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Memory for time: How people date events

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The effect of different formats on the accuracy of dating news and the distribution of personal events was examined in four conditions. In the first, participants had to date events in the absolute time format (e.g., "July 2004"), and in the second, they had to date events in the relative time format (e.g., "3 weeks ago"). In the other conditions, they were asked to choose between the two formats. We found a small backward telescoping effect for recent news events and a large forward telescoping effect for remote events. Events dated in the absolute time format were more accurate than those dated in the relative time format. Furthermore, participants preferred to date news events with the relative time format and personal events with the absolute time format, as well as preferring to date remote events in the relative time format and recent events in the absolute time format.

How do people date events? What kind of temporal information is stored? And what kind of temporal information is remembered? In the literature, there are different theories about how temporal information about events is stored. Friedman (1993) distinguishes three classes of theories about memory for time based on the kind of information that is stored—namely, distance, location, and serial order.

Distance is the amount of time that has elapsed between the occurrence of the event and the present. Distance is sometimes also called *relative time*. Examples of distance-based models of memory for time are the strength theory (Hinrichs, 1970) and the accessibility principle (Brown, Rips, & Shevell, 1985), in both of which the strength or the accessibility of the memory of an event determines whether the event is perceived to be recent or old. Brown et al. found that people thought that events they knew much about had occurred more recently than the events in fact had, and that events they knew little about had occurred more remotely than actually was the case.

Location, or absolute time, is the placement of an event in a larger time period. An example of a location-based model is the reconstructive theory (Anderson & Bower, 1972), in which subjects store information about the environment and their own internal state along with a particular item. Friedman (1993) found more evidence for such location-based theories of memory for the timing of past events than he found for distance-based theories, because location-based theories are able to explain properties of memory for time such as people's abilities to recall that an event happened at the beginning of a time period, to localize events accurately on a fine time scale but inaccurately on a grosser time scale, and to localize events more accurately in a heterogeneous time period than in a homogeneous one.

The third class of memory-for-time theories relates to serial order. Friedman (1993) referred to this class as based on relative time of occurrence, which should not be confused with relative time. *Serial order* or *relative time of occurrence* refers to whether an event occurred before or after certain other events, whereas *relative time* refers to the time between the occurrence of the event and the present. An example of a theory based on the relative time of occurrence is the associative chaining theory (Lewandowsky & Murdock, 1989), in which events are associated with events that directly succeed them in time.

The time associated with past events can be assessed in numerous ways (Skowronski, Walker, & Betz, 2003). Sometimes people are asked to estimate how long ago an event happened, which is called the *relative time format* because it is based on the amount of time between the event and the present. It refers to distance-based models of memory for time. At other times, participants have to estimate on what date or in which time period an event happened (Friedman & Huttenlocher, 1997). This is called the *absolute time format* because it is based on a fixed point or period in time, and it refers to location-based theories. In surveys, people are often asked how frequently events, such as doctor's visits, have occurred in a certain period (Loftus, Klinger, Smith, & Fiedler, 1990). Sometimes people have to decide which event occurred

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more recently (Skowronski et al., 2003) or in what order several events occurred (Burt, Kemp, Grady, & Conway, 2000). These formats refer to serial order models. In still other cases, people have to estimate the duration of events (Burt, 1992a; Burt & Kemp, 1991).

The accuracy of these assessments is often investigated with experiments in which participants have to record personal events for a certain period. After this period, they are presented with these events and asked to make temporal decisions about them (Barclay & Wellman, 1986; Betz & Skowronski, 1997; Burt, Kemp, & Conway, 2003; Burt et al., 2000; Gibbons & Thompson, 2001; Larsen & Conway, 1997; Larsen & Thompson, 1995; Linton, 1975, Study 3; Skowronski et al., 2003; Thompson, 1982, 1985a, 1985b; Thompson, Skowronski, & Lee, 1988; Wagenaar, 1986; White, 1982; see also Skowronski & Thompson, 1990). A second method is to ask people whether they keep a diary and, if so, to let them make temporal decisions about the entries in their diaries (Burt, 1992a, 1992b; Burt, Kemp, & Conway, 2001; Rubin, 1982, Experiment 5). A third method is to ask people to make temporal decisions about verifiable personal events, such as participation in an experiment or a medical examination (Auriat, 1992; Baddeley, Lewis, & Nimmo-Smith, 1978; Huttenlocher, Hedges, & Bradburn, 1990; Huttenlocher, Hedges, & Prohaska, 1988, 1992; Loftus et al., 1990; Prohaska, Brown, & Belli, 1998; Rubin & Baddeley, 1989; Sehulster, 1989). A fourth method is to ask people to make temporal decisions about when public or historical events occurred (Bratfisch, Ekman, Lundberg, & Krüger, 1971; Brown, 1990; Brown et al., 1985; Burt & Kemp, 1991; Crawley & Pring, 2000; Ferguson & Martin, 1983; Friedman & Huttenlocher, 1997; Kemp, 1988, 1994, 1996; Lee & Brown, 2004; Wright, Gaskell, & O'Muircheartaigh, 1997).

