Memory & Cognition
1989, 17 (6), 653-661

Telescoping is not time compression: A model of the dating of autobiographical events

DAVID C. RUBIN
Duke University, Durham, North Carolina

and

ALAN D. BADDELEY
MRC Applied Psychology Unit, Cambridge, England

A model of telescoping is proposed that assumes no systematic errors in dating. Rather, the overestimation of recent occurrences of events is based on the combination of three factors: (1) Retention is greater for recent events; (2) errors in dating, though unbiased, increase linearly with the time since the dated event; and (3) intrusions often occur from events outside the period being asked about, but such intrusions do not come from events that have not yet occurred. In Experiment 1, we found that recall for colloquia fell markedly over a 2-year interval, the magnitude of errors in psychologists' dating of the colloquia increased at a rate of .4 days per day of delay, and the direction of the dating error was toward the middle of the interval. In Experiment 2, the model used the retention function and dating errors from the first study to predict the distribution of the actual dates of colloquia recalled as being within a 5-month period. In Experiment 3, the findings of the first study were replicated with colloquia given by, instead of for, the subjects.

Telescoping occurs when people respond with an overestimate when asked questions such as how many times they have visited the doctor during the past 6 months or how often in the past 2 weeks they have purchased a particular product (Bradburn, Rips, & Shevell, 1985; Loftus & Marburger, 1983; Sudman & Bradburn, 1973; Thompson, Skowronski, & Lee, 1988). The phenomenon is called *telescoping*, because it is as if time shrinks to the present, in a temporal equivalent to the shrinking of distance that occurs when an object is viewed through a telescope. Such shrinking should cause events with actual dates before the target period to be recollected as if they had taken place within the target period. Here we will show that telescoping is a result of the way the question is asked rather than a result of the compression of time.

Note that no measure of time distortion is taken in survey questions that ask for frequency of occurrence in an interval. In fact, survey researchers have long noted overestimation of frequency caused by items being imported into a category when time is not involved. Mahalanobis (1946) noted systematic biases in the yield of jute in the Bengal crop survey of 1940-1941 as the size of the sample plot varied. As the square sample plot increased from 1 to 3 to 12 to 16 ft on a side, the estimated yield, in pounds per acre, decreased from 1,160 to 535 to 428 to 395. Similar effects were noted for rice and wheat. Mahalanobis's first hypothesis was that jute immediately outside the boundary was telescoped in for purposes of the count. In fact, the telescoping of crops near the boundary of plots did not explain the systematic biases that Mahalanobis noted; nonetheless, the observation and theory was the initial impetus for our investigation. It is plausible that in trying to answer correctly, people might have included events or plants that were near the boundary. If the question had been worded, "How many times in the last month did you . . . ," then only events older than the interval could have been imported, because events more recent than the interval would have been in the future; a systematic telescoping error would have resulted though no systematic time compression existed.

If standard studies showing telescoping based on the frequency of reported events need not demonstrate time compression, are there any studies in which time compression has been shown directly? In three diary studies of the dating of autobiographical memory (Rubin, 1982; Wagenaar, 1986; White, 1982), an overall lack of time compression has been found; the errors in dating resulted just as much from overestimation as from underestimation of the dates of verifiable events. In contrast, Thompson et al. (1988) have provided what appears to be a clear example of time compression. In three experiments, students were asked to date events from diaries that they had been keeping for 12 weeks. Thompson et al. divided the 12-week period into six intervals with mean delays of 1,

We wish to thank Herb Crovitz for early discussions of telescoping, Willem Wagenaar for making his data available, Wanda T. Wallace for computational assistance, Harry Bahrick and Chuck Thompson for their comments, and our colleagues at the Applied Psychology Unit who served as subjects. Partial support was provided by NIA Grant AG04278 and a Cattell Fund Sabbatical Award. Correspondence may be addressed to David C. Rubin, Psychology Department, Duke University, Durham, NC 27706.

3, 5, 7, 9, and 11 weeks. All three experiments resulted in statistically significant time compression of events from the oldest intervals and consistent but nonsignificant expansion of time for the most recent intervals. Averaging over the three experiments, the dating errors in days were −.3, −1.0, −.2, .6, 3.6, and 5.6, where positive values indicate time compression. Thus, although all six intervals show errors toward the middle of the 12-week period, the telescoping errors are much larger than the reverse telescoping errors. There is, however, another factor at play.

