



Developmental Differences in the Temporal Organization of Autobiographical Recall

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ABSTRACT

Autobiographical memory enables individuals to communicate not only what happened but when, drawing on both local event sequences and global temporal frameworks like recurring routines and conventional time systems (e.g. calendars, clocks). Developmental research has demonstrated gains in the ability to describe past events in sequence through childhood, yet little is known about how children embed experiences within global temporal structures. Moreover, existing studies of autobiographical organization often treat age as the primary driver of developmental change, which may overlook how differences in experience contribute to temporal organization as well. We hypothesized that, with age, U.S. children's autobiographical narratives would shift from being organized in sequences of local events toward being embedded in global, relational structures. Moreover, we predicted that children's experience navigating time independently in everyday life would relate to their tendency to describe experiences relative to temporal patterns. Ninety-two participants from the Austin community aged 7–25 years – a key age range during which episodic memory abilities and independence increase – described a typical day, and their narratives were coded with a scheme which distinguished local from global temporal organization. We also measured conventional time knowledge and developed a questionnaire to quantify the independence with which children navigate time in daily life. Results supported our hypothesized developmental shift; with age, participants referenced local sequences less and global time structures more. Furthermore, individual differences in experience were linked to distinct organizational properties, as conventional time knowledge predicted references to specific temporal locations, while independence predicted references to relational time patterns.

An essential function of autobiographical memory is to organize past experiences in time, enabling individuals to communicate not just what happened, but when. Importantly, time has multiple dimensions, including *local* temporal information about specific episodes and their order, as well as *global* temporal structures which relate experiences to each other across broad windows of time (e.g., recurring routines and patterns, conventional time systems; Friedman, 2013; Friend, Pathman, et al., 2026; Pathman & St. Jacques, 2013). While prior autobiographical research has documented children's ability to describe events in order (i.e., provide local temporal information; Nelson & Fivush, 2020), far less is known

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about their ability to embed experiences within global temporal structures. We hypothesized that, with age, children would transition from describing experiences using local event sequences to increasingly organizing them in relation to conventional time structures (i.e., calendars, clocks) and repeating temporal patterns. Moreover, we predicted that this transition would be shaped not only by age but also by lived experience, such that children's capacity to describe global temporal relations between events would relate to the independence with which they navigate time in everyday life. Here, we test this hypothesis across a critical age range (7–25 years) in which both memory abilities and real-world independence are emerging. The present study introduces novel autobiographical coding criteria and questionnaires to directly assess how age and lived experience jointly shape the organization of temporal information in narrative recall.

Existing studies of the temporal organization of autobiographical memory have primarily assessed children's ability to describe the order of events (Peterson & McCabe, 2013; Reese et al., 2011). This ability improves markedly across early and middle childhood (5–12 years), with older children showing greater chronological coherence (reporting events in a clear order) and contextual coherence (situating events in a specific time or place) (Fivush, 2011; Habermas & De Silveira, 2008; Peters et al., 2025; Reese et al., 2011). However, no existing coding schemes directly compare references to local and global dimensions of time, particularly within spontaneous autobiographical recall in which children are not directly prompted to provide temporal information. We hypothesized that, with age, children would shift from describing experiences relative to local event sequences toward two types of global frameworks: 1) conventional time systems and 2) recurring relational patterns.

Conventional time systems provide consistent, socially shared structures in which any events can be embedded, regardless of adjacency. These systems allow events to be described by specific temporal locations (e.g., clock time, calendar date) or in relation to temporal landmarks (e.g., the duration between an event and a holiday) (Friedman, 1986; Friedman et al., 2011). Children gradually acquire conventional time knowledge across middle childhood (7–11 years) through both formal instruction and everyday experiences (e.g., learning the months of the year and how clocks work; Friedman et al., 2011; Pathman et al., 2022). Importantly, laboratory studies suggest that with age, children increasingly integrate this knowledge into memory, as older children can more accurately anchor episodes to temporal landmarks such as holidays (9–16 years; Jack et al., 2016).; Notably, however, laboratory tasks may not capture how individual differences in children's lived experience contribute to this integration, making autobiographical recall a critical context to understand how personal experiences are integrated with conventional time knowledge. Adolescents are also more likely than children to include at least one temporal marker (e.g., a date) when narrating their life story (Habermas & De Silveira, 2008), though no work to date has tested how the prevalence of these temporal markers varies based on age or lived experience. We predicted that developing knowledge of conventional time would enable children to anchor their own experiences to time structures and landmarks, in turn providing more specific references to conventional time with age.