When people are asked what kind of information they used to determine when events occurred, they report various kinds of temporal information (Baddeley et al., 1978; Betz & Skowronski, 1997; Brown, 1990; Burt, 1992b; Linton, 1975; Thompson, Skowronski, & Betz, 1993): they state, for instance, that they knew the *exact date*; that they remembered a specific reference to another event (this category is usually called *related events*); that they remembered a general reference to a period (i.e., *context*); that they estimated the number of *intervening events*; that they used the clarity of memory to estimate the recency of the event (i.e., *accessibility* or *familiarity*); or that they remembered the day of the week in which the event occurred, because such events always occurred on a certain weekday (i.e., *temporal schemata*). Some of these subjective reports (i.e., exact date and context) correspond to location-based models, whereas other reports (i.e., intervening events and accessibility) correspond to distance-based models.

Friedman and Huttenlocher (1997) asked participants to date topics of a current affairs program and major news events from the last 9 months. Participants were asked to reply in the relative time format (e.g., weeks, months, or years ago) or in the absolute time format (e.g., exact date or month). Other responses were followed with the request to give an estimate of how many weeks, months, or years ago the story or news event happened. Friedman and Huttenlocher also asked which strategy the participants used: They asked them whether the stories or news events were related to other events, whether the content of the stories helped them to place the stories in time, or whether the vividness of the stories or the amount of information they could remember helped them decide how long ago the stories happened. Friedman and Huttenlocher found that participants answered in both formats, but preferred to respond in the relative time format. They did not find that participants used one strategy more frequently than the other strategies.

Shimojima (2002) asked university student participants how long ago they graduated high school and how long ago they entered university. Then, the participants had to rate how surprised they were at how little time had passed since the events. Although the students recalled the correct dates, they had the feeling that the events had occurred more recently than they had actually occurred. This feeling of time discrepancy was greater for the recent event (entrance into university) than for the remote event (high school graduation). These results indicate that people sometimes use multiple dating methods, such as location-based and distance-based methods, simultaneously, which leads to a feeling of discrepancy, because the more accurate location-based method gives a different estimation than does the less accurate distance-based method.

The results of Baddeley et al. (1978), Betz and Skowronski (1997), Brown (1990), Burt (1992b), Friedman and Huttenlocher (1997), Linton (1975), Shimojima (2002), and Thompson et al. (1993) show that people use both distance-based and location-based information to date events, rather than use one type of temporal information as is suggested by some theories of memory for the time of past events.

In this article, we propose a pragmatic model that identifies under what conditions (i.e., type and age of event) what temporal information (i.e., distance- or location-based) is employed. Therefore, the model integrates both types of memory-for-time theories. The model, represented in Figure 1, assumes that when an event is experienced, primary information is stored, including what the event is, who is involved, and where and when the event happens (Wagenaar, 1986). Primary (or *direct*) temporal information can include information about the time of day, weekday, or day of the month when the event occurs. Over time, parts, or even all, of this direct information may be lost, and with it some or all of the original memory. In addition to the primary temporal information, secondary (*indirect*) information is also stored (Anderson & Bower, 1972). Indirect temporal information includes information about the context of the event (Conway & Pleydell-Pearce, 2000; Linton, 1975, Study 2) and related events (Conway & Pleydell-Pearce, 2000; Kemp, 1996, 1999), such as landmark events (Loftus & Marburger, 1983). For

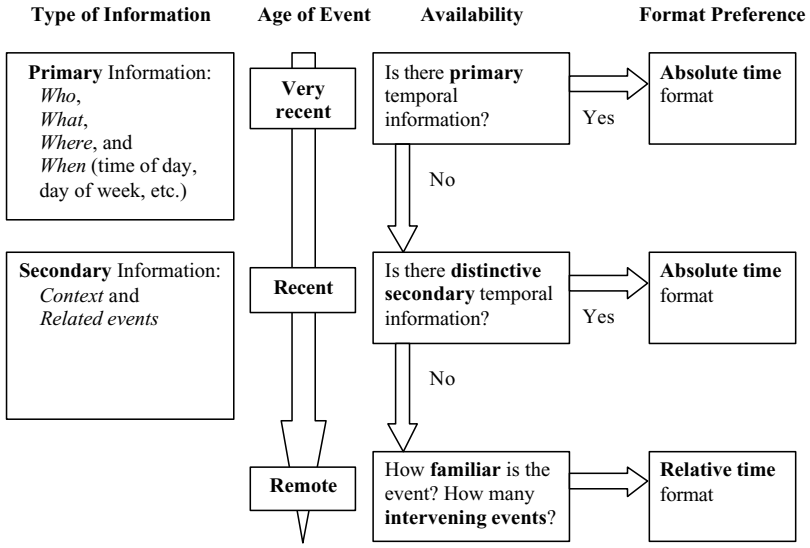

Figure 1. Schematic representation of which types of event information are stored, the age of an event, the availability of temporal information, and the preferred dating format.

instance, indirect temporal information may be where one lived or worked during the event, or which other events occurred shortly before or after. In time, this indirect information may also be lost.