Errors in judgment increase as the magnitude of the judgment increases for most forms of judgment, and time is no exception. Baddeley, Lewis, and Nimmo-Smith (1978) had people report the date of their last visit to the Applied Psychology Unit to take part in an experiment. They found that the magnitude (i.e., absolute value) of their dating errors increased at a rate of .19 days per day of elapsed time. Thompson (1982) had undergraduates record events over the course of a semester for themselves and their roommates. They then dated these events at the end of the semester. The median absolute error increased at a rate of approximately .16 days per day of elapsed time, with no difference between the undergraduates who recorded their events and the roommates who did not know which events were being recorded. In Thompson's (1985) study, a similar procedure produced a slope of approximately .10 days error per day elapsed, for subjects who recorded only their own events. Because in Thompson's studies the median of the absolute errors occurring in a 1- to 3-week period was used for each subject, the slopes are probably less than would have been obtained for the raw data.

Other studies contain data that support the linear time estimate of errors. Linton (1975) presented the mean absolute error of dating her diary items as a function of time. For events less than a week old, her dating is excellent. Calculations we made from her Figure 14.4 for dates between a week and 4 months old show that errors increased at a rate of approximately .22 days per day of delay. Rubin (1982) had students who had kept diaries for an average of 6 years recall events cued by words, date the events, and then check the dates in their diaries. A reanalysis of the data shows that the absolute error increased at a rate of .15 days per day. In particular, when all 504 dated diary events were included in an analysis as individual points, the absolute error in days was predicted by the equation .15 days ago − 5.21 (r^2 = .168). Thus, for the five studies reviewed, the magnitude of errors in the dating of events from a person's life increased, in a Weber's law fashion, at a rate of about 1 day for each week that passed.

Given these results, let us therefore not look at errors in dating as a function of time, but rather at relative errors in dating (i.e., dating error/time ago). For this measure, being off by 1 day in dating an event that occurred a week ago would be equivalent to being off by 4 days for an event a month ago. Dividing Thompson et al.'s (1988) errors for events by the number of days ago, the events occurred results in relative errors of −.04, −.05, −.01, .01, .06, and .07. The same pattern of movement toward the middle occurs, but now there is no clear overall bias toward telescoping. Rather, relative errors in the forward and reverse directions are nearly equal. The reason net telescoping occurs for Thompson et al.'s data, then, need not be time compression; rather, it can be explained by errors' increasing with the magnitude of the quantity judged.

There remains the question of why errors move responses toward the middle of the interval. This effect, which is due to boundary effects, is a variant of Mahalanobis's (1946) theory; it occurs if the sample plot is the whole field. The subjects know that all the events they are asked to date have occurred during the experiment. Errors in dating events near the start of the diary-keeping experiment can only move the response to a more recent date, unless the subject is willing to provide a date from the time before the experiment began. Errors in dating events near the end of the diary-keeping experiment can only move the response to a more distant date, unless the subject is willing to provide a date from the time after the experiment ended. This effect, which is also apparent in Figure 2 of White's (1982) diary study, can be described as errors in dating causing the recollected dates to regress toward the mean date of the interval (Brown, Rips, & Shevell, 1985).

A formal model of the effect of boundaries on dating was developed by Huttenlocher, Hedges, and Prohaska (1988) to account for systematic dating errors and was tested on reports of when people attended campus films that were shown only once during the academic year. The model, which assumes a normal error distribution that is truncated at boundaries, accounts for what otherwise looks like time compression. The model also accounts for distortions caused by internal calendar boundaries as described both by Robinson (1986) and by Loftus and Marburger (1983). Thus, the known cases of time distortion can be accounted for by boundary effects coupled with errors that increase with the magnitude of the response; no systematic dating bias is needed.

We have claimed that there is no direct evidence that telescoping is produced by time compression. In order to support this view, we need both a model that can produce telescoping without time compression and an experimental demonstration of its feasibility. Such a model, which is quite simple, consists of two factors: availability and dating accuracy. Consider Figure 1 as a hypothetical availability function—that is, as a representation of what percentage of events subjects can recall as a function of time. There are two observations of note: No events are recalled from the future, and, following an Ebbinghaus-type retention function, more events are recalled from the recent than from the remote past. Consider Figure 2 as a hypothetical error function for dating

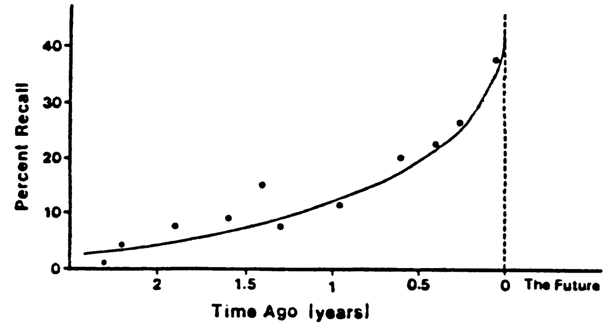

Figure 1. The percentage of colloquia (from Experiment 1) recalled as a function of time.

