Cognitive Development 37 (2016) 53–66

Contents lists available at ScienceDirect

Cognitive Development

Age-related differences in memory for time, temporal reconstruction, and the availability and use of temporal landmarks

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ARTICLE INFO

Article history:
Received 6 November 2014
Received in revised form 7 December 2015
Accepted 18 December 2015
Available online 4 January 2016

Keywords:
Memory for time
Dating
Reconstruction
Temporal landmark
Development

ABSTRACT

We examined the accuracy of memory for the time of an event, the use of temporal reconstruction, and the availability and use of temporal landmarks from late middle childhood to adulthood. Children, adolescents, and adults ($N = 128$) viewed a film during a campus visit. Eight months later, we asked them to (a) recall the time of the previous visit on a range of time scales; (b) explain *how* they arrived at those estimates; and (c) provide other dateable events from their lives (temporal landmarks). The accuracy of time judgments increased with age on the day-of-the-week and month time scales only. All age groups used reconstruction to arrive at their estimates for most of the time scales tested. Reports of dateable events from past years indicated that the availability of temporal landmarks increased across this age range. These results reflect a mixture of similarities and differences across the ages tested.

1. Introduction

For adults in modern societies, memory for personal and public events is infused with chronology. Although the precise localization of remembered events is usually not possible without resorting to records, events are believed to occupy particular times and we can often identify them approximately. Research on children's and adults' memory for the times of past events has revealed that the main process used to place remembered events in time is *reconstruction* (Friedman, 1993, 2001), with impressions of the ages of memories (or temporal *distances*) playing a secondary role (Friedman, 1996). In reconstruction, information about the time of occurrence is derived from what is remembered about the target event. At retrieval, contextual and other information associated with an event is combined with general time and autobiographical knowledge to infer when the event occurred. This general, non-event-specific knowledge includes representations of natural and conventional time patterns (e.g., the cycles of seasons or days of the week), the characteristics of parts of time patterns (e.g., summer is hot), and information about the times of events in one's own life (e.g., the year of a graduation).

There are at least three lines of evidence for adults' use of reconstruction. First, when asked to explain temporal judgments, adults often report inferring the times on the basis of another event whose time is remembered, such as a major news event or notable personal event, that is, a temporal 'landmark' (Baddeley, Lewis, & Nimmo-Smith, 1978; Friedman, 1987, 1993; Friedman & Wilkins, 1985; Thompson, Skowronski, Larsen, & Betz, 1996). Also frequent are references to routines (e.g., 'the

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http://dx.doi.org/10.1016/j.cogdev.2015.12.003
0885-2014/

day I usually go to town') and social or natural cycles (e.g., 'it snowed that day'; Baddeley et al., 1978; Friedman, 1987, 1993). Second, the times of events are judged more accurately when they occur near temporal landmarks (Friedman, 1987, 2004; Thompson et al., 1996). For example, Loftus and Marburger (1983) found that participants benefited from comparing the times of target events with that of the eruption of Mt. St. Helens. A third line of evidence for reconstruction is that researchers have observed systematic, nonlinear variation across time scales in the accuracy with which the time of past events is recalled, a phenomenon referred to as *scale effects*. For example, judgments of the month and hour that an event occurred are often more accurate than judgments of the day of the week or day of the month (Friedman, 1987; Friedman & Wilkins, 1985). Such scale effects are consistent with reconstructive explanations for time judgments, but cannot be explained by distance-based processes, which would predict a dramatic and monotonic decrease in accuracy when progressing from grosser to finer time scales.

The ability of children to recall the times of past events has been demonstrated in a number of studies. For example, Friedman (1991, Experiment 3) found that 4-year-olds exhibited accuracy greater than chance when they judged the part of the day during which an event had occurred 7 weeks earlier (but see Experiment 1). Similarly, in this and other studies, 6-year-olds recalled the day of the week of parent-nominated life events from the past 3 months with significant levels of accuracy (Pathman, Larkina et al., 2013, but see Friedman, 1991), 6-year-olds made accurate judgments of the month and season during which an event had occurred within the last several months (Friedman, 1991, Experiment 1; Pathman, Larkina et al., 2013; see also Friedman & Lyon, 2005), and 8–12-year-olds made very accurate judgments of the time of day and month of memorable life events up to 4 years after they had occurred (Friedman, Reese, & Dai, 2011).

