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Cognitive Development



Remembering the past to envision the future in middle childhood: Developmental linkages between prospection and episodic memory



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ABSTRACT

Prospection is the mental simulation of future events and may promote positive, future-oriented action in the present. Despite evidence of a relation between prospection and episodic memory, there is a paucity of research comparing the developmental trajectories of each during middle childhood, a time of substantial episodic memory development. This study examined prospection and episodic memory in 5-, 7-, and 9-year-old children and adults ($N=80$). Participants provided narratives and introspective judgments about their experience of mentalizing past and future events. The development of prospection was more protracted than that of episodic memory, although individual differences in past event episodicity predicted prospection. Although both prospection and episodic memory were characterized by a rich subjective experience, future events were rated as more difficult to envision and were more frequently viewed in the third-person perspective. Although both prospection and episodic memory appear to improve during middle childhood, results suggest that prospection may require additional skills.

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1. Introduction

Prospection is the ability to mentally project forward in time in order to pre-experience future events (Tulving, 1985, 2005). This capacity is critical for adaptive behavior. While it is possible to plan for the future based on a factual understanding of contextual consequences (e.g., I will practice piano because I want to be part of the year-end recital), mentally pre-experiencing possible outcomes (e.g., pre-experiencing the feeling of joy at being selected or disappointment at being excluded) connects an individual with a future self and may provide stronger motivation for action (Suddendorf & Corballis, 2007).

Although the capacity to anticipate future events is associated with a number of abilities including planning (Hudson, Shapiro, & Sosa, 1995; Thompson, Barresi, & Moore, 1997) and reasoning about mental states (Lagattuta, 2007), a special role for episodic memory has been proposed (Schacter & Addis, 2007a, 2007b). Episodic memory is the capacity to mentally reinstate a personally experienced event in specific, sensory–perceptual detail (Conway, 2001; Tulving, 1972, 1985, 2005). Despite their opposite temporal directions, episodic memory and prospection are similar in that they involve mentalizing about personal events that are isolated in space and time and contain rich contextual features (Tulving, 1985). Both are also characterized by autoegetic consciousness, which enables one to be aware of (and reflect on) one's subjective experience during an event's mental simulation (Tulving, 2001). Therefore, reports on phenomenological experience (such as the clarity and visual perspective of an event) may provide important insight into the similarities and differences between mentalizing past and future events.

The Constructive Episodic Simulation hypothesis provides a theoretical basis for an emphasis on similarities between these abilities (Schacter & Addis, 2007a, 2007b) by proposing that the mental simulation of future events involves accessing and then recombining details from one's autobiographical memory (Conway, 2001) in order to mentally simulate a realistic, yet novel, future event. From this perspective, remembering the past and mentally pre-experiencing the future are integrally related.

Empirical comparisons of the functioning of episodic memory and prospection suggest a strong relation between the two abilities in adults. Although representations of past events tend to be more detailed than future events, variables like valence and temporal distance affect past and future event representations similarly (D'Argembeau & Van der Linden, 2004). We also know there are commonalities in the neural substrates supporting these abilities (Addis, Wong, & Schacter, 2007; Buckner & Carroll, 2007), and that impairments in episodic memory often co-occur with impairments in prospection (Tulving, 1985; Williams, Ellis, Tyers, & Healy, 1996). Although these similarities support a functional relation between episodic memory and prospection, an important additional question is whether these two abilities exhibit similar developmental trajectories. The present study addresses this question by investigating the relation between episodic memory and prospection during middle childhood and comparing children's abilities to those of young adults.

1.1. *The development of episodic memory during middle childhood*

Developmental studies show robust improvements in episodic memory during middle and late childhood (Billingsley, Smith, & McAndrews, 2002; Ghetti & Angelini, 2008; Ghetti, Mirandola, Angelini, Cornoldi, & Ciaramelli, 2011; Piolino et al., 2007; Schneider, Knopf, & Stefanek, 2002; Shing, Werkle-Bergner, Li, & Lindenberger, 2008). In a study of personal event narratives, Piolino and colleagues (2007) asked 7–13-year-olds to report specific personal events from three different time periods in the past and to describe these events with as many details as possible. Analyses of event narratives revealed age-related increases in the episodicity of events within each time period (see also Picard, Reffuveille, Eustache, & Piolino, 2009; Willoughby, Desrocher, Levine, & Rovet, 2012). Similar developmental improvements have been observed in studies (Ghetti & Angelini, 2008; Ghetti et al., 2011; Shing et al., 2008) in which children were shown a series of items and asked to remember each item and its associated contextual features or subjective experience (defining features of episodic memory; Tulving, 1972). Results from these behavioral studies are complemented by developmental research on the neural substrates of episodic memory showing similar age-related differences (DeMaster, Pathman, & Ghetti, 2013; Ghetti, DeMaster, Yonelinas, & Bunge, 2010; Ofen et al., 2007).

Together, these studies yield strong evidence of a protracted developmental trajectory for episodic memory.

Since prospection and episodic memory are thought to be related, one might expect their developmental trajectories to mirror one another. However, the Constructive Episodic Simulation hypothesis (Schacter & Addis, 2007a, 2007b) suggests that prospection relies on episodic memory and may therefore be a more constructive and cognitively demanding process. If true, the development of prospection may lag behind that of episodic memory, its trajectory more protracted. It is also possible that there is no evident developmental relation given that the developmental trajectories of episodic memory and prospection may be constrained by cognitive processes unique or differentially important to one over the other.

1.2. *The developmental relation between episodic memory and prospection*

A lack of prior research makes it difficult to compare the development of prospection and episodic memory during middle and late childhood. However, research provides some support for an early developmental relation. Busby and Suddendorf (2005) asked preschoolers to report things they did and did not do yesterday, as well as things they would and would not do tomorrow. Analyses revealed significant improvement in children's ability to report both yesterday and tomorrow events between ages 3 and 5. More importantly, there was a positive correlation between 3 and 4-year-olds' ability to bring to mind and report true yesterday events and likely-true tomorrow events, supporting a positive relation between episodic memory and prospection during early childhood.