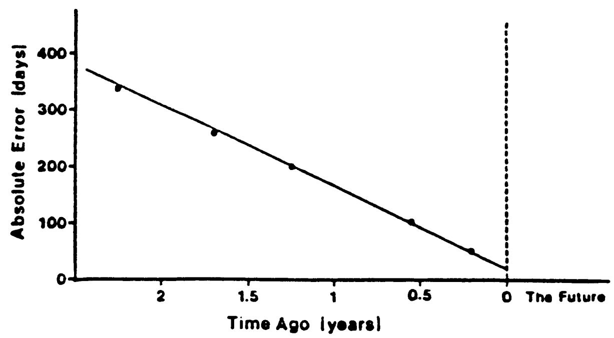

Figure 2. Absolute errors in dating the colloquia (from Experiment 1) as a function of time.

over the same period. Following a Weber's law function, absolute errors in dating increase linearly with increases in the time since the event. Both figures have a long history of empirical support. When given the task of recalling all events that occurred in a particular interval, the model (1) finds events based on the availability function shown in Figure 1, (2) provides each event with a recollected date equal to the actual date plus or minus an absolute dating error drawn from the distribution of absolute errors that produced Figure 2, and (3) reports the event if and only if its recollected date falls in the requested interval.

The model predicts telescoping for intervals that are bounded by the present (e.g., "How many times have you ... in the last ...") for two reasons. First, there are no intrusions into the target period from the future, because the availability function in Figure 1 is zero in the future. Second, although there is little recall from the distant past, the errors there are large enough to move recollected dates into the target period. For target periods not bounded by the present, telescoping or reverse telescoping could occur, depending on the balance between the decrease in availability with time and the increase in the magnitude of the errors with time. On the one hand, there is more recall for events from the recent past, but the errors are often too small to bring the recollected dates into the target period. On the other hand, there is less recall for events from the more distant past, but the errors tend to be much larger, often allowing these events to be recollected as occurring in the target period.

Consider Figure 3 as a hypothetical example containing the model's predictions, based on Figures 1 and 2, for recall from a target period ranging from 2 to 7 months before the recall. The figure shows the *actual dates* of events that the model reports as occurring in the 5-month target period. In particular, the figure is a histogram representing the number of events that had the *actual date* listed on the *x*-axis and a *recollected date* somewhere within the target period. Events that a subject or the model recalled but did not report because they did not receive a recollected date within the target period do not appear on the histogram, even if their actual dates were within the target period. There is slightly less telescoping (the area under the curve to the left of the target period) than reverse telescoping (the area under the curve to the right of the target period). Combined, events with actual dates in the telescoping period and the reverse telescoping period contribute about the same number of reported memories as do events with actual dates within the target period.

An alternative model was recently developed independently by Huttenlocher et al. (1988) to account for similar effects. Their model attempts to predict biases in dating caused by boundaries, whereas our model is formulated to account for the increased frequency of reporting of recent events. In particular, the Huttenlocher et al. model makes quantitative predictions about the size of time judgment errors (something our model does not do), and our model makes use of a retention function to construct a histogram of the actual dates of events reported as being within a target period (something the Huttenlocher et al. model does not do). The models are similar, however, both in assuming that the magnitude of dating errors increases with the time since events and in assuming that events with dates remembered as being outside of the target interval are not reported (although the Huttenlocher et al. model sometimes reports such events).

The remainder of this paper provides evidence for and describes the details of our model.