In addition to conventional time structures, we hypothesized that older children would display more global narrative organization based on the capacity to relate individual events to knowledge of recurring temporal patterns. For example, a child who regularly rides the school bus at 8 AM may not only remember individual rides but also abstract the rule that “the bus always leaves at 8.” This knowledge can then

scaffold recall of nearby events (e.g., breakfast must have occurred before 8AM). Notably, even younger children form knowledge of routines (i.e., that the bus leaves at 8); however, laboratory tasks show that the ability to apply one's knowledge of temporal regularities to new experiences increases through adolescence (Pudhiyidath et al., 2020). Thus, we predicted that children's capacity to spontaneously describe individual events relative to global temporal patterns may follow a similarly extended trajectory.

Critically, while we hypothesized that children would increasingly reference both conventional time and relational patterns with age, these forms of global knowledge differ in how they are acquired. Conventional time can be taught directly (e.g., learning holiday dates in school), whereas recurring temporal patterns are abstracted from lived experience. As such, we expected that children's capacity to describe temporal relations that are shared across repeated episodes may contribute unique variance in explaining temporal narrative recall above and beyond age. In particular, because children gain independence in managing everyday activities through adolescence (e.g., planning events, following schedules; Van Petegem et al., 2012), we hypothesized that their ability to embed experiences within relational frameworks would relate to how independently they navigate time in daily life. For instance, a child who independently rides the bus to school at 8 AM will have more experience applying temporal patterns (i.e., that the bus leaves at 8AM) to plan for future experiences (i.e., tomorrow). Similarly, when parents encourage children to contribute independently to narrative production, children show greater coherence when narrating future events, suggesting that these internalized experiences carry over into autobiographical memory (Fivush et al., 2006). We predicted that independence navigating time would extend to autobiographical memory as well, facilitating organization of events relative to temporal patterns above and beyond age.

To test these predictions, we developed a coding scheme that distinguishes between local (event sequences) and global (conventional time, recurring patterns) temporal information in autobiographical narratives. We applied this scheme to narrative descriptions of a typical day (i.e., regular, recurring personal events) rather than descriptions of unique personal episodes to align with our primary focus on capturing temporal organization across development. Specifically, we prioritized descriptions of typical autobiographical experiences rather than unique episodes because prior work shows that even young children can organize autobiographical reports around knowledge of repeated events (Fivush, 2011), thereby ensuring quantifiable temporal structure at all ages and enabling direct comparisons of developmental change from childhood to adulthood. In addition to capturing narrative organization, we created a questionnaire to quantify the independence with which children navigate time in everyday life to directly link children's experiences to the organization of their autobiographical recall. This approach was implemented in a continuous sample aged 7–25 years, an age range during which both temporal memory abilities and independence significantly increase, yet have not previously been compared within the same study (Pathman & St. Jacques, 2013; Van Petegem et al., 2012). Participants described a typical day, and individual words and phrases were coded to provide fine-grained measures of temporal language to facilitate direct comparison of local and global time references within the same narratives. Together, this study advances understanding of how age and experience shape the developmental transition from locally ordered sequences to globally structured accounts of personal experience.

Methods

Participants

Ninety-two participants were recruited from the University of Texas at Austin and the local Austin community. The developmental group included 70 participants aged seven to 17 years, approximately balanced by age (6.4 participants per age, Supplemental Figure S1; $M_{\text{age}} = 11.8$) and sex (female = 33), while the adult group included 22 adults ($M_{\text{age}} = 20.2$; range = 18–25 years; female = 16). This age range and sample size was determined based on related work examining autobiographical coherence across adolescence (Habermas et al., 2009; Peters et al., 2025) and a power analysis of the effect of age on temporal coherence in (Peters et al., 2025) which tested a similar age range (8+ years) ($f^2 = 0.24$, $pwr = 0.9$, $\alpha = 0.05$, minimum $n = 44$). Sample race/ethnicity was as follows and representative of the local Austin community: 14 Asian (15.2%), 3 Black/African-American (3.3%), 56 White (60.9%), 18 more than one race (19.6%), one declined to provide (1.0%). Twenty-three participants (25%) reported being Hispanic. This sample was socioeconomically representative of the local Austin community. Consent and assent were obtained using age-appropriate language in accordance with protocols approved by the institutional review board at the University of Texas at Austin. Developmental participants received \$25 in monetary compensation while adults received course credit for participation.