Quon and Atance (2010) have provided additional support for an early developmental relation. Preschoolers were asked content questions (e.g., "What did you do/get/eat...?") about past, generalized present (semantic memory condition), or future events that varied according to the level of control a child would typically have during those events. Results revealed age-related improvement in the accuracy of children's reports across all three conditions (per parental ratings). Additionally, high-control events were associated with greater response accuracy than low-control events across past and future conditions only; there was no effect of control in the semantic memory condition. This result suggests that both episodic memory and prospection develop gradually across the preschool years and supports a relation between past and future thinking that may not extend to semantic memory.

Together, these studies provide nascent support for a developmental relation between episodic memory and prospection. Nevertheless, there are many unknowns – two of which we address here. First, given the protracted development of episodic memory, it is important to trace the developmental trajectory of prospection beyond the preschool years. Second, episodic memories are characterized by vivid subjective experience. If episodic memory and prospection are functionally related, introspective reports should capture these mentalizing activities during prospection, as is the case for episodic recollection (Ghetti et al., 2011). Additionally, if developmental differences in the ability to introspect on episodic memory are evident, these should extend to prospection. No study to date has compared children's phenomenological experiences during episodic memory and prospection.

1.3. *The present study*

To address the aims of the study, we adapted a cue-word technique developed for school-aged children (Bauer, Burch, Scholin, & Guler, 2007) and a recollection/prospection paradigm used with adults (Addis et al., 2007). Participants were presented with cue words and asked to generate past and future event narratives related to them. Temporal distance and direction were varied within individuals; participants provided narratives about events occurring one week and one year into their personal pasts and futures. Research has shown that temporal distance affects the contextual quality of adults' reports of past and future events similarly (D'Argembeau & Van der Linden, 2004), but should not affect the ability to retrieve semantic information about events. Results indicating a similar effect of distance on children's past and future event narratives would therefore support a developmental relation between episodic memory and prospection.

Event narratives were assessed for veracity by parent or close other to ensure that past events were true and future events were likely to be true (as opposed to implausible or make-believe). Although we predicted participants would provide event narratives of high veracity, future events (particularly those occurring in the distant future) were expected to receive lower veracity ratings than past events due to the uncertainty inherent in future occurrences.

It is challenging to assess the episodic content of children's event narratives because age differences could reflect changes in reporting skills or language ability rather than true changes in experience. We attempted to address this issue by using a coding scheme (adapted from Piolino et al., 2007) that assessed episodic content independent of narrative length (i.e., credit was given for referencing any spatial or temporal element of an event regardless of amount of elaboration associated with that element). Furthermore, narrative length was coded so that we could account for this variable in explaining episodicity. We predicted that children's ability to provide both past and future event narratives of high episodicity (i.e., positioned in space/time and including other contextual detail) would improve across middle childhood due to presumed commonalities in the mechanisms underlying episodic memory and prospection. Based on findings with adults (Addis et al., 2007), we also predicted an effect of temporal direction such that the episodicity of past event narratives would be higher than that of future event narratives.

We also predicted that age-related improvements in the episodicity of future event narratives would be more protracted than age-related improvements in the episodicity of past event narratives. Since prospection is thought to involve accessing and recombining details from multiple past experiences (Schacter & Addis, 2007a, 2007b), we reasoned that it may be particularly challenging for children given that they have less flexible retrieval than adults (Ackerman, 1982; Paz-Alonso, Ghetti, Matlen, Anderson, & Bunge, 2009). Finally, the episodicity of temporally close event narratives was expected to be higher than that of temporally distant event narratives given previous findings with adults (D'Argembeau & Van der Linden, 2004).

To assess the subjective experience of episodicity, we asked participants to provide ratings of their mental experience during each event mentalization. These included: (a) degree of clarity with which the event was envisioned, (b) whether the event was envisioned from a first- or third-person visual perspective, and (c) how easy it was to think of the event. A rich subjective experience should be associated with higher ratings of event clarity, first-person visual perspective, and ease of thinking of the event (Berntsen & Rubin, 2006; Sutin & Robins, 2008; Tulving, 1972, 1985, 2005). To the extent that these phenomenological dimensions are equally represented in episodic memory and prospection, they should be similarly affected by the temporal distance manipulation. Conversely, a differential effect by temporal direction would suggest that the cognitive processes underlying these ratings may contribute uniquely or differently to past versus future mentalizing.

One might also anticipate different effects of our independent variables on introspective ratings based on studies showing dissociations among metacognitive judgments about episodic recollection (Metcalfe & Finn, 2008; Finn, 2008) and prospection (D'Argembeau & Van der Linden, 2012). We make no predictions regarding these types of dissociations but note that findings could reveal something unique about the subjective experience of episodic memory and prospection.

Finally, we expected that participants in all age groups would be able to report on event clarity and ease of thinking given that 4–5-year-olds can evaluate the quality of memory representations in terms of amount of memory detail and can make confidence judgments (Ghetti & Alexander, 2004; Ghetti, Qin, & Goodman, 2002). We also anticipated that young children would be able to report on visual perspective if it is a fundamental aspect of their subjective experience. However, if a manipulation of visual imagery is needed to establish and attribute visual perspective, younger children may exhibit poorer skills reporting visual perspective compared to other introspective aspects (Kosslyn, Margolis, Goldknopf, Daly, & Barrett, 1990). Furthermore, some developmental differences across ratings were expected given evidence that introspection on memory states improves during middle childhood (Ghetti, Lyons, Lazzarin, & Cornoldi, 2008; Ghetti et al., 2011; Roebbers & Howie, 2003; Roebbers, 2002).