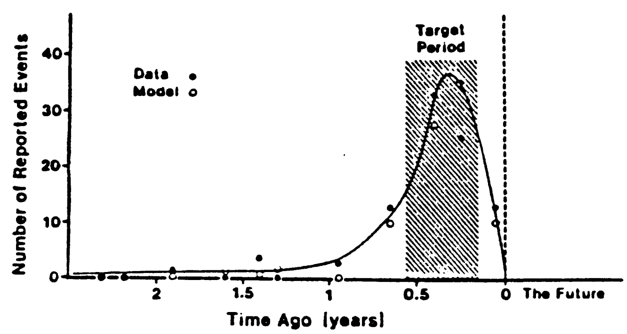

Figure 3. The distribution of colloquia reported as being in a 5-month target period, as a function of the actual dates of the colloquia reported. The data points are from Experiment 2. The model's points are based on data from Experiment 1.

EXPERIMENT 1
RECALL AND DATING OF 2 YEARS OF COLLOQUIA

Method

The main colloquia at the Applied Psychology Unit are the Thursday afternoon Chaucer Club talks. Over a period of 2.5 years there were 76 such talks. Fourteen members of the Unit who had been attending for more than 2 years were asked the following question: "Please recall each Chaucer Club talk that occurred in the last 2 academic years, that is after August 1, 1984. Please record enough information, such as the person giving the talk and/or the topic, to uniquely identify each Chaucer Club talk." There are typically no talks during the summer, so the August date provided a natural break point. After completing this section, subjects were given the speaker and topic of 25 Chaucer Club talks in a random order and asked to provide the date on which each occurred. The 25 talks were selected from among the 76 to be as uniformly distributed as possible across the 2.5-year period. Finally, the subjects were given a list of all the talks in alphabetical order and asked to indicate whether they had attended each talk.

Results

In order to obtain a smooth function, the 76 talks were divided into 11 time periods, each containing 7 consecutive talks—except for the most distant time period, which had only 6. Regression equations for the 11 data points were fit under the assumption that the 11 points are independent observations. Functions more complex than linear decay are more appropriate to describe these data (Rubin, 1982), but only linear trends were examined, because the limited data available are not sufficient to distinguish among the various monotonically decreasing functions.

Figure 1 presents the recall scores. There is a marked and fairly linear decrease in the percentage of recalled values with time, which can be described by the following equation: recall = −0.035 days ago + 29.64 (r^2 = .826).[1]. The equation including only the nine points within the 2-year period is: recall = −0.026 days ago + 24.25 (r^2 = .799). The recalls of colloquia in Figure 1 from before the 2-year target period are colloquia that were telescoped into the 2-year target period. No reverse telescoping was possible, because the 2-year period was bounded by the present.

The percentage of attended responses can be viewed as a recognition task. If one assumes uniform attendance, which is supported by casual observation over the years studied, then this attendance function describes the drop in recognition for the names of the speaker and the titles of the colloquia. The regression equation is: attend = −0.015 days ago + 45.26 (r^2 = .243, p = .12). Thus, as in laboratory studies, recognition, if it can be shown to decrease over time, decreases more slowly than recall.

The 25 talks for which dates were requested were grouped into five sequential categories of 5 colloquia each. The dating error was calculated by subtracting the actual date from the recollected one. Therefore, positive errors indicate movement toward the date of testing (June 12, 1986), or telescoping. In agreement with Thompson et al. (1988), older colloquia lead to telescoping, and more recent colloquia lead to smaller reverse telescoping. From the oldest to the most recent interval, the average dating error in days is 295, 198, 97, −51, −45 [$F(4,32)$ = 18.29], which can in large part be accounted for by a linear trend [$F(1,8)$ = 74.19]. Figure 2 displays the dating errors when the sign of the error is ignored (i.e., the sign is always considered to be positive). The errors differ across the intervals [$F(4,32)$ = 13.83], attributable in large part to a linear trend [$F(1,8)$ = 41.87]. The increase as the colloquia move from the present is about .40 days per day, or roughly twice what Baddeley et al. (1978) observed for visits made to take part in an experiment and twice what Linton (1975), Rubin (1982), and Thompson (1982, 1985) observed for diary entries. The larger errors here probably occurred because the particular colloquia fit less distinctively with ongoing events in the subjects' lives than did the events dated in the other studies.

EXPERIMENT 2
RECALL OF 5 MONTHS OF COLLOQUIA

Method

The subjects were 13 members of the Applied Psychology Unit who did not participate in Experiment 1. Because not all the subjects had been at the Unit for 2 years, they were not a randomly selected sample from the same population as in the previous experiment. This sampling was made necessary by the limited number of total subjects at the Unit. The subjects were asked to "Please recall each Chaucer Club talk that occurred in the 5 months between December 1, 1985 and April 30, 1986." The end dates of this period were both within terms, so that they did not coincide with any clear temporal landmarks (Loftus & Marburger, 1983; Robinson, 1986).