Direct temporal information, such as time of day, weekday, or day of the month may be forgotten quickly. However, this information can be reconstructed with the help of secondary information (Brown, 1990), such as contextual information. For instance, if an event happened while someone was going to work, it follows that the event must have happened in the morning. This type of contextual information is called a *temporal schema*, which refers to general knowledge about when events occur (Larsen, Thompson, & Hansen, 1995). There are different levels of temporal schemata. The longest schemata concern a person's course of life (e.g., people go to kindergarten when they are about 4 years old), but other schemata concern shorter scales. The distribution of events in a year (Kurbat, Shevell, & Rips, 1998; Pillemer, Goldsmith, Panter, & White, 1988), a week (Gibbons & Thompson, 2001; Huttenlocher et al., 1992), or a day (people have breakfast in the morning) are examples of shorter temporal schemata. Larsen and Thompson (1995) had participants date personal events on a calendar and measured the absolute error in days. Errors that were multiples of 7 days were overrepresented. This means that the subjects were often correct about the day of the week but incorrect about the week. Gibbons and Thompson compared the accuracy of events dated on a calendar to the accuracy of events dated without a calendar and found that participants who were given a calendar dated more events correctly than did others who were not given a calendar. When participants with calendars made an error, they reported errors that were multiples of 7 days more frequently than did participants without calendars. Although calendars improve the accuracy of reported dates, they may be impractical for some types of research—for instance, work that focuses on longer intervals, such as lifetime spans.

In the experiment reported here, we asked participants to date personal and news events. The personal events were obtained using the Galton–Crovitz cuing method (Crovitz & Schiffman, 1974; Galton, 1879; Janssen, Chessa, & Murre, 2003, 2005), in which participants are presented with a cue word and have to describe the first memory that comes to mind. Later, the participants have to date these events. Dates of events obtained with the Galton–Crovitz cuing method depend on the temporal information given by participants. When using this method, however, one must be aware of the telescoping effect, which is the displacement of events in time (Huttenlocher et al., 1990; Rubin & Baddeley, 1989; Thompson et al., 1988): Dates may be either too recent (forward telescoping) or too remote (backward telescoping). We tested the telescoping effect by asking participants to date as well news events that had been validated in a prior experiment (Meeter, Murre, & Janssen, 2005). Our new experiment consisted of four conditions. In the first, participants had to date personal and news events in the absolute time format (e.g., "July 2004"). In the second, other participants dated events in the relative time format (e.g., "3 weeks ago"). In the third condition, participants were invited to choose between the absolute time format, which was presented at the top of the screen, and the relative time format, which was presented at the bottom. The last condition was similar to the third, but the presentation order of the formats was reversed.

We assumed that if participants employed location-based information, such as the exact date, related events, or contextual information, they would choose to answer in the absolute time format, because this format resembles location-based information better than does the relative time format.

If participants employed distance-based information to date the event, such as the clarity of the memory or the number of intervening events, they would choose to answer with the relative time format, because it corresponds better with distance-based information than does the absolute time format. We further assumed that the choice between the absolute and relative time formats would be based on the availability and distinctiveness of the secondary temporal information: If secondary information is available and distinctive, participants will employ location-based information and will prefer to date an event in the absolute time format. If secondary information is no longer available or distinctive, distance-based information will be used, and participants will prefer to date an event in the relative time format. Finally, we assumed that personal events are associated with more contextual information and more related events than are news events.

In the choice conditions (i.e., Conditions 3 and 4), we expected that very recent personal and news events would mainly be dated in the absolute time format, because contextual information and related events would be distinctive and accessible. Remote events would be dated mainly in the relative time format, because contextual information and related events would have been forgotten. When dating personal events, participants should more frequently use the absolute time format than when dating news events, because personal memories are related to more other memories and also elicit more contextual information.

On the basis of earlier research (Janssen, Chessa, & Murre, 2004), we expected that in the forced conditions (i.e., Conditions 1 and 2), the results for recent news events would display a small backward telescoping effect. On the other hand, we expected that the results for remote news events would display a greater forward telescoping effect. The absolute time format should also elicit a smaller backward telescoping effect for recent events and a smaller forward telescoping effect for remote events than does the relative time format.

Finally, we expected that in the choice conditions, as in the forced conditions, recent news events would be displaced backward more when dated with the relative time format rather than the absolute time format, and remote news events would be displaced forward more when dated with the relative time format rather than the absolute time format, because relative time estimates are based on less temporal information than are absolute time estimates.

METHOD

Participants

The test was administered via the Internet, where it is still available at memory.uva.nl/testpanel/gc/. Our participants could have come into contact with the Web site in at least four ways: (1) through links on other sites; (2) through search engines; (3) through promotion in traditional media, such as newspapers and magazines (many of which included our Web address); and (4) through word of mouth.