2. Method

2.1. Design

We employed a 4 (age group: 5-year-olds vs. 7-year-olds vs. 9-year-olds vs. young adults) \times 2 (temporal direction: past vs. future) \times 2 (temporal distance: one week vs. one year) mixed design. Temporal direction and distance were varied within participants. Presentation order of temporal conditions (past/future; near/far) was counterbalanced across participants.

2.2. Participants

We assessed 80 participants from four age groups: 20 five-year-olds (mean age 65 months, range 61–71 months); 20 seven-year-olds (mean age 88 months, range 84–95 months); 20 nine-year-olds (mean age 114 months, range 109–119 months); 20 adults (mean age 241 months, range 217–307 months). Males and females were equally represented within each age group. Sixty-three percent of participants were European American, 14% were Asian, 9% were Hispanic, and 14% were of mixed ethnicity. Although socioeconomic status of participants varied, most were from upper middle class families and had at least one parent with some college education. Eight additional participants were excluded from final analyses: four 5-year-olds were unable to provide future events, one 5-year-old and one 7-year-old were unable to provide both past and future events, one adult became ill during the experimental session, and one adult was noncompliant. Participants were fluent in English and had no known cognitive impairments. Child participants were recruited through local community events and received \$10 for their participation. Adults were recruited through the psychology recruitment system at the local university and received course credit for their participation.

2.3. Materials and procedure

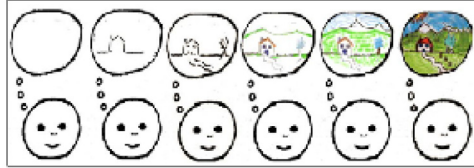
2.3.1. Episodic thinking interview

After obtaining consent, a female research assistant conducted the episodic thinking interview with each participant individually in a quiet testing room. The interview was constructed using a cue-word technique adapted from a method developed to examine autobiographical memory in school-aged children (Bauer et al., 2007) and from a recollection/prospection paradigm used with adults (Addis et al., 2007). Similar approaches have been used with children as young as 5 (Fitzgerald, 1991; Fivush, Hazzard, Sales, Sarfati, & Brown, 2003).

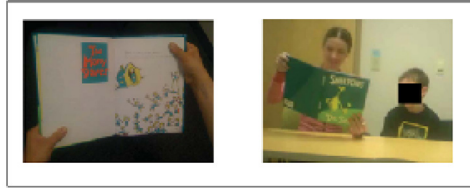
During the interview, participants were asked to generate and describe eight personal events (two events each from last week, last year, next week, and next year), each related to a given cue word. Cues were obtained from the MRC Psycholinguistic Database (Version 2.00) and included the words *book*, *cake*, *family*, *game*, *pet*, *pool*, *school*, and *song* (all nouns of neutral or mildly positive salience and with an age of acquisition rating between one and three years). Cue words were counterbalanced such that each cue word was equally represented within each condition. To reduce confusion, events within the same condition (last week, last year, next week, or next year) were blocked together, as were events within the same temporal direction (past or future). Order of conditions was fully counterbalanced across participants and a practice event was given before each temporal direction block matching the temporal direction of the test trials following it. (Cue words for practice trials were *sand* and *park*.) Events were therefore arranged in the following order: practice event 1, test events 1–4, practice event 2, test events 5–8.

For each cue word, participants were instructed to “Think of a time (*last week*, *last year*, *next week*, or *next year*) that the (*cue word*) makes you think of.” We expected all age groups to understand the meaning of “week” and “year,” given research suggesting that 5-year-olds have a rudimentary understanding of temporal measurement terms (Friedman, 1991, 2000, 2005; Grant & Suddendorf, 2009). Participants were told that each event should be isolated in time and space and not an everyday occurrence. We prompted for a specific event when participants described a repeated or continuous event (“Can you tell me about just one time?”). Once an appropriate event was reported, participants were asked for additional event details using the following prompts: (1) Can you tell me more about

Clarity visual scale:



First-Person/Third-Person visual scale:



Ease of Thinking of Event visual scale:

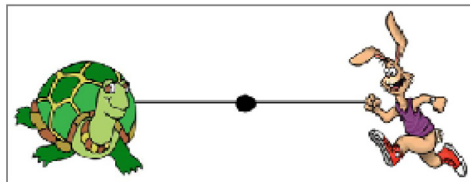


Fig. 1. Visual scales used to report introspective ratings of phenomenological details.

what (happened/will happen)? (2) Can you tell me more about who (was/will be) there? (3) Can you tell me more about where this (happened/will happen)? (4) Can you tell me more about when this (happened/will happen)? Each prompt was introduced only once.

After participants responded to the prompts, they were asked to provide subjective ratings of event clarity, visual perspective, and ease of calling the event to mind. To obtain a subjective rating of event clarity, we showed participants a *clarity visual scale* and asked, “When you thought about (event description), how clear did it look in your head?” This scale was adapted from one developed by Ghatti and Alexander (2004), who used it successfully with the same age groups involved in the present study (see Fig. 1 for pictures of all visual scales). This scale contained five pictures, each depicting an identical smiley face with a “thought bubble” that varied in content across pictures. The thought bubble in the first picture was completely empty to indicate no clarity at all. For data analysis, this picture was given a value of 0. The thought bubble in the last picture contained a detailed, colorful image and was said to indicate an event whose mental image was perfectly clear. For data analysis, this picture was given a value of 5. In the intermediate pictures, the thought bubble displayed increasing levels of detail and color. Intermediate pictures were said to indicate events that were “pretty unclear” (coded 1), “not so clear” (coded 2), “somewhat clear” (coded 3), or “very clear” (coded 4). When obtaining this visual scale rating (as well as ratings of visual perspective and ease of thinking of the event), the interviewer pointed to the pictorial representation of each response option and said it aloud. No participant expressed confusion when using the visual scales.

