Developmental and cognitive perspectives on humans’ sense of the times of past and future events

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Abstract

Mental time travel in human adults includes a sense of when past events occurred and future events are expected to occur. Studies with adults and children reveal that a number of distinct psychological processes contribute to a temporally differentiated sense of the past and future. Adults possess representations of multiple time patterns, and these representations take several different forms. Memory for the times of past events is built upon reconstruction of temporal locations, impressions of distances in the past, and order-codes. The times of future events are understood primarily as locations in represented time patterns, but propositions active in memory contain information that particular events are coming soon. Young children have difficulty distinguishing the past–future status of some events, showing that basic memory processes do not make the distinction clear. Concepts of the past and future may be required for differentiating these two categories of experience.

Keywords: Time; Memory; Orientation; Future; Representation

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Despite the fact that we are only able to experience directly the present moment, human adults in modern societies have a compelling sense of the reality of past and future times. We have internalized a view of the past and future as parts of a temporal framework, one that can be filled with the happenings of our lives. This view of time allows us to consider the pastness or futurity of events, their temporal distances from the present, their “locations” within patterns of time (e.g., the day, week, or year), and their order. When remembering events, we have a strong belief that they occurred at particular points in time, even if we often cannot remember exactly when it was. When we anticipate future events, we know that if they happen, they will occur at specific times. These remarkable abilities to transcend the present and consider times in the past and the future are parts of what several authors have called “mental time travel” (e.g., Suddendorf & Corballis, 1997). My particular focus is on the temporal component of mental time travel, the sense of when events have occurred or will occur. As for other facets of mental time travel, the challenge is to identify the specific processes that underlie the abilities. Cognitive, developmental, and comparative research can all provide important insights into the variety and nature of these processes.

The data that we will consider come from studies using the first two approaches, cognitive and cognitive-developmental psychology. Studies of adults and studies of children can each provide useful perspectives on the components of complex abilities. Among other advantages cognitive-psychological methods allow us to learn about fully developed abilities at the limits of performance (such as when there are competing demands on attention). Developmental methods help us to disentangle processes in a different way, by describing their sequential acquisition. If young children can perform some task in the absence of a later-developing ability, we can tell that another process is involved. In the following sections, I will focus on research that I and my collaborators and students have conducted on adults’ and children’s representation of time patterns and memory for the times of past events. In later sections, I present our findings on the development of children’s knowledge of the times of future events and of the past–future distinction. More detailed treatment of these issues is available in Friedman (1989, 2001, 2003; and see Hoerl & McCormack, 2001; McCormack & Hoerl, 1999; and Moore & Lemmon, 2001).

The representation of time patterns

One of the foundations of adults’ freedom from the bounds of the present is their ability to form representations of patterns of events that are distributed over long periods of time. Representations of time patterns, such as the parts of the day, week, and year, can be thought of as a kind of semantic knowledge. Quite apart from episodic content, we can grasp the times of morning, Sunday, and October. The representations are not even restricted to considering times relative to the present. We can readily use them to think about relative times of occurrence from different reference points (as we might in a work of fiction). But this knowledge clearly provides a framework that is often used when we think about our own lives and “mentally
travel” to those times. For example, if it is April, we can recognize that a personal event from the winter is more recent than one we know was in the fall, and we can think about the times of events planned for the coming months.

Research on adults’ representations of days of the week and months of the year has revealed that two distinct types of representations and processes capture the relative times of occurrence of the days of the week and months. (These ideas are closely related to Paivio’s, 1978, two-process distinction.) Verbal-list processes involve links between each element and its successor and allow us to move forward through the order in a step-wise manner. These processes are well suited to determining exact temporal distances, such as what month is three months after April. A second type, image-based processes, allows us to detect spatial-like relations between the elements of a time pattern, such as the wide separation of April and October. Support for the two-process distinction, and for this characterization of the processes, comes from a number of studies conducted with adults (summarized in Friedman, 1989). A first line of evidence involves selective interference between tasks designed to favor image or verbal-list processing of the months and two other tasks that are explicitly spatial or verbal-sequential (Friedman, 1983, Experiment 1. The temporal verbal-list task was saying aloud the month that comes \( N \) months after a stimulus month (as in the example of three months after April). The temporal-image task was judging which of two target months would be encountered first if one moved backward through the months from a stimulus month. (For example, if the stimulus month is October and the choices are June and December, June would be the correct answer.) The non-temporal interference tasks were pressing buttons in a particular spatial pattern and counting numbers aloud. An examination of response times and accuracy for the different combinations of temporal and interference tasks showed that the verbal-list month task was disrupted more by counting aloud and the image-month task was disrupted more by button pressing.

