drop that lasts a lifetime. Bahrick has described the existence of memories that decline little over decades as *permastore*. Bahrick finds this permastore retention function in many domains, but always in studies in which the material was initially learned early in life, during high school or college, and then tested later at intervals of between a few days and 50 years. If the data in Figure 1 were plotted on a linear scale, they too would drop rapidly and then level off. To show the similarity, some permastore data from Bahrick is plotted in Figure 8 with a power function fit (for more detail on this analysis, see Rubin & Wenzel, 1996). The power function and logarithmic function both fit Bahrick's data, as well as most data collected in the psychological laboratory (Rubin & Wenzel, 1996). If either the logarithmic or power function is used to describe retention, then ratios of time are what is important. The ratio of 3 years to 1 minute is 1,577,880 to 1. By comparison, the ratio of 60 years to 3 years is a meager 20 to 1. Thus, these functions and permastore make very similar predictions about the future loss of any information that still has a moderate level of recall after three years: It will show very little further loss.

Bahrick's studies fit the retention component first discussed in this chapter, but have little to do with the bump. In the data presented here for the bump, the age of the acquisition of the memories varied

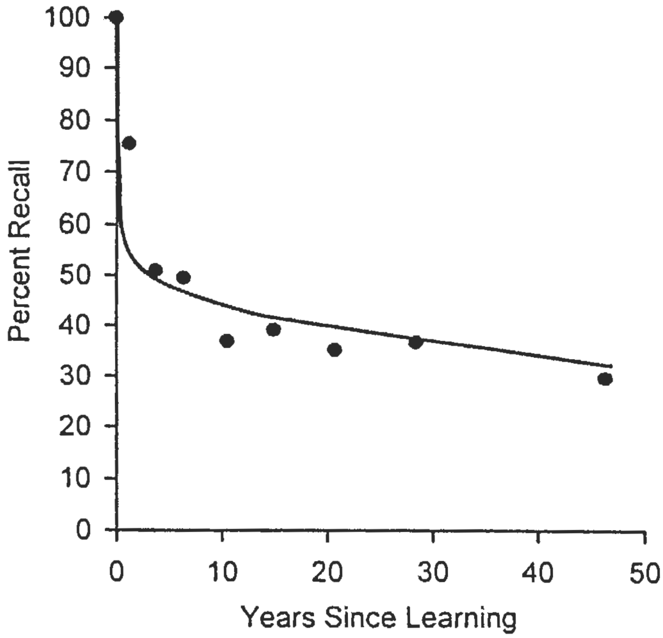

FIGURE 8. Retention data from an aggregation of six free-recall measures of knowledge of campus geography taken from Bahrick (1983). The level of initial learning was set equal to 100%. The curve shown is a power function. (Adapted from Rubin & Wenzel, 1996.)

across the life-span, and the age at recall of the memories was usually held constant. That is, the x-axis was always age at time of learning. The exception are the data reported from Schuman which varied both in age at learning and age at test, but even here the x-axis was age at the time of learning. In contrast, in Bahrick's studies, the age at learning was always fixed and the retention interval could have been labeled in terms of the age of the subject at the time of the test. That is, in the data that produce the bump and in the data that produce permastore, different variables are confounded with retention interval. In contrast, when we test 70-year-old subjects for factual, semantic material learned at different points in the life-span, the bump is still present.

Rubin, Rahhal, and Poon (1998) constructed multiple-choice questions in a mechanical algorithmic fashion for each year data was available for each of the following five domains: what teams played in the world series, what movie won the academy award, who won the academy award for best actor or actress, what was the most important news event according to the Associated Press, and who lost the presidential election. Thirty older adults were tested in 1984 and 30 other older adults were tested in 1994 to unconfound the particular questions from the subjects' ages at the time of the event queried. All topic areas showed better recall in the bump period than in later years. The combined data for all questions are shown in Figure 9, extending the autobiographical, episodic, free recall results from the studies presented earlier (which had answers that were not checked for correctness) to public, semantic recognition of verifiable responses.

The implications of these distributions for survey research are clear. If the questions respondents are to answer on a survey are based on autobiographical memory, then the database available to them is not uniformly distributed over their life-spans. Rather, the vast majority of memories will come from the recent past. For older adults, there will be a second smaller peak from when they were 10–30 years old. For important or vivid memories, the 10–30 bump can contain more memories than the recent few decades. The answers a respondent gives will be influenced by these distributions to the extent that the available memories differ from those that would have arisen from a more uniform sampling of memory. Because the form of the question can affect the distribution of autobiographical memories obtained by biasing toward older or more recent memories or toward important or more

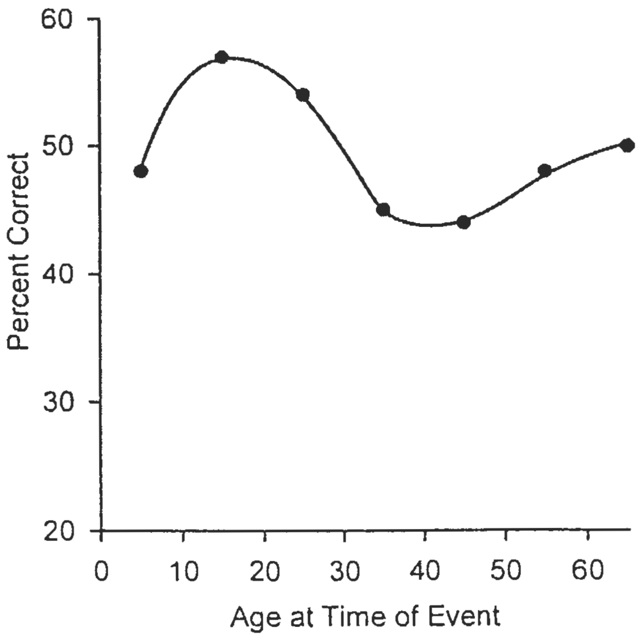

FIGURE 9. The percent of correct answers of older subjects to five-alternative multiple-choice questions as a function of their age at the time of the event questioned. The *y*-axis begins at 20%, which is chance.

general memories, one cannot be sure exactly what distribution any given survey question would produce without empirical testing. However, the effects discussed here are robust enough that they will certainly play a role.

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