Procedure

The experiment reported here was collected as part of a larger study assessing temporal memory in lab-based and autobiographical tasks. Here, we report the data from the autobiographical task, while the lab-based experiment is reported elsewhere (Friend, Varga, et al., 2026). For the present report, our goal was to capture developmental differences in references to local and global dimensions of time in autobiographical memory. First, to measure how children spontaneously organize descriptions of their experiences, experimenters provided participants with the open-ended invitation to “tell me everything that happens on a normal school day (or work day for adult participants), from the moment you get up to the moment you go to sleep.” Responses were recorded and transcribed for qualitative coding. To compare narrative production to individual differences in time knowledge, we next administered the conventional time knowledge portion of the Time Knowledge Questionnaire (Labrell et al., 2020). Finally, to assess the effects of individual differences in lived experience on narrative organization, we developed an experimenter-administered questionnaire to assess the independence with which children navigated time in their everyday lives (e.g., “do you decide what time to wake up, or does someone else decide?”) (see Supplemental Table S1 for full questionnaire).

Qualitative coding scheme

Because our goal was to test for a developmental shift from local to global temporal organization, we required a coding scheme that enabled direct comparison of both dimensions. As no existing scheme provided this comparison, we adapted features of several established approaches including the Autobiographical Memory Interview which captures references to events or time at the word/phrase level (Kopelman et al., 1989; Levine et al., 2002), narrative category coding which includes references to when or where events

occurred (Bauer et al., 2007), and temporal coherence measures which capture sequence order, but do so across full narratives rather than individual utterances (Habermas & De Silveira, 2008; Peters et al., 2025; Reese et al., 2011). Building on these foundations, we developed new qualitative coding criteria, described below, which extend prior approaches to include more precise and granular criteria for references to local sequences and global time within the same narratives.

Transcript parsing. First, two independent coders parsed each transcript into individual utterances, defined as words/phrases describing any unique occurrence or statement including details related to who was present, what happened, when and where the event occurred, and evaluative descriptions of any preceding category (i.e., how/why an event occurred) (Kopelman et al., 1989; Levine et al., 2002). To assess parsing reliability, 20% of transcripts ($n = 19$), equally distributed across the overall sample by age and sex, were randomly selected and parsed by both coders. We assessed the correlation between the number of utterances identified for each transcript by each coder, finding high agreement ($r = .99$, $p < 0.001$) (Levine et al., 2002). Disagreements in coding deferred to the primary coder, and the primary coder parsed the remaining 63 transcripts (~80% of the sample), using standard methods for assessing reliability from narratives (Bauer et al., 2007).

Narrative feature coding. All utterances identified during the parsing phase were then assigned to one of four categories: Events, Places, Sequencing Terms, and Global Time. Table 1 contains definitions and examples for each category, with descriptions of which categories were adapted from existing coding criteria in the table caption. We also identified repetitions of previous information (84 utterances) and removed them from further analyses. Again, 20% of the overall sample (19 transcripts/936 utterances) was randomly selected (balanced by age and sex) and fully coded by both coders. Reliability was assessed using Cohen's Kappa and Prevalence-Adjusted Bias-Adjusted Kappa (PABAK; used for categories comprising less than 10% of the reliability sample; Byrt et al., 1993; Friend et al., 2024). Reliability was high (K/

Table 1. Categories, definitions, and examples for the narrative feature coding scheme. Events and places are defined identically to the autobiographical memory interview to capture what happened and where in each narrative (Kopelman et al., 1989; Levine et al., 2002). Sequencing terms are adapted from the "when" category' of the narrative category coding scheme which includes references to temporal locations and sequencing terms but does not distinguish between the two (Bauer et al., 2007). The global time category was newly created to assess the central prediction that references to both conventional time and recurring temporal patterns will increase with age.