In another study (Friedman, 1983, Experiment 4), it was found that individual differences in performance on temporal-image tasks are selectively correlated with those on a cognitive-map task, and measures from a temporal verbal-list task are selectively correlated with those on an alphabet task. Together with the results of the selective-interference study, these findings show that there are at least two kinds of representations and processes that adults use to think about the relative times of occurrence of months, one sharing resources with spatial tasks and another sharing resources with verbal tasks. A number of other studies (Friedman, 1983, 1984) show that month and day-of-the-week tasks that were predicted to invoke image processing share several distinctive properties with spatial-image tasks. These “analog” effects further bolster the theoretical characterization of temporal-image representations.

Another kind of support for the two-process distinction comes from studies of children (Friedman, 1986). In two of these studies, children were asked to solve day-of-the-week and month tasks in which they judged which of two elements was nearer to a stimulus element (e.g., “Does Saturday or Monday come next after Thursday?”). In one condition they were instructed to go forward in time, and in another they were asked to go backward in time. The forward task can be solved by verbal-list
processes: sequentially reciting the days or months that come after the starting element until one of the choices is encountered. But it should be cumbersome to extract backward relations without temporal imagery. The results showed that 9- and 10-year-old children could solve the forward tasks, but 15-year-olds were the first of the age groups tested that were accurate on the backward tasks. There was a concurrent shift in participants’ reports from reciting to using imagery to solve the month task. The results are consistent with a two-stage model, in which children first know the order of the days of the week and months of the year as a sequence of verbal labels and later supplement this with image representations.

It is tempting to conclude from these findings that verbal-list representations of time patterns emerge in middle childhood, and image representations emerge in adolescence. But research on children’s knowledge of the pattern of daily activities (Friedman, 1990) shows that the story is not this simple. By 4 or 5 years of age, children are able to place in order cards representing main events from the waking day (e.g., waking, lunch, dinner, and going to bed at night). There is no reason to believe that they do so based on verbal-list processes—children are not taught to recite the sequence of daily activities—but there is some evidence that within a year or so thereafter, children possess image representations of the relative times of occurrence of daily activities. For example, 6-year-olds can judge which of two activities will come next going backward in time from various reference point. This ability is similar to ones that were taken to support adolescents’ use of imagery for the days of the week and months of the year, but it appears at much earlier ages for the content daily activities. The age disparity is probably due to the mental operations that children perform at different ages: even 4-year-olds are likely to have thought about where they are within the day hundreds of times, whereas orientation within the week and year is uncommon before middle childhood. In addition, adults’ drilling children on the list of days and months in elementary school may actually stand in the way of the spontaneous development of image representations of the days of the week and months.

In conclusion, adults’ ability to think about specific locations within time patterns depends on multiple kinds of representations and processes, including verbal representations and imagery. Furthermore, rather than a single integrated representation of time, we possess different representations for different time patterns, such as the day, week, and year. This conclusion is supported by examination of adults’ performance on tasks involving different time scales and by the fact that children represent some time patterns before others. The separate representation of time on different scales will prove to be important when we consider humans’ memory for times of past events.