Results

As in Experiment 1, recalls were collapsed into 11 groups of seven consecutive talks, with the oldest group having only six talks. This system resulted in the 5-month period of interest falling into exactly two groups. The percentage recall as a function of the actual date of the colloquia reported is given in Figure 3.

At a qualitative level, the data show that telescoping and reverse telescoping occur, in that talks from outside the 5-month period are recalled as having occurred within the period. If we had asked subjects to recall colloquia from the most recent 5 months, we could have observed only telescoping, because there would be no recall of talks from the future to lead to reverse telescoping. Before presenting a simulation to account for these data, we report an additional experiment.

EXPERIMENT 3
RECALL AND DATING OF COLLOQUIA BY THE SPEAKER

The data presented so far are from talks observed. Although memory for the occurrence of such events is part of autobiographical memory, it may differ in kind from events in which the rememberer plays a more central role (Larsen, 1988). Moreover, there was little recall for colloquia that occurred 2 years ago. In order to increase both the centrality of the events and the retention interval, we asked people to recall and date colloquia at which they had been speakers.

Method

Members of the scientific staff of the Medical Research Council's Applied Psychology Unit contribute entries to the Unit's weekly diary when they give talks that require their absence from the Unit. These weekly diaries were searched to find members of the scientific staff who regularly gave a moderate number of talks outside the Unit. Seven members of the scientific staff were asked to record in a booklet the place, topic, or other distinguishing feature of each talk they had given after 1980 that they might have recorded in the Unit's weekly diary. After the talks were listed, the subjects were asked to date all the talks. Finally, these subjects were given a numbered list of their talks taken from the Unit's weekly diary, and they were asked to place the numbers from this list next to the corresponding talks on their list of recalls. The subjects worked alone at their own pace. None of the subjects had taken part in Experiments 1 or 2.

Results

Measures were calculated for the 6 academic years from 1980-1981 to 1985-1986. Only 6 months of data were collected for the first period and 11 months for the last, so adjustments were made to normalize the data to 12 months. In particular, the number of talks in the diary and the number of talks recalled were multiplied by 12/6 for the first interval and 12/11 for the last interval. After normalization, the number of diary entries per year was fairly constant, with 49, 46, 42, 41, 35, and 44 entries going from the most recent to the earliest year.

The number of talks recalled as being in each of the academic years from 1985-1986 through 1980-1981, whether or not they were in the diaries, decreased slightly (46, 32, 27, 25, 27, and 12), as did the percentage of talks recorded in the diaries that were recalled (42%, 46%, 31%, 15%, 23%, and 23%). The absolute dating error appears to increase somewhat with the passage of time over the 6 years (76, 13, 128, 12, 41, and 195 days). The relative dating errors show a negative to near zero to positive trend with increasing delay (−65, −6, 14, −18, −1, and 195 days).

It appears that the subjects in this study, who were recalling and dating talks that they, as opposed to other people, had given, had smaller dating errors and a less steep retention function, though differences in the retention interval and the limited amount of data in Experiment 3 make quantitative comparisons tenuous. Moreover, because of the limited amount of data, there are no inferential statistics. Therefore, the apparent trends must be taken with caution. Nonetheless, the data are consistent with those of Experiment 1, indicating that those results should hold for events more central to one's life than listening to a colloquium.

A SIMULATION USING THE TWO-FACTOR MODEL OF TELESCOPING

Our model assumes that two factors produce telescoping in general and in the 5-month study in particular. The first is availability or recall; the second is dating accuracy. As in two-factor theories of recall-recognition, items are recalled first and then they are compared to the target interval to see if they fit. The availability factor includes two contributors to telescoping: the increased availability of recent events, and the lack of availability of events from the future.

Availability is taken to be the same as recall without the request that the talks be within a specific time period. This added simplification is probably wrong, in that availability probably can be directed to a time period (or more accurately to an "extendure" or other clearly marked period of one's life; e.g., see Brown, Shevell, & Rips, 1986; Linton, 1986; Robinson, 1986). That is, the use of time periods as organizations that help retrieval probably cannot be reduced to boundary effects, even if the dating errors caused by such boundaries can (Huttenlocher et al., 1988). Nonetheless, the assumption offers a good first approximation, and the only simple one available. To the extent that recall can be temporally directed to the requested interval, the model will produce a function that is flatter than the empirical data.

