A comparison of preschoolers’ memory, knowledge, and anticipation of events

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Abstract

This study examined the development of the episodic and semantic memory systems, with an emphasis on the emergence of the two aspects of the former: episodic memory (the ability to re-experience a past event) and episodic future thinking (the ability to pre-experience a future event). Three-, 4-, and 5-year olds were randomly assigned to one of three conditions: past, semantic, or future. Children were asked questions about the same eight events, phrased in past, generalized present, or future tense. Half of these events were ones for which parents rated their children as having a high level of control (or input) over how the event unfolds, whereas the other half were rated as “low control.” Responses were scored with respect to their specificity and accuracy. Results revealed age differences in children’s accuracy scores across all three conditions. Children’s episodic future thinking and episodic memory, but not their semantic memory, were less accurate for low control events, compared to high control events. These results offer a new perspective on the development of the episodic and semantic memory systems, and the methods used to assess them.
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Vividly recalling the past and pre-experiencing the future are two of the most remarkable feats of the human mind. These two capacities have been dubbed “mental time travel” (e.g., Suddendorf & Corballis, 2007; Tulving, 1985) and are argued to be unique to humans, to emerge late in development, and to be mediated by the episodic memory system (Suddendorf & Corballis, 2007; Tulving, 1985; Wheeler, Stuss, & Tulving, 1997). The semantic memory system, in contrast, mediates an organism’s access to general knowledge about the world (e.g., that Paris is the capital of France) (e.g. Wheeler, 2000). This system is believed to be present in other species and also to emerge earlier in development than the episodic memory system (Tulving, 2005; Wheeler, 2000).

Although most research (developmental and otherwise) has focused on mental time travel into the past, there has recently been a surge of interest in its future counterpart (for a review, see Suddendorf & Corballis, 2007). This capacity has been described using a number of different terms including “episodic future thinking” (Atance & O’Neill, 2001), “prospection” (Buckner & Caroll, 2007; Gilbert & Wilson, 2007), and “simulation” (Schacter & Addis, 2007). Tulving (2005) argues that capacities that rely on mental time travel into the future, including anticipating and planning events, are a quintessential aspect of human life. In fact, the evolutionary significance of the episodic memory system may be that it allows for mental time travel into the future (Suddendorf & Corballis, 1997; Tulving, 2005). Indeed, as Suddendorf and Corballis (2007) argue, an organism who can behave in anticipation of a future need that is not currently experienced will have a selective advantage over one that cannot.

Perhaps in response to these arguments about the importance of mental time travel into the future, developmentalists have begun to study its emergence. More broadly, questions that
pertain to the age at which episodic memory and episodic future thinking develop, how they are distinct from semantic memory, and the relation between episodic memory and episodic future thinking have received empirical attention in the developmental literature. We begin this article with a brief review of this work, and then identify some important questions that remain to be addressed. We next describe a study that aims to answer some of these outstanding questions.

The development of episodic memory and episodic future thinking

Although some researchers argue that episodic memory does not develop until age 4 or older (e.g., Perner & Ruffman, 1995; Suddendorf & Corballis, 1997; Tulving, 2005; Wheeler, Stuss, & Tulving, 1997), others view its development as occurring more gradually during early childhood (e.g., Bauer, 2007; Nelson & Fivush, 2004; Reese, 2002). For example, most 2-year-olds can provide verbal accounts of past events (e.g., Eisenberg, 1985; Fivush & Hamond, 1990; Nelson, 1989; Sachs, 1983), though these typically require substantial prompting and specific questions from an adult (Nelson & Fivush, 2004). Starting around ages 3 and 4, however, children become better at answering open-ended questions about an event and require fewer specific prompts to do so than younger children (e.g., Hamond & Fivush, 1991). Furthermore, when directly questioned about “yesterday,” it is also around age 4 that children can accurately report events that they have personally experienced (Busby & Suddendorf, 2005). Many factors are argued to account for this progression in children’s episodic (and autobiographical1) memory development, including development of the “cognitive self” (as measured by mirror self-recognition), language and narrative skills, and social exchanges with others (see Nelson & Fivush, 2004, for a review of these and other factors).