**Memory for the times of past events**

Mental representations of conventional time patterns allow us to move forward and backward through time, but they do not in themselves constitute a sense of one’s own past and future. A mature sense of the past includes the general belief that life
events that we recall took place at specific times and the ability to remember \textit{when} particular events occurred, even if imprecisely. This sense is closely related to what many researchers call “autobiographical memory.” There is evidence that at least three different kinds of processes contribute to adults’ memory for the times of autobiographical events (Friedman, 1993, 2004). The processes that are most closely linked to the semantic representation of time patterns, discussed earlier, I call “location-based processes.” These are ways of remembering that lead us to link a remembered event with a location within a time pattern. For example, I may recall that I visited a particular restaurant during the late summer. A second way of remembering when events took place is by gauging their “distances” in the past. An example is having the impression that an event occurred about a month ago. Third, we can remember the order of some events (e.g., the fact that one preceded another) quite apart from placing either in a time pattern or remembering their distances in the past. Although adults can easily translate information from one form (distances, locations, or orders) to the others, the distinctions are important for understanding the elementary processes on which adults’ sense of the times of past events are based. Research with adults and children supports the existence of each of the three types of processes.

The existence of location-based processes can be demonstrated by a phenomenon called “scale effects.” When adults remember personal or public events, they are sometimes more accurate on fine time scales than they are on grosser time scales (Friedman, 1987; Friedman & Wilkins, 1985). For example, I asked a group of college employees to recall the time of an earthquake that had occurred about 9 months prior to the survey and instructed them to provide separate estimates of the hour, day of the week, day of the month, month, and year when the quake occurred (Friedman, 1987). The most interesting finding is that even though the average month estimate was off by nearly 2 months, the average judgment of the time of day was accurate to within about 1 h. The greater accuracy on the time-of-day than month scale is difficult to explain by distance-based and other processes in which distance in the past is an integral quantity. But it is quite compatible with particular location-based theories that assume reconstruction of past times from whatever information is recalled about an event. Such information could sometimes constrain one time scale (e.g., time of day) but not another (e.g., time of the year). Additional evidence for this interpretation comes from the finding that when respondents were asked to explain how they arrived at their answers, a large proportion reported relating the earthquake to a daily event, such as lunch. Other researchers’ demonstrations of scale effects and other lines of support for the reconstruction of locations are summarized in Friedman (1993, 2001).

Although distance-based processes are incompatible with scale effects, there are some circumstances in which humans rely on impressions of distances in the past to gauge when an event occurred. Perhaps the clearest evidence comes from young children’s ability to judge the distances of events in the past on long time scales well before they are able to use representations to answer the questions (Friedman, 1991; Friedman, Gardner, & Zubin, 1995; Friedman & Kemp, 1998). Children as young as 4–5 years of age are able to correctly judge which was a longer time ago, an event that had
occurred 7 weeks earlier and one that they had experienced 1 week before the test. In other studies children were asked to tell which was a longer time ago, Christmas or their birthday. The task proved to be a difficult one for children as old as 9 years if the two events were similar distances in the past (e.g., 9 and 10 months ago). This shows that they could not use representations of the months to solve the problem. However, when the ratio of the lesser to the greater distance was small (e.g., Christmas was 10 months ago and the child’s birthday was 2 months ago), even 5- through 9-year-olds were very accurate. Before locations can be used to compare times in the past, children have access to another source of information about relative times of occurrence.

There are also conditions in which adults use distance-based processes, including circumstances in which no useful cues to temporal locations are available, judgments must be made very rapidly, or the ratio of two distances to be compared is small (Curran & Friedman, 2003; Friedman, 1996, 2001). In one such study, adults were asked to judge the times of particular stories that had been broadcast on the television news magazine show “60 Minutes” (Friedman & Huttenlocher, 1997). We chose stories that would be difficult to relate to contemporaneous events, and we assumed that regular viewers would find it difficult to relate most stories to differentiated personal events, because for most regular viewers the show would be part of their Sunday evening routine. For these reasons it seems unlikely that participants would be able to reconstruct the locations on scales longer than the week. Despite the paucity of differentiated information about locations, judgments of distances in the past were found to be a linear function of true distance in the past, but only for about the previous 2 months. Beyond this distance the curve flattened substantially, and stories from about 1 year ago were judged to be only slightly farther in the past than those from about 6 months ago. Similar curves were obtained when 3- to 6-year-olds were asked to judge how long ago their birthdays and a set of holidays had occurred, using a kind of ruler to represent distances in the past (Friedman & Kemp, 1998). Together these findings tell us that distance-based processes provide differentiated information about the times of events from the past several months, but the times of older events are more difficult to distinguish from one another. Little is known about the specific mechanisms underlying distance-based judgments, but some quality of memories experienced as vividness appears to be involved (Friedman, 2001).