Before the participants started the test, we emphasized that the experiment was genuine and serious. We then asked them to provide informed consent and to give personal information, such as their date of birth, level of education, and e-mail address; how many times a week they read a newspaper or watched the news; and a user name and password. The participants could later use their user name and password to log in directly if they wanted to take the test a second time.

The mean age of the 1,579 participants was 44.29 years (SD = 14.53). The distribution of the participants is given in Table 1. The four groups did not differ with regard to age and education. However, the first group consisted of more men than did the other groups [$\chi^2(3, N = 1{,}579) = 13.561, \alpha < .001$].

Cue Words and News Questions

We selected 64 words with a value of 6.00 or more for imagery, concreteness, and meaningfulness from Paivio, Yuille, and Madigan's (1968) list and translated them into Dutch. Each participant received a random selection of 10 cue words from the list. The cue words and their Dutch translations are given in the Appendix.

To assess the telescoping effect, the participants were also given questions about when certain national and international news events took place. These news events had to be events that everybody could remember. The 96 news questions were selected from the Amsterdam Media Questionnaire (AMQ), developed by Klomps (2001), and the Daily News Memory Test (DNMT), developed by Meeter et al. (2005). Each participant received a random selection of 10 news questions. The AMQ is a retrograde amnesia test. We used it to derive news questions about events from the '50s through the '90s. The original AMQ contains fill-in-the-blank questions about news events that have been answered correctly by at least 70% of a reference population of normal participants. The selected AMQ questions were changed into questions asking for dates. For example, *Which princess died in Paris at the end of 1997?* was transformed into *When did Princess Diana die in Paris?* Events that could be dated through deduction, such as Olympic games or presidential elections, were not selected. The DNMT is an online retrograde amnesia test (memory.uva.nl) to which new questions are added every day. It was used to derive news questions about events from 2000 until 2004, and only multiple-choice questions that were answered correctly by 90% of the reference population were selected. The DNMT questions were changed as well to elicit a date. For instance, *In which sea did the Russian submarine Kursk sink on August 13, 2000?* was transformed into *When did the Russian submarine Kursk sink?*

Procedure

After the participants had read the instructions, they were given 10 cue words one by one. We gave the participants 10 cue words rather than 20, as Crovitz and Schiffman (1974) had, because we wanted to limit the number of participants who would drop out (Reips, 2000). Therefore, we designed the test in such a way that on average, the participants would take approximately 30 min to complete the test (M = 25 min 33 sec). While inspecting each word, the participants had to describe the first memory about a personal

Table 1
Number of Participants (N), Mean Age (With Standard Deviation), Number of Men (M), and Number of Women (F) per Condition

		Age			
Condition	N	M	SD	M	F
1. Abs.	396	45.06	14.33	157	239
2. Rel.	395	43.46	14.90	119	276
3. Abs. + Rel.	395	44.93	14.81	134	261
4. Rel. + Abs.	393	43.69	13.96	111	282
Total	1,579	44.29	14.53	521	1,058

Note—Abs., absolute time format; Rel., relative time format; for Conditions 3 and 4, participants could choose either the absolute or the relative time format, but the formats were presented on screen in the order given.

event that came to mind. They were explicitly told that the reported events did not have to be interesting, because we wanted to prevent them from describing only major events from their lives instead of the personal events that first came to mind. At this stage, they were not yet told that they would have to assign dates to these events later in the test, because we did not want them to describe only events they could easily date, such as birthdays or holidays.

After each cue word, the participants were given a news question. We expected that by alternating the recall of personal events and the dating of news events, the participants would be less likely to use a single period as a starting point for all their memory searches. In the first condition, the participants had to date news events in the absolute time format. In this format, they were asked to indicate when the event took place by assigning a date or a period to the event—for example, "June 17, 1997," "August 2000," or "1998." In the second, they had to date events in the relative time format. In this format, they had to estimate how long ago an event happened, for instance, "3 hours ago," "5 weeks ago," or "2.5 years ago." In the third condition, the participants were asked to choose between the absolute and relative time formats, and the last condition was similar, but the order of the formats on screen was reversed. The participants were asked to pick their choice with text fields and scroll-down menus; for instance, if they wanted to indicate that an event happened 1 year ago, they would enter a "1" in the number text field and select "year" from the unit menu. Participants could select "days," "weeks," "months," and "years" from the unit menu. If they wanted to answer that an event occurred in September 2002, they had to select "September" and "2002" from the scroll-down menus, but they could leave the day menu empty. To leave the day menu empty, the participants had to select the score option (i.e., "-"). The month menu had values from "January" to "December," the day menu from "1" to "31," and the year menu from "1930" to "2004." Finally, the participants could select a check box indicating "I have never heard of this event" if they did not know about the news event at all. However, they still had to give an estimate.

When the participants had finished describing memories and dating news questions, they were given the cue words and the accompanying memories again, and they were asked to date the memories in the same format or formats they had used for the news questions. After the test, the participants were given their answers and the correct answers to the news questions, as well as some information about the purpose of the experiment.