Category	Definition	Examples
Event	A unique occurrence or observation; a unique detail/information bit	"I wake up," "I watch some TV," "read a book"
Place	Any information that involves localization in space or changes in spatial location	"at school," "in the library," "my mom drives me to school"
Sequencing Terms	Words used to organize events relative to each other in sequence and do not explicitly reference conventional time or recurring time patterns	"then," "after," "before," "next," etc.
Global Time	Encompasses references to conventional time knowledge and references to knowledge of recurring routines. Includes descriptions of specific temporal locations, distances, and relations (i.e., schedules/routines)	"at 12 o'clock," "for an hour," "on Wednesdays"

Table 2. Reliability and prevalence of narrative feature categories. Prevalence and reliability by category; Prevalence-Adjusted Bias-Adjusted Kappa is used for categories <10% of reliability sample.

Category	Prevalence (Full Sample)	Prevalence (Reliability Sample)	Reliability
Event	56.4% (2372)	54.9% (484)	K = 0.85
Place	6.8% (284)	8.06% (71)	PABAK = 0.97
Sequencing Terms	24.8% (1041)	26.4% (233)	K = 0.92
Global Time	10.1% (425)	7.61% (67)	PABAK = 0.98

PABAK > 0.8, Table 2) and disagreements again deferred to the primary coder who then coded the remainder of the sample (63 transcripts; 3270 utterances).

Global time dimension coding. After assessing differences in references to local and global time, we aimed to decouple references to conventional time structures which are typically learned through direct instruction, and temporal patterns which are derived across related experiences. We defined three sub-categories of global time references based on dimensions of time often tested in episodic memory paradigms but rarely extended to autobiographical work – temporal locations (specific points or landmarks in conventional time), temporal durations (the distance in time between two events in conventional time units), and temporal relations (recurring time patterns derived across related experiences) (Friedman, 2013; Friend, Pathman, et al., 2026; Pathman & St. Jacques, 2013). We selected all utterances coded as references to Global Time ($n = 425$) for further coding, randomizing their order to eliminate any participant-specific biases. These utterances were then categorized as temporal locations, durations, or relations (Table 3). Both coders coded 100% of this subsample with high reliability ($K > 0.9$; Table 4).

Table 3. Categories, definitions, and examples for time dimension coding. Follow-up time dimension coding is meant to decouple references to conventional time structures which are typically learned from direct instruction (location and duration) from routines or patterns which are extracted from one's lived experience (relation).

Category	Definition	Examples
Duration	A description of how long an event lasted	"that class lasts an hour," "5-minute passing period," "for a long time"
Location	A specific description of when a single event occurred in time	"around 5:45am," "in the morning," "then it's fifth period"
Relation	A description of a temporal relation between multiple events, including conditional temporal language and descriptions of schedules or routines	"if it's on a Monday," "Tuesdays and Thursdays at 3," "8:30 on regular school days"

Table 4. Prevalence and reliability by category. Both coders coded all utterances.

Category	Prevalence (Full Sample)	Reliability
Duration	21.4% (91)	K = 0.92
Location	41.2% (175)	K = 0.94
Relation	37.4% (159)	K = 0.94

Temporal independence questionnaire and validation. We developed a “temporal independence” questionnaire to quantify the extent to which children independently navigated time in their everyday lives (e.g., “do you choose what time to wake up or does someone choose for you?”) (see Supplemental Table S1 for full questionnaire). This questionnaire used forced-choice questions and categorical answers (e.g., dependent vs. independent) to minimize subjectivity in scoring criteria. Nevertheless, to ensure reliable adherence to coding criteria, both coders again coded 20% of participants’ responses, balanced by age and sex. Inter-rater reliability was high ($K = 0.91$) and disagreements deferred to the primary coder. This scoring approach yielded single scores of independence for each participant (range = 11–29, mean = 21.1, $SD = 5.3$). Five participants did not complete this questionnaire and were excluded from independence analyses.

Since the independence questionnaire was newly developed, we also tested the variance this measure captured across development to ensure our questionnaire was sensitive to age differences in temporal independence but not biased toward a specific age. We tested for significant relations between age (continuous) and variance with a Breusch-Pagan test of heteroscedasticity, as well as between age groups via Levene’s test for homogeneity of variance (child: 7–9 years, early adolescent: 10–12 years, adolescent: 13–17 years; adult: 18 + years). Critically, variance in temporal independence was not related to age (BP coefficient = 0.91, $p = 0.34$), nor did any developmental group significantly differ from each other ($ps > .19$). As expected, adults displayed less variance in independence than the three developmental groups ($ps < .02$). Importantly, homogenous variance within the developmental group suggests this questionnaire successfully captured age differences in temporal independence without being biased to any particular stage of development. Independence also did not vary by culture/ethnicity (single ethnicity White vs. multiple ethnicities/non-White; $p = 0.523$) or by sex ($p = 0.178$), nor did ethnicity or sex interact with age to predict independence ($ps > 0.297$). Finally, internal reliability was also high (Cronbach’s alpha = 0.85), and removal of any individual item resulted in negligible changes to alpha, indicating that the temporal independence questionnaire reliably measured a single construct without evidence for meaningful subscales.