The first factor, availability, was estimated from the recalls from the 2-year study. Because the retention function reported for the 2-year study showed little recall from the beginning of the 2-year period, the request for a 2-year period probably differed little from a request without time limits. Each individual recall of a talk was listed. Estimates of dating errors also came from the 2-year experiment; all dating errors, including errors of zero days, were listed. The random pairings of recalls and the absolute value of dating errors from each of the 11 intervals, shown in Figures 1 and 3, were made with the restriction that all recalls had to be used once before any recall could be used twice and that all errors in each of the 11 intervals had to be used once before any error in that interval could be used twice.

In order to simulate a recollected date, the actual date of each recall and an error were combined by randomly assigning a positive or negative value to the error. This procedure allowed us to avoid building any systematic directional dating biases into the simulation, while it allowed the size of the errors to be smaller for more recent intervals. The 13 subjects reported a total of 89 colloquia, so pairings were made until 89 recollected dates fell within the 5-month interval. In the simulation, there were 212 events "recalled" by the first stage of the model that were assigned recollected dates outside the 5-month target period. The model did not report these events, much as we assume that a subject would not report an event that was recalled but that had a recollected date outside the target period. Of the 212 nonreported events, 95 were from the telescoping period, 46 were from the 5-month target period, and 71 were from the reverse telescoping period.

The subjects' dating errors near the boundaries of the date of the testing and the date they arrived at the Unit should be smaller than their errors away from these two boundaries, because these boundaries limit the dates that can be given. The simulation did not correct for the underestimation of the size of the actual dating errors due to the two boundaries, which could lead to an underestimation of intrusions. This underestimation could have been corrected, either through keeping the sign of the errors from the Experiment 1 data, and thereby using a sample of actual errors, or through increasing the size of the variance of the errors to account for the truncations that occur at boundaries. The increase in variance could have been made by using errors near the middle to estimate errors near the boundaries or by using the methods proposed by Huttenlocher et al. (1988).

The only complication to this simulation was that the recalls of the talks were sampled to reflect the date of arrival at the Unit of the subjects, some of whom were at the Unit for only a year. The recollected dates for these subjects were obtained by sampling the recalled talks at which they were present. The results of the simulation, which was performed with index cards and a hand calculator, are presented in Figure 3. The model provides a reasonable qualitative fit to the data, with perhaps a bit too little forward telescoping.

GENERAL DISCUSSION

A Formal Model

In presenting our ideas and data, we have made an effort to keep the mathematics to a minimum, both for ease of understanding and because the data at hand do not allow us to distinguish among various quantitative alternatives. Instead, a simulation based on data collected was used to test the feasibility of the proposed model. There are, however, considerable data and theories from other sources that constrain a quantitative model.

Studies of both laboratory recall and autobiographical memory indicate that the retention function should not be linear, exponential, or logarithmic. A power function offers a good two-parameter fit to the data, as do a hyperbola and several three-parameter functions (Rubin, 1982; Wickelgren, 1974). When intervals extend over decades and the subjects are over 40 years old, corrections for reminiscence will be required (Rubin, Wetzler, & Nebes, 1986); when intervals including early childhood are used, corrections for childhood amnesia will be required (Wetzler & Sweeney, 1986). For certain domains, people show very little, if any, loss after a period of 6 years (Bahrick, 1984). Nonetheless, for almost all practical applications, a power function would provide an excellent fit to retention data. Because only the relative frequency of recall as a function of time is needed, only one parameter, the exponent of the power function, needs to be estimated.

Errors in dating can be assumed to be distributed normally, or, if precision requires, log-normally (Rubin, 1976) around the true date with no systematic bias. The magnitude of the dating error can be assumed to increase linearly with the time since the event, leaving a second and third parameter to be estimated: the slope and the intercept of the magnitude of the error as a function of time ago. If the intercept were assumed to be zero, the third parameter would not be needed. Huttenlocher et al.'s (1988) truncated normal distribution could be used to help estimate the standard deviation of the underlying distribution from the observed distribution that is truncated because of boundaries. Alternatively, a long interval could be used to estimate dating errors, with dates near the boundaries of the interval being excluded from the calculations.