Several lines of evidence converge to support the conclusion that children used reconstruction in the studies described above. First, as in the studies of adults, reported methods were often consistent with the use of remembered temporal cues and inference. In three studies, 4- to 13-year-old children recalled the times of past events and explained their time judgments (Friedman, 1991; Friedman & Lyon, 2005; Pathman, Larkina et al., 2013). In all three studies, children aged 6 years or older (but not younger) often referred to remembered information that could help to reconstruct the time. Explanations of time-of-day judgments referred mainly to daily routines, with some relating to environmental cues. For day of the week, reference to weekly routines strongly predominated. Justifications of month and season judgments mainly comprised references to environmental cues and to landmark events whose dates were known (Friedman, 1991; Pathman, Larkina et al., 2013). Scale effects provide a second line of evidence for reconstruction by children. For example, in four studies, children's time-of-day judgments were much more accurate than would be expected on the basis of their judgments on longer time scales (Friedman, 1991; Friedman & Lyon, 2005; Friedman et al., 2011; Pathman, Larkina et al., 2013). A third line of evidence for children's use of reconstruction draws on the relation between their general time knowledge and the accuracy of their time judgments. In their study of 8–12-year-old children, Friedman et al. (2011) tested the relation between one kind of general time knowledge – thinking flexibly about time patterns – and accuracy in judging the times of life events from the past 4 years. The authors found a substantial relation between general time knowledge and accuracy, which supports the predictions of reconstruction theories.

The studies reviewed here provide evidence for the use of reconstruction by adults and by children aged 4–12 years, and they show the levels of accuracy that are achieved at these ages. Yet there are currently no data that tell us how accuracy, temporal reconstruction, and the availability of temporal landmarks might change between middle childhood and adulthood, even though there are a number of reasons to expect changes during this period. First, given that the prefrontal cortex continues to mature during this time (Giedd et al., 1999; Sowell, Thompson, Holmes, Jernigan, & Toga, 1999), the ability to reconstruct the times of remembered events might also develop. Several studies of adults have provided evidence for prefrontal involvement in reconstructive time-memory tasks (Bastin, Van der Linden, Michel & Friedman, 2004; Curran & Friedman, 2003; Curran & Friedman, 2004). Second, changes in cognitive representations of the days of the week and months of the year beyond late middle childhood (Friedman, 1986; Friedman et al., 2011; Pathman & Ghetti, 2014) could also lead to changes in temporal reconstruction. Third, changes in schedules and responsibilities from childhood to late adolescence might lead to greater availability of cues to the times of past events. For example, Friedman and Lyon (2005) found that 13-year-olds were able to recall the time of day at which demonstrations had been presented 3 months earlier within 20 min of the correct time, on average. It is difficult to imagine how these participants could have achieved such impressive levels of accuracy without having used their differentiated schedules of classes to reconstruct the time. Furthermore, adolescents and young adults are expected and encouraged to take greater responsibility than children for their schedules, meeting deadlines, and planning for the future. One might therefore expect increases between childhood and adulthood in the encoding of dates that can be used as reference points – landmarks – in reconstructing the times of events.

Research on the ability to date past events is not only motivated by theoretical interests; it also has relevance in applied settings. In legal contexts, for example, making a mistake about when a particular event occurred can have serious consequences. If a suspect makes a change to a previously given alibi, the majority of law enforcement officials will interpret this as evidence of dishonesty and, by implication, guilt (Dysart & Strange, 2012). Witnesses, too, might be considered unreliable if details that they report – such as the time at which an event took place – are shown to be incorrect (Borckardt, Sprohge, & Nash, 2003; see also Cashmore & Trimboli, 2006; Leippe & Romanczyk, 1989). In these contexts it is important to know; (a) the extent to which the ability to remember the time at which an event occurred varies with age; and (b) whether memory for *when* an event took place can predict the accuracy with which the content of the event is recalled.

The main purpose of the present study was to provide information about whether the transition from childhood to adulthood brings about changes in memory for time, the use of reconstruction, and the availability of landmarks. Our first