Analysis overview

To test the hypothesis that autobiographical memory organization would shift from local to global with age, we used multiple regression models with the total number of utterances in each category as the dependent measure (one observation per participant), and age (in years and months) as the primary predictor of interest. Both linear and non-linear models of age were considered, but no non-linear developmental effects were identified (all polynomial age term $ps > 0.2$). After assessing age differences for each category, we examined whether individual differences in time knowledge and temporal independence moderated these effects by testing for main effects or interaction effects with age.

Critically, to ensure that any identified age effects were specific to the temporal organization of each narrative and not broader differences in narrative production, we included control measures for the total number of utterances produced (the talkativeness of the participant) as well as the number of events described by each participant (the scope of the narrative) (adapted from Frausel et al., 2021). Though talkativeness and scope similarly capture individual differences in narrative production, including both as covariates did not

alter any age effects and improved R-squared for all models, suggesting that controlling for both measures improved model fit. Finally, we included a categorical covariate for sex based on prior work identifying sex differences in the quantity and content of information children produce in autobiographical tasks (Grysmen & Hudson, 2013). Data was analyzed using R, version 4.4.1 (R Core Team, 2024). Anonymized data and analysis code are available at <https://osf.io/xtu5s/>. Full tables for regression analyses are provided in Supplementary Tables S2-S11. This study's design and analyses were not pre-registered.

Results

Developmental shift from sequence-based to conventional temporal organization in autobiographical recall

To capture developmental changes in local and global temporal organization, we analyzed how the prevalence of references to both local and global time varied with age. Sequencing terms (local) decreased with age ($B = -0.23$, $SE = 0.08$, $t = -2.77$, $p = 0.007$) (Figure 1A; Table S2), while explicit references to global time (conventional and relational) increased with age, suggesting a developmental shift from local to global temporal organization ($B = 0.34$, $SE = 0.09$, $t = 3.69$, $p < 0.001$) (Figure 1B; Table S3). Moreover, above and beyond age, global time references were negatively associated with sequencing terms ($B = -0.73$, $SE = 0.06$, $t = -12.32$, $p < 0.001$; Table S4), suggesting a developmental transition from local to global narrative organization rather than two parallel but independent trajectories. Sex did not interact with age to predict references to local or global time, though female participants provided comparatively more sequencing terms, controlling for overall utterances ($B = 1.80$, $SE = 0.75$, $t = 2.41$, $p = .018$; Table S2), and fewer references to global time ($B = -2.03$, $SE = 0.82$, $t = -2.48$, $p = 0.015$; Table S3) than male participants. There were no age differences in the number of events or locations referenced when controlling for the talkativeness and scope of each narrative ($ps > 0.199$).

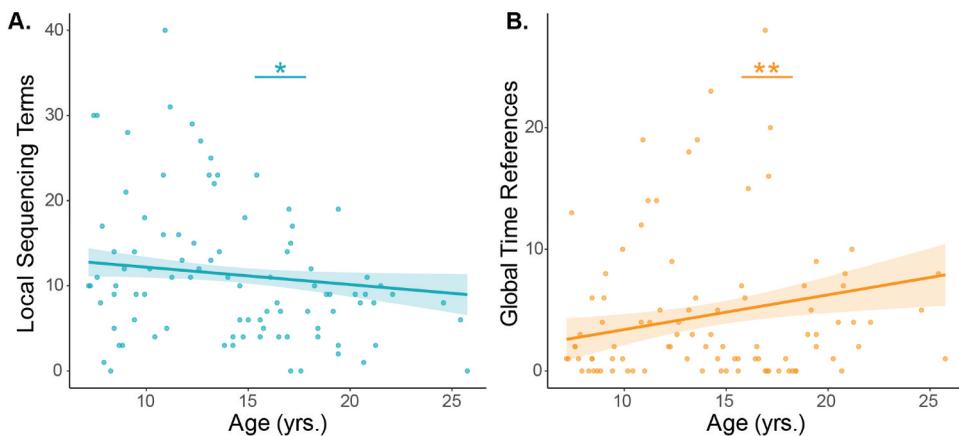


Figure 1. Developmental differences in references to local sequences and global time patterns. A) Use of sequencing terms in autobiographical narratives decreases with age while B) references to global time increase with age. Plots show regression lines and 95% confidence intervals derived from regression models including all covariates, points indicate individual participants.