A third kind of information, relations of order, also plays a role in humans’ memory for the times of events. Of course, many pairs of memories can be ordered logically (e.g., starting college before graduating), and this sort of process is assumed to be one of the components of reconstruction. But there is evidence that before–after relations are sometimes directly stored in memory. The relevant studies involve lists of words, some of which are strong associates of one another or, in other experiments, members of the same semantic category (Tzeng & Cotton, 1980; Winograd & Soloway, 1985). The lists also include unrelated words. After all of the stimuli had been presented, participants were asked to judge which member of each of many pairs of words had been seen a longer time ago. In all of these experiments, participants were more accurate when pairs include two related words than when they were two unrelated words. The authors of these studies believe that order-codes are formed during the presentation of the initial list whenever an event reminds the
participant of an earlier one, and this order information is then stored in memory. Although these findings are persuasive, all of the evidence comes from laboratory studies conducted over brief periods of time. We do not know at present whether order-codes contribute to everyday memory for events that are distributed over much longer periods of time or when they come to be used by children.

Adults probably draw on all three processes to remember when past events occurred, and they can even directly retrieve the dates of a small minority of events (e.g., one’s graduation) when the dates have been recalled many times before. Considering their development in children can also augment our understanding of the processes underlying memory for times. So far, there is no evidence for developmental changes in distance processes or the use of order-codes. There is even some reason to believe that distance processes change little with development: we find similar functions relating subjective to objective distance in the past both for young children (Friedman & Kemp, 1998) and adults (Friedman & Huttenlocher, 1997). The use of order-codes has not been studied, but the presumed mechanism—later events reminding one of earlier events—might well be present in early childhood. The processes likely to change the most with age are the ability to reconstruct the locations of events. This is because representations of conventional time patterns develop after early childhood. Preschool children are actually able to reconstruct the part of the day (morning) when an in-class activity had taken place 7 weeks earlier (Friedman, 1991). But it is not until about 6 years that children accurately report the month and season of the same event. Children of this age also begin to use logical constraints to infer the season (e.g., it was this school year) and day of the week (it was a school day and not a weekend). The ability to use reconstruction seems to develop along with children’s growing knowledge of different time scales.

Another study revealed that even for particular time scales, there are different levels of understanding past times (Friedman, 1992). Children between 4 and 9 years of age were asked to tell something that happened yesterday, last weekend, last summer, and during several holidays from the past year. They were instructed to try to recall things that did not happen every day, weekend, and so forth. When recollections were checked with teachers and parents, it was found that even 4- and 5-year-olds could produce memories that were accurate for the time in question and often specific to its most recent occurrence. These findings show that children of this age divide the past into distinct categories of experience and frequently retrieve events that are specific to the most recent instance of that time. However, it is not until well into middle childhood that children can accurately judge which of the different pairs of events was a longer time ago. Young children’s memory for events taking place at particular times seems to be a matter of isolated “islands of time.” Only at later ages can memories, even ones that can be linked to a time name, be viewed within the framework of representations of long-scale time patterns.

The developmental studies indicate that while distance-based processes may change little with development, children’s understanding of the temporal locations of past events does change greatly during middle childhood. Young children can sometimes recall things that happened at a particular location, and they can use knowledge of their daily routine to infer that an in-school demonstration must have been in
the morning. But it is not until at least 10 years of age that children can use representations of conventional time patterns to establish which of two events was a longer time ago. Together these findings tell us that adults’ sense of the past is built upon basic cognitive processes, including distance-based processes and probably order-codes, and other processes involving cultural systems for structuring time. These systems require formal learning and individual practice to master and are, of course, unique to humans.