RESULTS

Participants were allowed to take the test more than once, because we wanted to prevent them from taking the test a second time under a different name (Reips, 2000). However, in this study we only analyzed the first test a participant took, for data collected between November 2003 and August 2004.

First, we checked the reported dates to see whether participants took one period in their lives as a reference for all their memory searches. To check this, the coefficient of variation was calculated (i.e., the standard deviation divided by the mean). Four participants were discarded for having a coefficient of variation smaller than 0.1. The other participants did not take a single period as a starting point; their average coefficient of variation was 1.466.

We also checked for the possibility that participants used the period of the previous news question as a starting point for the subsequent memory search instead of using the cue word. Absolute differences (in days) between the answer to a news question and the date assigned to the following personal memory were calculated. The participants did not use the news questions as a reference for the personal memories [$t(13919) = -0.272$, $p = .786$].

The numbers (and percentages) of events that participants indicated they had never heard of for each condition were, respectively, 453 (11.5%), 581 (14.0%), 389 (10.0%), and 466 (11.9%). These answers will be called guesses.

Preferences

When we compared the dating formats in the choice conditions, we found that in general participants preferred to date events with the relative time format [53.03%; $\chi^2(1, N = 14{,}807) = 22.02$, $\alpha < .001$]. However, when we further analyzed the dating formats in those conditions, we found that the order in which the formats were presented on the screen affected participants' choices [$\chi^2(1, N = 14{,}807) = 2{,}495.72$, $\alpha < .001$]. When the absolute time format was presented at the top of the screen (i.e., in Condition 3), participants preferred to date events with that format (67.75%). When the relative time format was presented at the top (i.e., in Condition 4), they tended to date events with the relative time format instead (73.30%). Presentation order affected the preferred dating format for both news events [$\chi^2(1, N = 6{,}948) = 1{,}098.73$, $\alpha < .001$] and personal events [$\chi^2(1, N = 7{,}859) = 1{,}451.10$, $\alpha < .005$].

When we looked at type of event and dating format, we found that participants preferred to date news events with the relative time format (58.26%), but they preferred to date personal events with the absolute time format (53.67%) [$\chi^2(1, N = 14{,}807) = 210.34$, $\alpha < .001$]; they preferred to date guesses with the relative time format [72.16%; $\chi^2(1, N = 855) = 168.00$, $\alpha < .001$].

Finally, when we looked at the age distribution of the dating formats, we found an effect of event age [$\chi^2(2, N = 14{,}807) = 318.63$, $\alpha < .001$]. We chose two cutoff points arbitrarily: 100 and 1,000 days. Participants preferred to date *very recent* events (within the last 100 days) with the absolute time format [59.49%; $\chi^2(1, N = 3{,}845) = 140.50$, $\alpha < .001$]. *Recent* events (100–1,000 days ago) were most frequently dated with the relative time format [53.87%; $\chi^2(1, N = 4{,}263) = 6.70$, $\alpha < .01$]. *Remote* events (more than 1,000 days ago) were also most frequently dated with the relative time format [59.29%; $\chi^2(1, N = 6{,}699) = 192.98$, $\alpha < .001$]. However, when we analyzed the events separately (see Figure 2), we found an interaction effect of age and type of event on the dating format [$\chi^2(5, N = 14{,}807) = 412.44$, $\alpha < .001$]: Participants preferred to date very recent news events with the absolute time format [55.80%; $\chi^2(1, N = 405) = 5.45$, $\alpha < .05$], recent news events with the relative time format [55.50%; $\chi^2(1, N = 2{,}991) = 36.19$, $\alpha < .001$], and remote news events also with the relative time format [62.19%; $\chi^2(1, N = 3{,}552) = 211.14$, $\alpha < .001$]. Similarly, they preferred to date very recent personal events with the absolute time format [60.00%; $\chi^2(1, N = 3{,}440) = 137.6$, $\alpha < .001$] and remote personal events with the relative time format [54.31%; $\chi^2(1, N = 3{,}147) = 23.34$, $\alpha < .001$], but re-

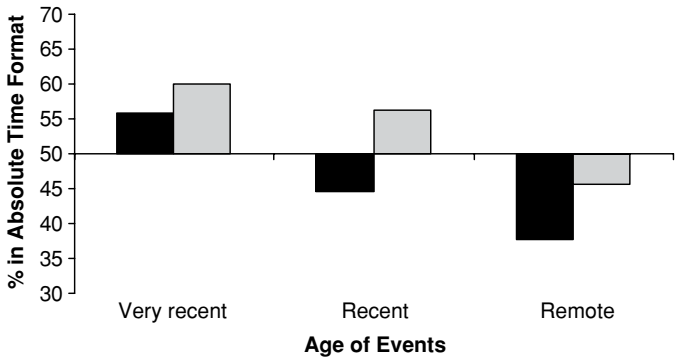

Figure 2. Percentages of events that are dated with the absolute time format for very recent, recent, and remote events and for news events (black bars) and personal events (gray bars).

cent personal events were most frequently dated with the absolute time format [56.29%; $\chi^2(1, N = 1{,}272) = 20.13$, $\alpha < .001$].