Time knowledge and independence modulate age differences in global temporal organization

As expected, older children showed greater knowledge of conventional time ($B = 0.17$, $SE = 0.04$, $t = 4.94$, $p < 0.001$; Table S5) and more independence in navigating time in daily life ($B = 0.96$, $SE = 0.08$, $t = 12.78$, $p < 0.001$; Figure 2A; Table S6). Importantly, while both measures increased with age, all following models retained age as a predictor to ensure that any relation between narrative organization and time knowledge or independence indicated unique experience-related variance above and beyond age.

Having established developmental differences in references to global time in autobiographical narratives, we next examined which specific dimensions of global time underlie these changes, focusing on conventional time structures (temporal locations and durations) and recurring temporal patterns (temporal relations; see Table 3 for definitions and examples). We predicted that knowledge of conventional time structures would primarily relate to references to temporal locations and durations, since conventional time provides a framework for anchoring events to specific landmarks. By contrast, we predicted that references to recurring temporal patterns would be less related to conventional time, because time patterns are typically extracted across related experiences rather than tied to fixed temporal landmarks. Accordingly, we hypothesized that references to temporal relations would instead relate to independence, with older and more independent children having greater experience navigating time and, thus, more opportunities to abstract and learn temporal patterns.

As predicted, we found that references to specific temporal locations and durations both increased with age (location: $B = 0.15$, $SE = 0.07$, $t = 2.11$, $p = 0.04$; duration: $B = 0.11$, $SE = 0.04$, $t = 2.56$, $p = 0.01$; Tables S7-S8). Moreover, conventional time knowledge predicted references to specific temporal locations ($B = 0.50$, $SE = 0.20$, $t = 2.44$, $p = 0.02$; Table S9).

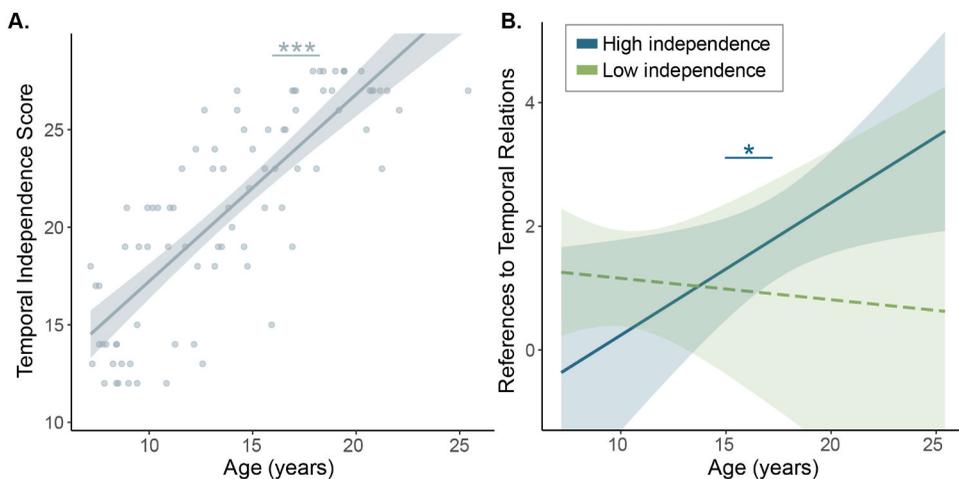


Figure 2. A) temporal independence increases with age and displays uniform variance during development. B) age and independence interact to predict relational organization of autobiographical recall, such that greater independence corresponds to increased references to temporal relations with age. High and low independence are split via median split for plotting only.

Notably, when including conventional time knowledge as a predictor in the regression model, age no longer predicted references to temporal locations ($p = 0.48$), suggesting that age-related increases in these references may be attributable to individual differences in time knowledge. References to temporal durations and relations were not associated with time knowledge ($p_s > .1$), suggesting that knowledge of conventional temporal concepts may uniquely relate to children's ability to anchor experiences to specific points in time, while relations and durations are less likely to be linked to specific temporal landmarks.