To obtain a subjective rating of visual perspective, the interviewer showed participants a *first-person/third-person visual scale* and asked, “When you thought about (event description), how did it look like to you? Did it look like you were watching it from your own eyes (first-person visual perspective) or from the outside (third-person visual perspective)?” This visual scale was developed using video footage of the interviewer reading a story (*Too Many Daves* by Dr. Seuss) to the participant during a break from an unrelated study that occurred approximately one week prior. While reading the story, the interviewer sat to the right of the participant and held the book open with both hands. A photograph was taken of both the participant and experimenter; this photograph was used to portray an event experienced from a third-person perspective (i.e., envisioned from the perspective of an external observer, with the participant visible). For data analysis, this picture was given a value of

0. A first-person perspective picture was obtained by taking a photograph of what would have been in the participant's line of vision during the task (i.e., a picture of the book open and framed by the experimenter's hands). This picture, which was the same for all participants, was used to indicate an event whose mental image was viewed from a first-person perspective (i.e., envisioned from the participant's own eyes, in which the participant is not visible). For data analysis, this picture was given a value of 1. The first- and third-person perspective pictures were presented side by side on the visual scale.

To obtain a subjective rating for ease of thinking of an event, the interviewer showed participants an *ease of thinking of event visual scale* and asked, "When you thought about (event description), how quickly did it come to mind? Did it come to mind slowly, somewhat quickly, or quickly?" This visual scale contained three pictures. The first portrayed a tortoise and was said to indicate an event that came to mind slowly. For data analysis, this picture was given a value of 0. The third picture portrayed a hare and was said to indicate an event that came to mind quickly. For data analysis, this picture was given a value of 2. Between the tortoise and hare was a solid black dot (the final picture). This dot was said to indicate an event that came to mind somewhat quickly and was given a value of 1 for data analysis.

2.3.2. Scoring episodicity of event narratives

Episodic thinking interviews were videotaped and transcribed. Scores were based on a five-point episodicity scale adapted from Piolino and colleagues (2003, 2007). Scores ranged from 0 to 4 and were based on specificity of content (single or repeated event), spatial and temporal detail (where and when event occurred or will occur), and the presence of other contextual detail (imagery, emotions, and thoughts). A score of 0 was given if a participant failed to report anything or reported general information only (e.g., "Cake is something delicious with frosting on it"). A score of 1 was given if a participant reported a vague event, one that was repeated or continuous with little or no detail regarding time or space (e.g., "I went to the pool"). A score of 2 was given for a generic event, one that was repeated or continuous but situated in time and/or space (e.g., "Playing with my family... at my house... in the afternoon"). A score of 3 was given for a specific event (isolated and situated in time and/or space) without any other contextual detail (e.g., "Going and playing games at Sunsplash, the water park... next week..."). A score of 4 was given for a specific event (isolated and situated in time and/or space) with other contextual detail such as imagery, emotions, or thoughts (e.g., "Turning 21... I imagine eating cake at my house... It'll be chocolate and there will be lots of decorations... colorful and bright, and I imagine Bubba my dog wearing a party hat...").

Two independent raters blind to participant age and gender scored the event narratives. The narratives contained information about temporal direction (past or future tense) and distance (e.g., temporal markers), making it impossible for raters to maintain blindness to these conditions; however, raters were not informed of the predicted effect of these variables. Inter-rater reliability based on the Spearman correlation coefficient was .83 ($p < .001$) across all event narratives. Discrepancies between raters were resolved by calculating the two raters' mean score.

2.3.3. Scoring veracity of event narratives

After each session, parents (or close other for adult participants) were read participants' event narratives over the phone and asked to rate each narrative's thematic and temporal veracity on a three-point scale where "not true," "partially true," and "true" were coded as 0, 1, and 2, respectively. The mean of each event's thematic and temporal veracity scores was computed to provide an index of that event's overall veracity ranging from 0 to 2. Collection of veracity scores after participation allowed us to give parents the narratives without the constraints posed by a concurrent child session, and it allowed us to use an identical procedure for child and adult participants; however, not all parents (or comparable close others) could be reached via telephone. Additionally, some adult participants did not agree to have their events verified. Thus, veracity scores are available for 84% of the total sample (16 five-year-olds, 17 seven-year-olds, 19 nine-year-olds, and 15 young adults).

3. Results

We first present results for episodicity scores, followed by results for phenomenological ratings. Preliminary analyses revealed sex differences in episodicity and reported ease of forming a mental image, with females evincing higher episodicity scores than males, and males reporting greater ease of forming mental images for past events, $ps \leq .05$. Thus, gender was included in the analyses for these variables. Otherwise, and unless noted, data were analyzed using a 4 (age group: 5-year-olds vs. 7-year-olds vs. 9-year-olds vs. adults) \times 2 (temporal direction: past vs. future) \times 2 (temporal distance: one week vs. one year) repeated measures analysis of variance (ANOVA).

Because veracity scores were collected as a control measure, we analyzed these scores first. Using the repeated measures ANOVA described above, we observed main effects of direction, $F(1,65) = 20.39, p < .001, \eta_p^2 = 0.25$, distance $F(1,65) = 6.82, p = .01, \eta_p^2 = 0.10$, and age $F(3,63) = 10.21, p < .001, \eta_p^2 = 0.33$. Higher veracity scores were obtained for past ($M = 1.79, SD = .28$) versus future events ($M = 1.59, SD = .40$), and near ($M = 1.74, SD = .33$) versus distant ($M = 1.63, SD = .37$) events. Mean veracity increased with age; simple effects analyses revealed that 5-year-olds' veracity ratings were significantly lower than 9-year-olds' and adults' ($ps \leq .01$), and that 7- and 9-year-olds' veracity ratings were significantly lower than adults' ($ps \leq .02$). These results suggest that participants engaged in the task despite age differences in veracity; the future is inherently more uncertain than the past, and distant events are more removed from one's present experience. Importantly, each age group provided event narratives rated high in overall veracity (i.e., high in both thematic and temporal veracity, as overall veracity represented the mean of these scores), with overall means ranging from 1.47 to 1.95 (where 0 is not true, 1 is partially true, and 2 is true).