The development of a differentiated sense of the future

Of the processes that underlie memory for the times of past events, only the use of representations of time patterns could contribute to a sense of the future. Neither distance-based processes nor order-codes, of course, apply to events that have not yet occurred. In contrast, representations allow us to think about “where” in the future various anticipated events will occur. Because representations of long-scale time patterns emerge during middle childhood, we might expect that younger children lack a differentiated sense of the future beyond the present day. However, a number of studies show that a partially differentiated sense of the times of events that are weeks and months in the future is present in 5-year-old children (Friedman, 2000, 2002, 2003). The studies also reveal that humans’ sense of the future is not unitary. In these studies children were asked to judge future distances not in conventional units but by pointing to places on a spatial representation (a road that appears to begin near the viewer and recede toward distant mountains). In some of the studies, children were also asked questions, such as, “How long is it until Valentine’s Day?”

Evidence for future differentiation in 4-year-olds is very limited, but 5-year-olds are able to distinguish a few categories of future distances. When tested before and after Valentine’s Day, 5-year-olds’ responses to the picture task showed two categories: a relatively near one, including Valentine’s Day (whether it was about 1 week in the future or 1 week in the past) and summer; and a relatively distant category, including Halloween and Christmas. Through at least 7 years, children’s success on this task appears to be based on the availability of propositions in memory that specific events are coming soon, are a long time away, or are coming in a particular number of weeks or months. First, judgments on the picture task show one or two categories of events from the coming weeks and months and another undifferentiated category of more distant events. For example, 7-year-olds tested a few weeks before Halloween judged dinner, Saturday, and Halloween as near. They pointed to more distant parts of the road for Thanksgiving, Christmas, Valentine’s Day, and summer, but there was little differentiation of the future distances of this set of events. Second, when asked how long it is until an event, children through 7 years of age give global descriptions (e.g., a short time or a long time) rather than describing the distance in conventional units. One exception is that 7-year-olds reported the number of months until their birthdays with approximate accuracy. However, this was only true if their birthday was within about the next 2 months.
All of these findings can be explained by children’s memory of adults’ statements about the future distances of events. From very early childhood, parents talk with their children about future events (Friedman, 2003). Although we know little about references to future distances in particular, it seems very likely that parents (and later, teachers) refer to the nearness of many future events and even talk about the number of day, weeks, and months until the events most important to children. Adults’ statements that have been repeated many times or heard quite recently could be retrieved when children are asked about the times of future events. This appears to provide a basic way of distinguishing future distances of some events before representations can be used.

By 10 years of age, children can use representations of the annual cycle to judge distances of events up to a year in the future (Friedman, 2000). On the picture task, 10-year-olds produce judgments that are approximately a linear function of the events’ true distances in the future. They also overwhelmingly refer to distances in conventional units when asked how long it is until Christmas, next summer, and so forth. A final line of support for the advent of representation-based judgments of the annual events comes from correlations between the ability to judge future distances from the present and performance on a purely representation-based task, the ability to judge the order of annual events from various reference points within the year. However, just as with memory for the times of past events, the sequential acquisition of representations of different time patterns means that children come to differentiate the future at different ages for different time scales. Many 7-year-olds can tell the number of days until the weekend, but they seldom report the correct number of months until some distant holiday. There is also evidence that children can judge the future distances of daily activities (e.g., dinner) at earlier ages than they can gauge the distances of annual events (Friedman, 2002).

These findings tell us that adults’ sense of the future is not integral, but the product of multiple representations. We use different representations to think about future times on different scales, employing one kind of representation to consider the events that will take place later today, others to think about times later in the week, and so forth. We have also seen that propositions that are active in memory (e.g., your birthday is coming soon) provide children with another way of distinguishing the future distances of some events. Although there is no direct evidence about the role of propositions in adults’ sense of the future, the accessibility in memory of the information that the weekend is coming soon probably contributes to their unusual speed in identifying the current day when it is Friday (e.g., Koriat & Fischhoff, 1974).