Surprisingly, while references to temporal locations and durations both increased with age, we did not find a significant main effect of age on descriptions of temporal relations ($p = 0.17$). However, an age-by-independence interaction revealed that participants who navigated time more independently in their everyday lives increasingly described recurring temporal relations with age, whereas less independent participants did not ($B = 0.03$, $SE = 0.01$, $t = 2.20$, $p = 0.03$; **Figure 2B**; Table S10). Confirmatory analyses showed that only highly independent participants (identified via median split) exhibited age-related increases in references to temporal patterns ($B = 0.30$, $SE = 0.12$, $t = 2.45$, $p = 0.019$; Table S11) while less independent participants showed no such effect ($p = 0.52$). Importantly, this continuous age-by-independence interaction indicates a combinatorial role of developmental stage and real-world experience, as neither predicted relational temporal organization individually. Accordingly, these findings suggest that age may not provide a full proxy for development when experiences significantly differ between children, and that age and lived experience jointly shape the temporal organization of autobiographical memories during development. We also did not identify any main or interaction effects of temporal independence for the use of any other category or sub-category ($p_s > 0.17$), suggesting that the ability to organize narratives based on relations extracted across experiences uniquely reflects the independence with which children navigate those experiences.

Discussion

The present study directly assessed the temporal language that children use to structure their autobiographical memories across development, comparing references to local event sequences and global time structures. We examined these measures continuously by age in U.S. participants aged 7–25 years, a period of development when both autobiographical memory and real-world independence undergo significant change (Pathman & St. Jacques, 2013; Van Petegem et al., 2012). Across this age range, we found that both age and lived experience influenced how participants used time to organize personal narratives, as older children and young adults made proportionally more references to global time patterns relative to local event sequences when freely recalling past experiences. Moreover, individual differences in real-world experience predicted distinct aspects of temporal organization – conventional time knowledge was linked to references to fixed temporal locations, whereas temporal independence predicted references to recurring temporal patterns. Together, these results reveal that with both age and experience, children increasingly embed specific details within relational time knowledge.

This study extends prior developmental work showing that autobiographical recall becomes more sequentially coherent from childhood into adolescence (Habermas & De Silveira, 2008; Habermas et al., 2009; Peters et al., 2025; Reese et al., 2011). While informative, studies that assign scores to the overall coherence of a narrative may overlook finer-

grained linguistic features that clarify what aspects of time children use to structure their experiences at different ages. Our approach isolates the specific temporal structures children use to organize their narratives, enabling direct comparisons of how often local and global dimensions of time are referenced. This fine-grained approach allowed us to not only test whether children generally describe each, but to capture a developmental transition between local and global dimensions of time, a transition that would not be identifiable by coding across full narratives or focusing on order alone. Thus, extending previous approaches with a finer temporal resolution revealed a qualitative shift in temporal organization with age from prioritizing basic sequence order to global time frameworks.

These findings also highlight how children's developing ability to acquire and apply relational knowledge shapes their memory for past experiences. While two events can be recalled in order based on their adjacency during a continuous experience, embedding events within global time structures requires both prior temporal knowledge (i.e., knowing about temporal patterns or conventional time) and the capacity to apply that knowledge flexibly to new situations, aligning new experiences with existing frameworks (Friedman, 2013; Pathman et al., 2013). This ability to situate experiences within existing temporal knowledge allows children to recognize regularities that predict when activities or routines will recur, supporting skills like effective time management and future planning (McCormack & Hoerl, 2017). Importantly, such prospective memory abilities are also associated with real-world behaviors like academic achievement and impulse control, underscoring the need to understand children's developing ability to embed new experiences within existing knowledge (Bromberg et al., 2015; Pham & Taylor, 1999). Notably, laboratory studies show that younger children are less likely to reinstate prior knowledge during new experiences or to integrate new information with what they already know (Brod et al., 2013). These limitations may help explain why younger children rely more heavily on basic sequence relations, a simpler but less structured way of organizing experience, which may constrain their ability to anticipate and plan. The developmental shift from local sequences to global knowledge structures may therefore reflect broader age-related changes in how personal experience is integrated with higher order knowledge, extending mechanisms identified in laboratory paradigms to the organization of autobiographical narratives during development.