3.1. Episodicity scores

Analysis of episodicity scores revealed a main effect of age, $F(3,72) = 6.54, p = .001, \eta_p^2 = 0.21$, such that episodicity scores increased with age (see Fig. 2a). Five-year-olds' event narratives were significantly less episodic than those reported by 9-year-olds ($p = .04$) and adults ($p < .001$), 7-year-olds' event narratives were significantly less episodic than those reported by adults ($p = .001$), and 9-year-olds' event narratives tended to be less episodic than those reported by adults ($p = .05$). We also observed a main effect of temporal direction on episodicity scores, $F(1,72) = 75.01, p < .001, \eta_p^2 = 0.51$, such that past event narratives ($M = 3.12, SD = .64$) were more episodic than future event narratives ($M = 2.64, SD = 0.54$). This pattern was observed across all age groups. We observed no effect of temporal distance on episodicity scores, $F(1,72) = 0.03, p = .87, \eta_p^2 = 0.00$.

To further examine the relation between episodicity scores for past and future events, we conducted a simultaneous multiple regression analysis to determine if individual differences in episodicity for past events would predict episodicity for future events. Gender, age, average number of words per past event narrative, and average number of words per future event narrative were included in the regression. We included gender because preliminary analyses revealed sex differences in episodicity. We included age, average number of words per past event narrative, and average number of words per future event narrative to rule out that any relation between past and future event episodicity was attributable to common sources of development in narrative style and/or verbal ability. Average number of words per past event narrative, $F(3,76) = 6.86, p < .001, \eta_p^2 = 0.2$, and future event narrative, $F(3,76) = 9.45, p < .001, \eta_p^2 = 0.27$, increased with age. Five-year-olds used an average of 47.09 words ($SD = 23.17$) for past events and an average of 37.78 words ($SD = 18.88$) for future events. Seven-year-olds used an average of 57.71 words ($SD = 47.02$) for past events and an average of 47.09 words ($SD = 26.35$) for future events. Nine-year-olds used an average of 65.23 words ($SD = 39.51$) for past and an average of 51.23 words ($SD = 26.23$) for future events. Finally, adults used an average of 116.39 words ($SD = 82.08$) for past and an average of 83.69 words ($SD = 40.47$) for future events. Both average episodicity score for past events ($\beta = .47, p < .001$) and average number of words per future event narrative ($\beta = .47, p = .01$) significantly predicted average episodicity scores for future events; gender ($\beta = .05, p = .58$), age ($\beta = .03, p = .79$), and average number of words per past event narrative ($\beta = -.26, p = .12$) did not. Multicollinearity analysis revealed a tolerance value greater than .20 for all predictors. The resulting multiple regression was significant, adjusted $R^2 = 0.42, F(5,74) = 12.55, p < .001$. Thus, average episodicity score for past events explained a significant proportion of variance in average episodicity score for future events beyond that explained by length of future event narrative alone, consistent with the idea of a functional relation between the two during childhood.

3.1.1. Ancillary analysis: a more stringent criterion of episodicity

Based on work by Piolino and colleagues (2007), we conducted an ancillary analysis to examine whether results would differ if we applied a more stringent criterion of episodicity. The episodicity scale is ordinal, and scores increase as a function of detail reported. A score of 4 means that participants' reports described a specific event, situated in time and/or space, and included other contextual detail. Although this level of detail is not sufficient for autoegetic consciousness, it is an integral feature of this level of consciousness (Tulving, 1985). Therefore, strict episodicity scores were generated by giving a score of 1 to narratives with previous scores of 4, and a score of 0 to all other previous scores. When the same overall ANOVA described earlier was conducted on the strict episodicity scores, the pattern of results was replicated, but the effect of age, $F(3,72) = 7.17, p < .001, \eta_p^2 = 0.23$, was qualified by an age \times temporal direction interaction, $F(3,72) = 2.79, p = .05, \eta_p^2 = 0.10$. As evident in Fig. 2b, simple effect analyses revealed that adults produced significantly more contextually rich past event narratives than 5- and 7-year-olds ($ps = .01$). Similarly, 9-year-olds tended to produce more contextually rich past event narratives than 5- and 7-year-olds ($ps = .08$). A somewhat different pattern emerged when we examined age-related differences in the production of contextually rich future event narratives. Specifically, adults produced significantly more contextually rich future event narratives than all other age groups, including 9-year-olds ($ps \leq .001$); no other age differences were observed. Together, these age-related differences in contextual detail suggest a more protracted developmental trajectory for prospection compared to episodic memory. As with the previous analysis, no effect of temporal distance on strict episodicity scores was observed, $F(1,72) = 0.60, p = .44, \eta_p^2 = 0.01$.