Estimate Specificity

When participants dated events with the absolute time format, they could either give the complete date, the month and year, or only the year the event had occurred. We found that dates for personal events were more detailed than those for news events (see Table 2). When participants dated their personal memories, they provided the complete date more frequently (62.7%) than when they dated news events (34.9%) [$\chi^2(2, N = 15{,}813) = 1{,}354.00$, $\alpha < .001$]. Furthermore, dates of very recent events were also more detailed than those of recent or remote events (see Table 3). When participants dated very recent events (within 100 days), they provided the complete date more frequently (85.7%) than when they dated events that happened more than 100 days ago (41.1%) or more than 1,000 days ago (35.4%) [$\chi^2(4, N = 15{,}813) = 3{,}187.42$, $\alpha < .001$]. Finally, dates for guesses were less detailed overall: When participants indicated that they did not know about an event at all, they more frequently provided only the year that the event occurred (54.6%) than for an event they indicated that they did know about (21.9%) [$\chi^2(2, N = 16{,}755) = 607.21$, $\alpha < .001$].

Table 2
Percentages of News, Personal, and All Events Dated in the Absolute Time Format With the Complete Date, the Month and Year, or Only the Year

	News Events	Personal Events	All Events
Complete date	34.9	62.7	50.4
Month + year	32.6	23.8	27.7
Year	32.5	13.5	21.9
Total	100.0	100.0	100.0

Table 3
Percentages of Very Recent, Recent, and Remote Events Dated in the Absolute Time Format With the Complete Date, the Month and Year, or Only the Year

	Very Recent Events	Recent Events	Remote Events
Complete date	85.7	41.1	35.4
Month + year	9.7	36.0	27.4
Year	4.7	22.9	37.1
Total	100.0	100.0	100.0

Note—Because of rounding, some columns do not total exactly 100%.

Telescoping Effect

The news events could either be dated as too recent (forward telescoping) or too remote (backward telescoping). When an event was displaced forward in time, we denote the error as negative, whereas positive errors mean that the event was displaced backward in time. We found that very recent news events were hardly displaced ($Mdn = -1$ day). Recent events were displaced backward in time ($Mdn = 23$ days), but remote events were displaced forward in time ($Mdn = -365$ days). When we looked at the differences between the conditions, we combined the events dated with the absolute time format in the choice conditions (3 and 4), as well as the events dated with the relative time format in those conditions. Figure 3 presents the median dating error in each condition for very recent, recent, and remote events.

The temporal displacements of events dated with the absolute time format (black diamonds, Figures 4 and 5) were best described with logarithmic functions ($y = -57.157 \ln x + 259.02$, $R^2 = .2482$ [solid black line, Figure 4] and $y = -36.427 \ln x + 151.51$, $R^2 = .2165$ [solid black line, Figure 5]). The temporal displacement of events dated with the relative time format (gray squares, Figures 4 and 5) were best described with linear functions ($y = -0.0876x + 18.931$, $R^2 = .6969$ [dashed gray line, Figure 4] and $y = -0.0962x + 32.341$, $R^2 = .6040$ [dashed gray line, Figure 5]).

When we compared the dating errors of the news events in the first condition and in the second condition, we found that the relative time format was less accurate than the absolute time format [$t(7046) = 6.575, p < .001$, two-tailed]. This overall effect was caused by differences in dating errors for recent events [$t(3063) = 3.347$, $p =$

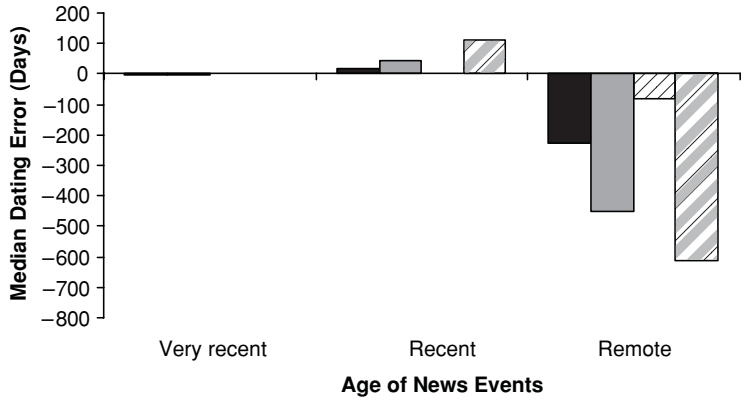

Figure 3. Median dating errors, in days, for very recent, recent, and remote events dated with the absolute and relative time formats in the forced conditions (black or gray solid bars, respectively) and the choice conditions (black or gray striped bars, respectively).