Finally, the present findings build on a body of research showing that, beyond age, differences in lived experience largely shape autobiographical memory development (Bauer & Larkina, 2019; Fivush, 2011; Mullen & Yi, 1995; Nelson & Fivush, 2020). First, above and beyond age, children's conventional time knowledge predicted their references to specific temporal locations. While prior work has linked time knowledge to broader cognitive skills such as vocabulary and working memory (Pathman et al., 2022), our findings suggest that it also provides a scaffold for organizing autobiographical memories in time. Moreover, this study examined not only the knowledge children possessed but also how independently they applied it in everyday life.

Because the ability to use temporal knowledge in novel contexts improves into adulthood (Pudhiyidath et al., 2020) and decision-making becomes increasingly self-directed through adolescence (Van Petegem et al., 2012), we predicted that independence in applying time knowledge would support more sophisticated memory organization. Consistent with this premise, only children who were more temporally independent showed age-related increases in references to recurring temporal relations (e.g., "on Mondays"; Figure 2B),

indicating that opportunities to manage time autonomously explain variance in temporal organization beyond age alone. These individual differences underscore the importance of studying temporal memory in autobiographical contexts, whereby lived experience can be directly linked to how events are temporally organized. Such patterns are unlikely to emerge in laboratory paradigms using arbitrary or newly learned events, for which prior relational knowledge cannot be applied. In sum, our results reveal that maturational processes related to age *combine* with the effects of experience to influence how individuals organize their own personal experiences in time.

Notably, by asking participants to narrate a typical day in their lives, this study was designed to elicit descriptions of recurring experiences (i.e., a typical Monday) rather than narratives of specific, discrete events as are often probed in autobiographical tasks. This methodological choice was motivated by our focus on characterizing developmental changes in temporal organization and structure. Prior work demonstrates that even young children can reliably temporally organize event reports around familiar routines (Fivush, 2011) but do not always do so for cued episodes (Bauer et al., 2011). Thus, prioritizing descriptions of typical experiences in the present report ensured that developmentally accessible and quantifiable measures of temporal structure could be derived across our broad age range, enabling comparisons from childhood to adulthood. However, this design choice may also limit the generalizability of the present findings to all forms of autobiographical memory, and future work should extend this coding approach to more constrained prompts which elicit descriptions of unique, personally-experienced events.

Directly examining how temporal organization varies based on the temporal characteristics of the events being described will clarify the extent to which the present findings generalize to autobiographical memory more broadly. For instance, while children aged seven to ten years can describe the content of specific past events based on cue words, they are less likely to spontaneously produce details about temporal context for events that are more remote in time than recent experiences (Bauer et al., 2007). Consequently, children's reliance on sequencing terms rather than global time markers may be especially pronounced when describing remote events, potentially yielding stronger age differences. Conversely, prompting a child to describe an event near a familiar temporal landmark (e.g., their birthday) may allow younger children to reference more global time markers because of their knowledge of the surrounding temporal context. Together, these examples illustrate how the unique temporal features of specific episodes may shape how children describe them, particularly during childhood when the ability to embed episodes within conventional time knowledge is still developing (Friedman et al., 2011). Future studies that prompt children to recall specific cued episodes and compare these narratives to adults' accounts of the same events could clarify how temporal organization varies with both age and the specific experiences being described.

In conclusion, our findings demonstrate a developmental shift in autobiographical memory from local, sequence-based accounts to the embedding of experiences within global time structures. This organization has significant implications for real-world behaviors from prospective thinking (Pham & Taylor, 1999; Bromberg et al., 2015) to providing accurate eyewitness testimony about when events occurred (Wandrey et al., 2012), as it suggests that the types of temporal details children use to organize their experiences significantly vary across development. Moreover, the transition from local to global organization is shaped by both age and individual differences in time knowledge

and independence managing time in daily life. These effects of experience highlight the need to consider children's experiences and independence when examining how autobiographical memory develops across late childhood and adolescence. Here, we provide a measure to do so in the domain of time, but children gain independence in several domains across this age range (e.g., navigating space, social relations, money, etc.), which may similarly affect episodic and autobiographical memory processes. The present results suggest that it is critical for future autobiographical work to collect information about children's independence and how their unique experiences combine with age to shape how they describe their experiences.

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