Distinguishing between the past and the future

Any complete account of the processes contributing to mental time travel must explain how we differentiate past and future times. Adults regard the past and the future as different categories of experience, categories that are properties of the physical world. It is therefore surprising to note that some physicists consider the past–future distinction to be unnecessary for describing the physical world
This position seems at odds not only with intuition but with the fact that there are measurable properties of memories (e.g., Johnson, Foley, Suengas, & Raye, 1988) that cannot also be true of anticipated events. Yet there are also anthropological (Gell, 2000) and developmental (Nelson, 1996) arguments for the past–future distinction being a social construction. What are the psychological processes underlying differentiation between the past and the future? Again, important insights can be gained by considering research on the development of the ability, including the errors that children make (Friedman, 2003).

In many of the studies of children’s sense of the past and of the future that were discussed in the previous two sections, common errors were judging as very recent an event that will occur in the near future, or judging an event that happened in the recent past to be coming soon. For example, in Friedman et al.’s (1995) study, when tested in the fall, many children as old as 8 years judged a birthday that would actually take place before Christmas to be more recent than Christmas. Similarly, as we saw earlier, 5-year-olds usually assigned Valentine’s Day to the near future 1 week after it had occurred (Friedman & Kemp, 1998). These errors might result in part from testing only the past or only the future in a particular study. The young children might find the nearness of the event more compelling than the fact that it is close in the wrong direction and respond in the only way they can convey its closeness. It is therefore notable that similar errors appear when children are given a clear choice between the past and the future in a task designed to make the distinction salient (using a picture of a car traveling along a road, with circles in front and behind it representing the two categories; Friedman, 2003). When tested about 1 week after the holiday, many 4-year-olds respond to the stimulus “Valentine’s Day” by pointing to the circle representing the future. This error may be attributable to the continued accessibility in memory of the now-outdated proposition that Valentine’s Day is coming soon. Another possibility is that even their memories of Valentine’s Day itself may be mixed with memories of preparing for the holiday. If these interpretations are correct, basic memory processes might not always provide as clear a distinction between the past and the future as we might suppose.

Another error indicates that problems using early representations may also produce past–future confusion. On the same task, children tested between breakfast and lunch were at about chance levels in judging the pastness of breakfast. Here the problem may be the difficulty of thinking about backward relations in early representations of the daily activities, a difficulty that has been found in another study (Friedman, 1990).

In most of the examples mentioned so far, another explanation for children’s confusion of the past and the future is possible: with cyclic contents, events such as Valentine’s Day and breakfast are both past and future; the previous occurrence is in the past, and the next one is in the future. To test whether cyclic relations were the cause of errors, I conducted a study involving 4- and 6-year-olds’ judgments of unique or unusual personal events ranging from several months in the past to several months in the future (Friedman, 2003). The 6-year-olds were quite accurate, but the 4-year-olds, although performing at levels greater than chance expectations, made many errors on both past and future events. These findings show that young children’s problems with
the past–future distinction are not limited to cyclic events. The study also provides a clue about the reasons for the age change. Six-year-olds were also more accurate on another task measuring children's understanding of the causal relations between the past, present, and the future (e.g., that past, but not future, events can influence the present; Friedman, 2003), and these two abilities were substantially related for this age group. These findings raise the possibility that young children’s errors in distinguishing the past–future status of events result in part from the absence of a clear conceptual distinction between these two temporal categories. An alternative explanation, that their errors are rooted in a lack of understanding of terms for past and future times, seems at odds with the variety of tasks on which young children show past–future confusion.

Although the distinction between the past and the future is a fundamental component of adults’ mental time travel, the contrast between the two categories of experience is not early developing. Basic memory processes might be expected to make the distinction very clear, but the errors made by young children suggest that memory actually provides a mixture of useful and confusing information about whether an event occurred in the past or will happen in the future. For example, thoughts of both approaching and past events can be active in memory, and we can remember propositions that events are coming soon even after the events have occurred. Probably adults are subject to the same mix of information in memory, but they are able to over-ride this raw information with two forms of knowledge unavailable to young children. First, adults have flexible representations of time patterns, ones that allow them to clearly distinguish between traveling backward and forward in time. Second, they possess a conceptual understanding of the differences between the past and the future.