.001, two-tailed] and remote events [$t(3548) = 5.930$, $p < .001$, two-tailed]. Recent events dated with the relative time format were displaced backward in time more than those with the absolute time format, and remote events dated with the relative time format were displaced forward in time more than those with the absolute time format. We did not find a difference in the displacement of very recent news events.

Furthermore, when we compared the dating errors of news events in the choice conditions with the absolute and relative time formats, we found an overall difference [$t(6976) = 6.223$, $p < .001$, two-tailed]. We also found differences between the two formats in the dating errors of recent and remote events, but not in the dating errors of very recent events. Recent events dated with the relative time format were displaced backward in time more than those with the absolute time format [$t(2995) = -3.585$, $p < .001$, two-tailed], and remote events dated with the relative time format were displaced forward in time more than those with the absolute time format [$t(3579) = 7.608$, $p < .001$, two-tailed].

Finally, when we compared the dating errors of events dated with the absolute time format in the two choice conditions with the dating errors in the first condition, we found a marginally significant difference [$t(6393) = 1.688$, $p = .091$, two-tailed]; recent events dated with the absolute time format in the first condition were displaced backward in time more than those with that format in the choice conditions [$t(2860) = 3.914$, $p < .001$, two-tailed]. We also compared the dating errors of the news events dated with the relative time format in the choice conditions with the dating errors in the second condition. In this comparison, we found no overall difference. However, recent events dated with the relative time format in the choice conditions were displaced backward in time more than those with that format in the second condition [$t(3198) = -2.672$, $p = .008$, two-tailed].

Besides separate independent-samples t tests, we also tested the telescoping effect with a 3 (time: very recent, recent, or remote) × 2 (choice: forced or choice) × 2 (format: absolute or relative) ANOVA. We found effects of time [$F(2,14023) = 347.037$, $p < .001$] and format

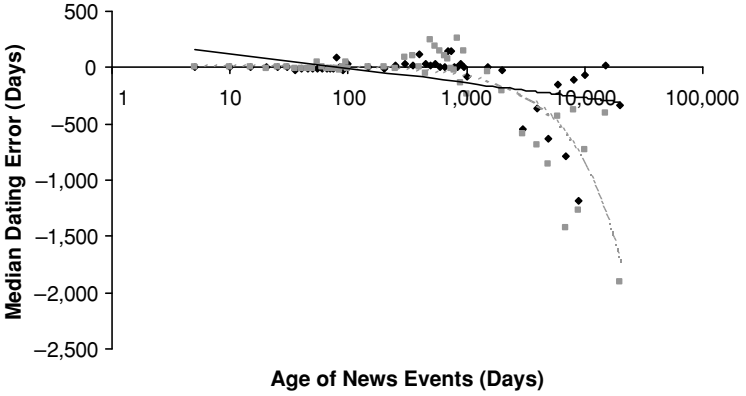

Figure 4. Median dating errors, in days, on a logarithmic scale for news events in the forced conditions (absolute time format, black diamonds; relative time format, gray squares), and their best-fitting functions.

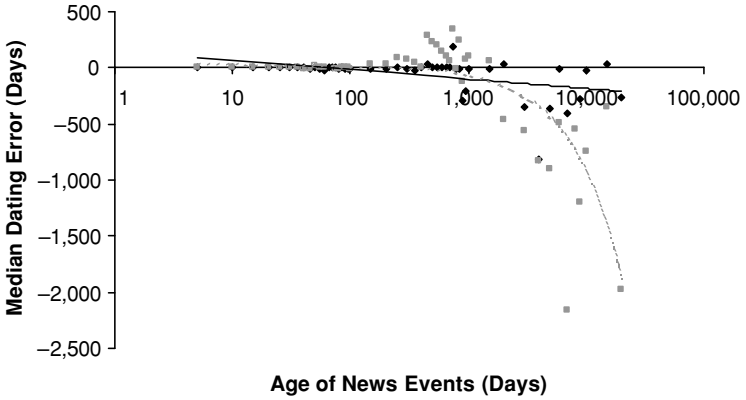

Figure 5. Median dating errors, in days, on a logarithmic scale for news events in the choice conditions (absolute time format, black diamonds; relative time format, gray squares), and their best-fitting functions.

[$F(1,14024) = 10.496$, $p = .001$], but not of choice. The displacement of news events increased as events became more remote, and news events dated in the relative time format were displaced more than those in the absolute time format. We also found an interaction effect of time and format [$F(5,14020) = 31.586$, $p < .001$] on the displacement of news events: The difference between the formats increased as news events became more remote. Finally, we found an interaction effect between time, format, and choice [$F(11,14014) = 5.846$, $p = .003$] in which the increase in difference between the formats was greater in the choice conditions than in the forced conditions.

DISCUSSION

We found that very recent news events, those within the last 100 days, were hardly displaced; people on average made almost no errors in dating these events. Recent news events, which had occurred between 100 and 1,000 days earlier, were displaced backward in time; that is, people thought these events had occurred longer ago than they actually had. However, news events that had occurred around 3 years earlier were, on average, hardly displaced once again. We will return to this point in a moment. Remote news events, which had occurred more than 1,000 days earlier, were displaced forward in time, so people thought those events had occurred more recently than they actually had.