An analytical model would function in much the way the simulation did. The parameters needed could be estimated, using the same population and type of questions as in the final test or survey, which would provide an independent estimate of the degree of telescoping. First, events would be sampled in accordance with the power function. Second, the distribution of recollected dates for each point on the recall probability curve would be calculated, using an error from a distribution whose standard deviation increases linearly with the time since the event. Third, the proportion of the distribution of recollected dates that fell within the period requested would have their events reported, and the proportion of the distribution of recollected dates that fell outside the interval would have their events ignored.

This model, like the simulation, assumes that when people guess a date in the future, they simply reject the event as outside the target period, just as they do with a date from the time immediately before the interval began. In contrast, Huttenlocher et al. (1988) simply placed all future estimates at the present. A more plausible assumption than either of these might be that all dates placed in the future are rejected and dated again until they fall on a date that is not in the future, though not necessarily within the target period. Similarly, all past dates before some especially salient boundary, such as birth or moving to the place where the events of interest took place, might also be rejected and redated until they fell within reasonable bounds. This process of rejection and redating need not be conscious.

One aspect of behavior thought to cause telescoping (e.g., see Sudman & Bradburn, 1973) is overcompliance among respondents who are trying to please the interviewer by producing events about which they are being questioned. The model as it stands does not include this factor, but the model could be extended to include it, assigning a probability of less than 1 to the rejection of events whose recollected dates fall outside the questioned interval. This could involve either a function that is independent of how far the recollected date is from the interval, or an adjustable criterion that is sensitive to the distance from the interval boundary. Relaxing the adjustable criterion would increase the chance of falsely including events from outside the target interval with events near the boundary most likely to be added (Tanner & Swets, 1954). Such strategies would increase reporting. An examination of the rejections from the simulation indicates that the effect on the degree of telescoping would depend on the exact nature of the modification, because more events that occurred within the target period would also be reported. Nonetheless, rejection of fewer events would usually lead to a greater proportion of intrusions.

Alternative Dating Strategies That Lead to Time Compression

There exist many ways to date events. The events studied and reviewed up to this point had all played a role in the ongoing personal or professional lives of the subjects. They could all be tied to other events and dated relatively to them. But what would happen if the subjects were asked to date events not as easily related to ongoing activities, such as plane crashes, hijackings, assassinations, Supreme Court rulings, play openings on Broadway, and the presentation of assorted Nobel Prizes, Academy Awards, and Emmy Awards? If reported (Larsen, 1988)—as opposed to personally experienced—events were not as tied to ongoing activity, then normal dating in terms of reference points would be difficult. An alternative, and probably less reliable, strategy would be to date such events in terms of how vivid, detailed, or easily accessible memories of them are.

Brown et al. (1985) and Bradburn et al. (1985) proposed such an accessibility principle to account for temporal judgments and demonstrated its effectiveness for dating news events not clearly tied to the ongoing political narrative of national politics (Brown et al., 1986) or to the ongoing personal narrative of the lives of the subjects. For such events, more vivid memories lead to more recent datings; thus vivid memories demonstrate telescoping caused by time compression.

Could the accessibility principle result in noticeable telescoping for autobiographical memories that are more directly tied to subjects' lives, such as the ones studied here? Thompson et al. (1988) specifically addressed this question in their diary study. They found that, in all four of their experiments, the relationship between the clarity of memories as rated by the subjects and the dating errors did not support the accessibility principle. In fact, the direction of the difference in dating errors between poorly remembered and well-remembered events in all experiments, though not statistically significant, was in the wrong direction. Wagenaar's (1986) data appear to support the accessibility principle. Overall, he obtained no telescoping, but for events that he judged to occur once a month or less, he obtained telescoping. This could be interpreted as evidence for the accessibility principle, in that these rarer events are probably more vivid. On the other hand, it could be the distribution of these events that causes the net telescoping.

In fact, this is the case. Wagenaar produced 140 dating errors for salient events: 83 were telescoping errors and 57 were reverse telescoping errors. The average error for each year of the Wagenaar study from 1979 to 1983 was 451, 160, −205, −35, and 3 days, respectively. The number of errors in each year was 24, 56, 31, 17, and 12, respectively. The first observation to note is that, as in all the other studies examined, errors tend to move the recollected dates toward the middle of the interval. The second observation to note is that most of the errors come from early in the study: 80 from 1979 and 1980 versus 29 from 1982 and 1983. Net forward telescoping can be produced by combining these two observations with the standard increase in the magnitude of errors as the time since the events reported increases. If Wagenaar's errors in dating salient events had been distributed more evenly over the interval, as were his events in general, forward telescoping would probably not have occurred for his salient events. In any case, there is no evidence from Wagenaar's study to support time compression for salient events.