**Conclusions about the cognitive processes underlying humans’ sense of the times of events**

When adults think about when past events have occurred and future events will occur, time often appears to be a seamless, integral continuum. But our examination of the psychological processes underlying adults’ sense of past and future times leads to a very different conclusion: these abilities rest on a patchwork of representations and processes. We represent time separately on different time scales, and both mental representations and basic cognitive processes contribute to a differentiated sense of the past and the future. Semantic representations of time patterns capture different contents, including parts of the day, week, and year, and take multiple forms, including imagery and verbal-list representations. Evidence for the multiplicity of components comes from studies of adults and from the gradual development of the ability to use representations of time patterns from early childhood through adolescence (see Table 1). Some of the representations capture conventional patterns of time, and others store patterns of activities, such as those that take place daily. As children grow older, they acquire representations of longer time scales, and they come to use representations of particular contents with increasing flexibility, including the ability to think backward in time.
Table 1
Age by which processes or abilities are evident

|                        | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|------------------------|---|---|---|---|---|---|----|----|----|----|----|----|
| **Representations**     |   |   |   |   |   |   |    |    |    |    |    |    |
| Image—daily activities |   |   |   |   |   |   |    |    |    |    |    | 5  |
| Verbal-list—days of Week|   |   |   |   |   |   | 7 (recite) | 9 (use to judge distances) |   |    |    |    |
| Image—days of week     |   |   |   |   |   |   |    |    |    |    |    | 15 |
| Verbal-list—months     |   |   |   |   |   |   | 9 (recite) | 11 (use to judge distances) |   |    |    |    |
| Image—months           |   |   |   |   |   |   |    |    |    |    |    | 15 |
| **Memory process**     |   |   |   |   |   |   |    |    |    |    |    |    |
| Distance               |   |   |   |   |   |   | 4  |    |    |    |    |    |
| Order-codes            |   |   |   |   |   |   | ?  |    |    |    |    |    |
| Reconstruction—daily activities |   |   |   |   |   |   | 4  |    |    |    |    |    |
| Reconstruction—days of the week, months, seasons |   |   |   |   |   |   | 6  |    |    |    |    |    |
| Compare distances by locations within the year |   |   |   |   |   |   |    |    |    |    |    | 10 |
| **Future differentiation** |   |   |   |   |   |   |    |    |    |    |    |    |
| Rough differentiation of distances |   |   |   |   |   |   | 5  |    |    |    |    |    |
| Metric differentiation of distances |   |   |   |   |   |   |    |    |    |    |    | 10 |
| **Past versus future** |   |   |   |   |   |   |    |    |    |    |    |    |
| Distinguish past–future status of events |   |   |   |   |   |   | 6  |    |    |    |    |    |
Representations infuse adults’ sense of the times of past and future events, but developmental studies show that other, basic psychological processes provide some degree of differentiation within each of the two categories of experience. Well before children can use representations of long-scale patterns to think about the times of past events, distance-based processes provide some information about when events occurred (Table 1). Even 4-year-olds, who cannot yet think about relative temporal locations on time scales longer than a day, have a rough sense of the distances of some events in the past. Other basic memory processes allow young children to link specific memories to time names (e.g., weekend, summer), even though they do not yet know when these times occurred relative to one another. An intuitive sense of the times of some future events is also present before representations can be used to think about future times. Here the basic processes appear to be memory for adults’ statements about when anticipated events will occur.

The distinction between the past and the future, so fundamental to adults’ view of time, is also a developmental construction. Young children are often confused about the past–future status of events, whereas by about 6 years of age the distinction seems clear (Table 1). Basic memory processes provide important clues to the pastness of events, including the special memorial qualities of events that have actually been experienced. But it appears that memory also contributes information that is confusing to children: memory for now-outdated propositions that an event is coming soon and the salience in memory of thoughts and others’ statements about approaching events (which may cause them to rival the salience of past events). There is some reason to think that a conceptual understanding of the past–future distinction contributes to 6-year-olds’ ability to make a sharp division between the two categories of experience. Together with representations of time patterns and basic properties of memory, these concepts probably contribute to adults’ ability to mentally travel to times other than the present.

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