Furthermore, the displacement of recent news events was smaller than the displacement of remote news events. The paradox that news events that had occurred around 1,000 days earlier were dated more accurately than those that had occurred between 100 and 1,000 days earlier was caused by the shift from backward to forward telescoping and by the use of signed rather than absolute dating errors. This shift may be explained by a relative change in the amounts of time prior to and after the event: If a news event has occurred recently, it is more likely that an error will be made backward, because there is more time prior to the event. If an event occurred a long time ago, it is more likely that the error will be made forward, because there is more time after the event (Rubin & Baddeley, 1989). The size of the absolute dating errors shows that the displacement in the dating of events increased linearly with time. Therefore, the news events in this experiment that had occurred around 1,000 days earlier were just as likely to be displaced backward as forward in time, but they were not dated more accurately than more recent events.

Prior research (Friedman & Huttenlocher, 1997; Thompson et al., 1993) has shown that people sometimes use distance-based temporal information to date events, although location-based information is more accurate. This result was replicated in our study. We found that participants dated events with the relative time format as well as with the absolute time format, even though news events dated with the absolute format were dated more accurately than those with the relative time format.

We found that in general the order that formats were presented determined participants' choices. When the absolute time format was presented at the top of the screen, participants tended to answer in that format, but when the relative format was presented on top, they tended to answer in that format instead. This means that participants are able to date events in both formats (Shimojima, 2002). When we looked at the type of an event, its age, and the preferred dating format, we found that people preferred to date more recent events in the absolute time format, but they preferred to date more remote events in the relative time format. Furthermore, we found that people preferred to date personal events in the absolute time format but news events in the relative time format. The majority of remote events therefore caused the initial preference for the relative time format. This preference to date news events with the relative time format was also found by Friedman and Huttenlocher (1997), who asked participants to date topics from a current affairs program and major news events.

Finally, when people chose to date an event in the absolute time format, they could give the complete date, just the month and the year, or only the year that the event

happened. People provided the complete date more frequently when the event was personal or when it had happened very recently. When people did not know about the news event, they tended to provide only the year that the event occurred.

The results of this experiment are in line with our model, which integrates location-based theories and distance-based theories of memory for time. Although the model is still under development, it can already explain some interesting effects. It successfully predicted the dating formats that people prefer for dating events, and also the difference in size of the telescoping effect between the dating formats, on the basis of the availability of secondary temporal information.

This model's underlying assumptions need to be examined more closely. We have assumed that when events are dated in the absolute time format, location-based information is being used, such as the context or related events. We have also assumed that events dated in the relative time format are dated using distance-based information, such as the clarity of a memory or the familiarity of an event. These assumptions need verification. Another topic that we are examining is presentation order. Currently, we are running an experiment on our Web site in which we compare preferences in dating formats when the absolute time format is presented at the top or the bottom of the screen (with the relative time format at the bottom or the top of the screen, respectively) with those when the absolute time format is presented at the left or the right of the screen (with the relative time format on the right or the left, respectively). Finally, we plan to run an experiment in which we examine the telescoping effect more closely; in that experiment, we will compare sizes of the backward and forward telescoping effect for different age groups and try to determine the point on the *x*-axis where the telescoping effect shifts from backward to forward for each group. On the basis on our model, we predict that the size of the effects will be larger for older participants and that the point will be located later for older participants.

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APPENDIX
Cue Words and Their Dutch Translations

English	Dutch	English	Dutch	English	Dutch
Bar	Bar	Pipe	Pijp	Meat	Vlees
Church	Kerk	Ship	Schip	Potato	Aardappel
City	Stad	Shoes	Schoenen	Sugar	Suiker
Factory	Fabriek	Ticket	Kaartje	Wine	Wijn
Hall	Hal	Window	Raam	Baby	Baby
Hospital	Ziekenhuis	Bird	Vogel	Doctor	Dokter
Library	Bibliotheek	Cat	Kat	Judge	Rechter
Market	Markt	Flower	Bloem	King	Koning
Prison	Gevangenis	Horse	Paard	Student	Leerling
Street	Straat	Garden	Tuin	Woman	Vrouw
Tower	Toren	Woods	Bos	Coast	Kust
Plate	Bord	Cotton	Katoen	Mountain	Berg
Book	Boek	Dust	Stof	River	Rivier
Bottle	Fles	Fire	Vuur	Sky	Lucht
Bowl	Kom	Fur	Bont	Storm	Storm
Chair	Stoel	Gold	Goud	Arm	Arm
Clock	Klok	Steam	Stoom	Army	Leger
Coin	Munt	Stone	Steen	Kiss	Kus
Newspaper	Krant	Apple	Appel	Railroad	Spoorweg
Flag	Vlag	Butter	Boter	Star	Ster
Nail	Nagel	Coffee	Koffie		
Engine	Motor	Corn	Maïs		

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