The data from Experiment 1 can also be used to address this issue. For each of the 25 dated talks, we know the mean dating error, the percentage of people who recalled the talk in the initial free recall task, and the percentage of people who remembered attending the talk. If recall and the report of attendance are measures of accessibility or vividness, we would expect positive correlations between dating errors and these variables—that is, more telescoping for colloquia, with higher reported attendance and higher recall. The correlations between the mean errors for the 25 talks and the percentages of people recalling and reporting attending the talks are $r(24) = -.400$ ($p = .048$) and $r(24) = -.086$ ($p = .682$), respectively—if anything, this is a correlation in the wrong direction.

The distinction between events that are and are not tied to other events in a subject's life has been presented as a dichotomy. It is not, and knowing under exactly what conditions the accessibility principle has a measurable effect remains an unsolved problem. Nonetheless, there is no evidence for the accessibility principle's effect in the dating of events that are part of a subject's personal narrative, even for events as loosely tied as weekly colloquia.

The Accuracy of Dating Cued Autobiographical Memories

One of the most frequently used methods of studying autobiographical memory was developed by Crovitz and Schiffman (1974). Subjects are asked to recall an event from any period of their lives brought to mind by each of a series of cue words. Later, the subjects are asked to date these events. This method produces lawful, interpretable data (Rubin, 1982), but the analysis of such data usually assumes that the dates given are unbiased estimates of the actual dates of the events. Considering what we know, how realistic is this assumption? If there were no systematic time compression, we would expect both reverse telescoping for recent events due to boundary effects caused by the present and telescoping for older events due to boundary effects caused by the subjects' dates of birth. There could, however, be no intrusions or events rejected because of dating, because the period queried consists of each subject's whole life.

The one diary study using the Crovitz and Schiffman method supports this claim. Rubin (1982) had 9 undergraduates, who had kept diaries continuously for an average of 6 years, generate memories in response to 100 cue words, date the memories, and check the dating in their diaries. A total of 504 dated diary events was found in this way. The first observation to note is that there was no overall telescoping. The mean overall error was 0 days. The second observation to note is that recollected dates tended to move away from the boundaries. A reanalysis of the Rubin (1982) data shows that, as with Thompson et al.'s data, there was an overall gross trend to telescope older events. The error in days, including the sign of the error, was predicted by the equation $-.08$ days ago $+$ 46.81, where the negative sign indicates increased telescoping as a function of time. This effect was small compared to the effects of accurate dating and the increased magnitude of errors with delay. The r^2 values for the correlation between the actual diary dates and the recollected dates, the absolute errors, and the errors including sign are .848, .168, and .044, respectively.

There is one kind of study of autobiographical memory, however, that is subject to the kind of telescoping errors discussed here. It is common in studies of childhood amnesia to ask subjects to recall all autobiographical memories they can from before a certain age, such as from before they were 8 years old (Crovitz & Quina-Holland, 1976; Waldfogel, 1948). In such studies, large reverse telescoping effects should be expected because (1) intrusions can only come from more recent events, not from before birth; (2) there are many more memories from recent years than there are from childhood amnesia years; and (3) the coherent time-line needed to date such events is especially weak for the period near birth. In fact, it may be the lack of a well-defined time-line that causes much of childhood amnesia. People may be able to remember events, but not be able to date them. Pilot data collected at Duke by Bobbie Brown and Tina Nugent support this speculation. The best predictors for the reported age at the time of an earliest childhood memory were indices such as the number of moves before age 5 and the number of younger siblings, indices that provide time markers in an otherwise uncharted time period.

In conclusion, we suggest that our simple model offers a psychologically plausible account of the phenomenon of telescoping, an account that is consistent with existing data. If the simulation or analytical version works for more extensive survey data, the model should offer a useful tool for the interpretation of results in the applied area of retrospective survey analysis. At the least, it calls for a revaluation of a temporal basis for telescoping.

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NOTE

1. Unless otherwise noted, all statistical tests cited are significant at the .001 level. Where used as the units of analysis, colloquia and events are assumed to be independent. Subjects with missing values were excluded in repeated measures analysis of variance tests.

(Manuscript received July 8, 1988;
revision accepted for publication May 8, 1989.)