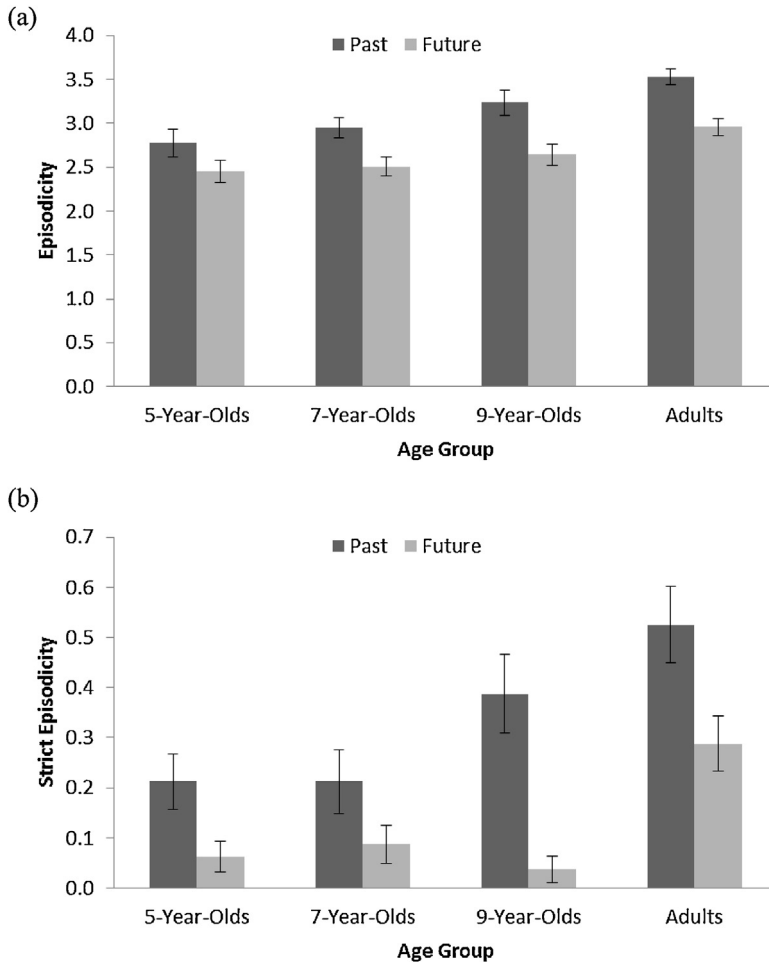


Fig. 2. (a) Mean episodicity scores (\pm SE) for past and future events across age groups (ranging from 0 to 4). (b) Mean strict episodicity scores (\pm SE) for past and future events across age groups (ranging from 0 to 1). Results indicate main effects of age and temporal direction that are qualified by an age \times temporal direction interaction ($p = .05$).

We did not use strict episodicity scores to conduct the same regression analysis described earlier due to floor performance in children. Stringent future episodicity scores differed significantly from zero only for 7-year-olds, $t(19) = 2.33$, $p = .03$, and not for 5- or 9-year-olds, $t(19) < 2.03$, $.06 < p < .19$. However, we included narrative length as a covariate in an analysis of covariance (ANCOVA) including the same independent variables above, and we observed an age \times temporal direction interaction, $F(3,71) = 4.55$, $p = .01$, $\eta_p^2 = 0.16$.

3.2. Introspection-based judgments on phenomenological details

Introspective ratings of phenomenological details probed aspects of an individual's subjective mental experience during recollection and prospection; they included ratings of event clarity, visual perspective while envisioning the event, and ease of thinking of the event. These scores were used as dependent measures in the same ANOVA model described earlier.

3.2.1. Event clarity

A main effect of temporal distance, $F(1,76) = 8.52$, $p = .01$, $\eta_p^2 = 0.10$ (Table 1), was qualified by an age \times temporal distance interaction, $F(3,76) = 5.50$, $p = .002$, $\eta_p^2 = 0.18$ (see Fig. 3), such that distant events were rated as less clear than near events for 9-year-olds ($p = .02$) and adults ($p < .001$); 5- and 7-year-olds did not show a significant differentiation. There were no significant effects of temporal direction on event clarity. Thus, 9-year-olds and adults reported experiencing distant events less clearly than near events regardless of direction.

Table 1

Effects of temporal direction (past, future) and distance (near, distant) on introspective ratings of event clarity (scored 0–5), visual perspective (third-person scored 0; first-person scored 1), and ease of coming up with the event (scored 0–2). Means and standard deviations are presented.

Introspective rating	Temporal direction			Temporal distance		
	Past	Future	<i>p</i> -Value	Near	Distant	<i>p</i> -Value
Clarity	3.46 (1.01)	3.28 (1.00)	.18	3.55 (1.05)	3.21 (0.94)	.01
Visual perspective	0.67 (0.25)	0.58 (0.29)	.02	0.65 (0.25)	0.60 (0.25)	.07
Ease of thinking of event	1.24 (0.43)	1.11 (0.45)	.02	1.27 (0.45)	1.07 (0.46)	.01

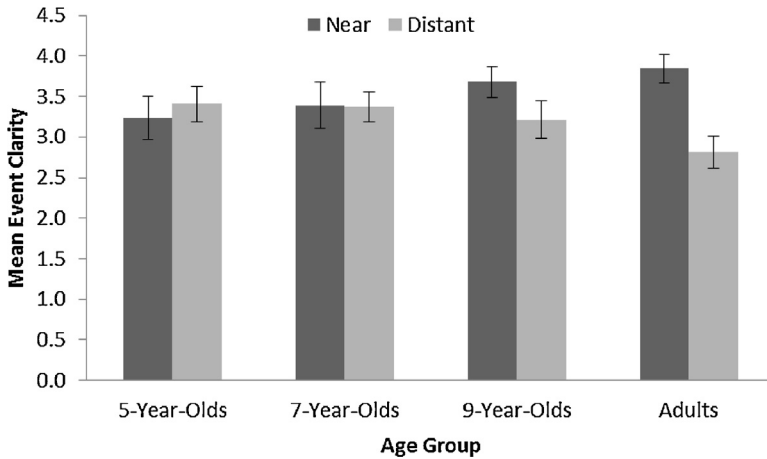


Fig. 3. Mean event clarity ratings (\pm SE) for near and distant events across age groups (ranging from 0 to 5). Results indicate a main effect of temporal distance ($p = .01$) that is qualified by an age \times temporal distance interaction ($p = .002$).

3.2.2. Visual perspective

We observed a main effect of temporal direction, $F(1,76) = 5.58$, $p = .02$, $\eta_p^2 = 0.07$. Past events were envisioned from a first-person perspective more frequently than future events (Table 1). No effect of temporal distance on visual perspective was observed.

3.2.3. Ease of thinking of the event

Because preliminary analyses revealed gender differences in ease of thinking of event ratings, we added this variable to the ANOVA. A main effect of temporal direction was observed, $F(1,72) = 6.05$, $p = .02$, $\eta_p^2 = 0.08$, such that future events were rated as being more difficult to think about than past events (Table 1), but this effect was qualified by an age \times temporal direction interaction, $F(3,72) = 3.85$, $p = .01$, $\eta_p^2 = 0.14$ (see Fig. 4), as it was not evident in adults. If anything, adults' ratings appeared to show the opposite trend ($p = .14$). A main effect of temporal distance on ease of thinking of event ratings was also observed, $F(1,72) = 8.11$, $p = .01$, $\eta_p^2 = 0.10$, such that distant events were rated as being more difficult to think of than near events.

4. Discussion

Prospection is an important cognitive ability that allows one to mentally pre-experience future events to promote more adaptive behavior in the present (Suddendorf & Corballis, 2007). Only a few studies have compared its developmental relation to episodic memory. Of those that have, middle childhood (a time of substantial episodic memory development) and the subjective experience of event mentalization have been largely overlooked. This study begins to address these gaps in the literature by examining the developmental relation between episodic memory and prospection during middle childhood (and adulthood) using a paradigm that examines the subjective experience of event mentalization via phenomenological ratings.

We predicted developmental improvements in prospection during middle childhood given evidence that episodic memory and autobiographical memory skills develop beyond early childhood (Ghetti & Angelini, 2008; Picard et al., 2009; Piolino et al., 2007; Shing et al., 2008; Willoughby et al.,

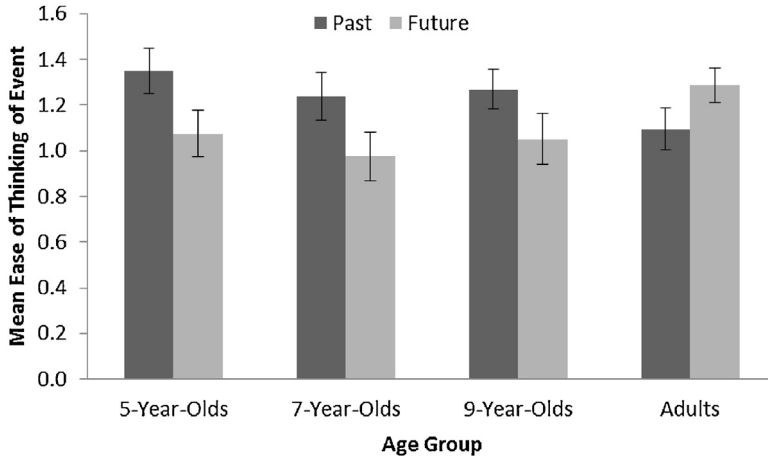


Fig. 4. Mean ease of thinking of event ratings (\pm SE) for past and future events across age groups (ranging from 0 to 2). Results indicate a main effect of temporal direction ($p = .02$) that is qualified by an age \times temporal direction interaction ($p = .01$).

2012) and given research showing a functional relation between episodic memory and prospection in adults (D'Argembeau & Van der Linden, 2004; Schacter & Addis, 2007a, 2007b). We also predicted similarities and differences between the narratives and phenomenological ratings of past and future events based on the possibility that episodic memory and prospection share common processes but are not identical constructs.

As predicted, the episodicity of both past and future event narratives improved during middle childhood. Furthermore, individual differences in the episodicity of past event narratives predicted individual differences in the episodicity of future event narratives. These results are consistent with a recent study (Wang, Capous, Koh, & Hou, *in press*) in which, 7–10-year-olds were interviewed about past and future events. Although the authors did not observe developmental differences within this age range, comparisons to adult data from an earlier study (Wang, Hou, Tang, & Wiprovnick, 2011) showed that children in this age range relied more on general knowledge in their narratives compared to adults. Additionally, there was a significant correlation between the episodic specificity of their past and future event narratives. Together, these studies converge to support a developmental and functional relation between episodic memory and prospection during middle childhood.

Despite the relation we observed between past and future episodicity, future events were less episodic than past events overall. Children also seemed aware of their difficulty constructing future events, rating future events as more difficult to think of compared to past events. These findings support the notion that prospection is more challenging than episodic recollection. It is not clear why the experience of thinking about future events was comparatively easier for adults, given that they also produced lower episodicity scores for future compared to past events. It is possible that young adults' orientation toward the future affects their perception; college is a unique life phase, dense with promises and anticipated challenges about what the future may bring (Arnett, 2004). The connection between their perceived ease of constructing a future event and their current investment in (and forecasting of) future states is speculative at this point but may be an interesting direction for future investigations.

Near events were rated as easier to think of than distant events regardless of temporal direction across age groups. This confirms that the ease of thinking measure is sensitive and reflects meaningful assessments from both children and adults. It is also consistent with functional similarities between episodic memory and prospection: As temporal distance increases, it becomes more difficult to envision a precise episode from either temporal direction (D'Argembeau & Van der Linden, 2004).

Like ease of thinking ratings, visual perspective ratings were also sensitive to temporal direction. Specifically, future events were envisioned from a third-person perspective more often than past

events. While a third-person perspective has been associated with the reconstructive nature of memories (Sutin & Robins, 2008), a first-person perspective has been associated with stronger feelings of re-living an event (Berntsen & Rubin, 2006). It is therefore not surprising that past events (i.e., events already lived) were viewed more often from a first-person perspective than future events (i.e., events mentally constructed). Research also indicates that events involving high emotion or self-awareness are more likely to be recalled from a third-person perspective (Libby, Eibach, & Gilovich, 2005; Nigro & Neisser, 1983). Since individuals have some control over events they have not yet experienced (as opposed to those that they already have), future event mentalizations may be especially relevant to the goals and emotional state of the current self. This possibility is consistent with recent research suggesting that an individual's sense of self is partly fostered by the mentalization of meaningful personal future events (D'Argembeau, Lardi, & Van der Linden, 2012). In sum, variables related to the self may contribute to differences in the subjective experience of past and future event mentalizations.

Unlike ease of thinking and visual perspective ratings, clarity ratings did not appear sensitive to temporal direction. However, an age by temporal distance interaction revealed that 9-year-olds and adults rated near events as more clear than distant events across both temporal directions. This result aligns with adult research showing that near events are envisioned in greater contextual detail than distant events (D'Argembeau & Van der Linden, 2004). Failure to detect this effect in 5- and 7-year-olds should not be due to difficulty with this scale, since these age groups have demonstrated reliable use of similar versions of it in previous studies (Ghetti & Alexander, 2004; Ghetti & Castelli, 2006). However, it should be noted that children's clarity ratings in the present study were generally lower than in previous research. This may be important considering research suggesting that phenomenological ratings are less likely to differentiate between experimental conditions when their overall strength is low (Ghetti et al., 2008). Here, assessments of visual clarity seem less sensitive to temporal direction than ease of thinking and visual perspective ratings. Dissociations among metacognitive judgments of memory (Finn, 2008; Metcalfe & Finn, 2008) and prospection (D'Argembeau & Van der Linden, 2012) have been reported in the literature, and additional research on these dissociations may help to further characterize influences on the subjective experience of recollection and prospection.

In sum, introspective ratings provided a valuable complement to episodicity scores and suggest that even 5-year-olds exhibit some awareness of the differences between remembering the past and envisioning the future. Although these findings must be replicated, they offer additional insight surrounding the relation between episodic memory and prospection.

The goal of our ancillary analysis was to adopt the most conservative approach we could, assessing whether any difference in the developmental trajectory of narratives about past versus future would emerge if we examined only the ability to provide highly contextualized events. With this index, a difference in the developmental trajectories of past versus future event narratives emerged. Children showed comparable difficulty providing future event narratives across age groups, with only adults able to produce highly contextualized future event narratives. This was not the case for past events, where even 5-year-olds were able to remember highly contextualized events. Also, four of six participants excluded from analyses for being unable to imagine an event were 5-year-olds who reported past events but *not* future events. Together, these findings suggest that prospection may be inherently more difficult than episodic memory, and even older children may struggle to integrate future episodes with elements of context, limiting their ability to produce highly detailed future event narratives.

The Constructive Episodic Simulation hypothesis provides a theoretical framework within which these findings may be regarded. According to this hypothesis, prospection relies on episodic memory because it involves accessing and then re-combining elements of past experiences in order to generate novel future events, making it more challenging than remembering alone (Schacter & Addis, 2007a, 2007b). Although future event narratives were significantly less episodic than past event narratives across all age groups, a result that is supported by research with adults (Addis et al., 2007), it remains unclear what factors make simulating future events even more difficult for children. Since mentally simulating future events requires a great degree of flexibility in retrieval processes and in the capacity to manipulate and combine retrieved information, several possibilities should be considered.

First, based on evidence that children's retrieval processes are much more rigid and dependent on external cues than adults' (Ackerman, 1982; Paz-Alonso et al., 2009), the mental simulation of detailed

future events may be particularly demanding for children because it requires them to retrieve *several* events before flexibly constructing one novel simulation. The mental simulation of a past event, while challenging, does not make the same retrieval demands. Second, the simulation of future events requires a highly demanding manipulation of information and might therefore be particularly taxing on children's working memory (Bayliss, Jarrold, Gunn, & Baddeley, 2003; Cowan, 1997). Finally, prospection is correlated with executive processes as well as visual–spatial processing abilities and time perspective (D'Argembeau, Ortoleva, Jumentier, & Van der Linden, 2010), and it is possible that simulating future events is more challenging for children because they are less skilled in these respects. Future research should examine whether these skills contribute differently to remembering the past versus envisioning the future. An assessment of general intellectual functioning may also prove helpful in accounting for individual differences.

A few caveats regarding the present study warrant mention. Because future events are uncertain, it is more difficult to assess their veracity compared to past events. Although veracity scores indicated that all age groups reported generally true past events and likely-to-be-true future events, it is possible that future event narratives included more imaginary acts than actual projections into the future. Imagination and pretense are a hallmark of childhood (Fein, 1981). If event narratives simply reflected unconstrained imaginative acts, finding such a protracted developmental trajectory would have been unlikely; the ease with which children imagine and pretend (Fein, 1981) should have attenuated developmental differences. Nevertheless, it seems important to compare narratives of future versus imagined events (see Race, Keane, & Verfaellie, 2011, for an investigation with adults).

There was no effect of temporal distance on episodicity scores, which was inconsistent with our hypothesis. This may be partly accounted for by the fact that our experimental paradigm allowed participants to freely select the event to report. It is possible that this led them to select the few events they could remember best or anticipate most strongly across temporal distance. Thus, although individuals' mentalizations of distant events may be, on average, less episodic than near events overall, participants' selection of events resulted in a less sensitive test for this difference. The effects of temporal distance on phenomenological ratings suggest that those measures may be more sensitive to subtle differences in episodic thinking and support their inclusion in future research.

Finally, we note that future studies would benefit from the inclusion of an adolescent sample. The results from the stringent episodicity analysis show that adults produced significantly more contextually rich future event narratives than all of the other age groups, and no other age differences were observed for this outcome. The inclusion of an adolescent sample may help elucidate when this developmental shift occurs.

Our results support a relation between episodic memory and prospection during middle childhood, a finding that begins to bridge early childhood and adult memory research. Our results also provide insight surrounding the functional relation between the two. The developmental trajectory of prospection is more protracted than that of episodic memory, and yet past event episodicity predicts future event episodicity across individuals. Moreover, introspective ratings of phenomenological details provide compelling evidence of both similarities and differences in the subjective experience of past versus future mental time travel. Thus, the integration of data from narratives and introspective assessments has proved a promising approach for examining the relation between recollection and prospection.

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