Fewer studies have addressed the development of episodic future thinking and, of these, all have focused on the 3 to 5 age range. During this period of development, children begin to
anticipate future states of the self (e.g., Atance & Meltzoff, 2005) and show a rudimentary ability to order events according to when they will occur in the future (e.g., Busby-Grant & Suddendorf, in press; Friedman, 2002). Around age 4, children also begin to talk about events that they will actually experience “tomorrow” (Busby & Suddendorf, 2005). In addition, related skills including planning (Hudson, Shapiro, & Sosa, 1995) and delay of gratification (Mischel, Shoda, & Rodriguez, 1989; Thompson, Barresi, & Moore, 1997) also develop substantially between 3 and 5 years of age. As such, it appears that important changes in both episodic memory and episodic future thinking are occurring during the preschool years.

The distinction between the episodic and semantic memory systems

The general claim is that the semantic memory system develops earlier than the episodic memory system (i.e., episodic memory and episodic future thinking) (e.g., Tulving, 2005). By this account, event recall in children as young as 2 years of age (e.g., Fivush & Hamond, 1990), for example, is believed to be evidence of semantic memory, rather than episodic memory (e.g., Perner and Ruffman, 1995). In other words, it may be that young children draw on semantic memory to know what happened, but do not remember the event through episodic memory. Similarly, Wheeler (2000) argues that event recall cannot be equated with episodic memory because children may be able to recall a particular event without the capacity to re-experience their past in a personal way.

Nevertheless, children’s event recall does suggest an important distinction between episodic and semantic memory. Often, children’s knowledge of scripts is argued to reflect semantic memory, whereas event memory (i.e., memory for one particular episode) is argued to reflect episodic memory. A script is defined as a generic knowledge structure that reflects an understanding of the temporal-spatial sequences of events in certain contexts (Schank &
Abelson, 1977). Hudson and Nelson (1986) asked 3- and 5-year-olds questions either in general, script form (“What happens…?”) or in specific event form (“What happened one time…?”). They found that children at both ages had more difficulty providing specific episodes than general accounts. In addition, their data suggest that children relied on general event knowledge in responding to both types of questions. Fivush (1984) also found that scripts for school activities were more easily recalled than specific school events. Taken together, these findings suggest that semantic memory is in place before episodic memory.

Similar to the distinction between knowing and remembering the past, researchers have distinguished between knowing about the future versus projecting the self into the future (e.g., Atance, 2008; Atance & O’Neill, 2005). Although researchers have not directly examined whether there is a developmental distinction between semantic memory and episodic future thinking, there are data consistent with this claim. Hudson, Shapiro, and Sosa (1995) asked 3-, 4-, and 5-year-olds questions in “script” (e.g., “Can you tell me what happens when you go to the beach?”) and “plan” (e.g., “Can you tell me a plan for going to the beach?”) conditions. Although there were no significant age differences in the number of actions mentioned in the script condition, older children reported more actions in the plan condition. However, it is important to note that planning may not directly reflect episodic future thinking, because a child may be able to project into/talk about a future event without being able to plan for it. As mentioned, no study has directly compared children’s knowledge of an event (i.e., semantic memory) to their ability to project into the same event (i.e., episodic future thinking).

The relation between episodic memory and episodic future thinking

One of the most exciting findings on mental time travel ability is that there exists overlap in the cognitive and neural mechanisms responsible for episodic memory and episodic future
thinking. Neuropsychological case studies show that certain brain-damaged individuals exhibit both episodic memory and episodic future thinking impairments (Klein, Loftus, & Kihlstrom, 2002; Tulving, 2005) and, neuroimaging studies with healthy individuals support the idea that the processes involved in remembering our pasts and predicting our futures overlap (e.g., Addis, Wong, & Schacter, 2007; Okuda et al., 2003; Szpunar, Watson, & McDermott, 2007). The developmental data, however, are sparse and less conclusive about this issue.

Busby and Suddendorf (2005) assessed 3-, 4-, and 5-year-old children’s episodic memory and episodic future thinking by asking them to identify an event that happened yesterday (e.g., “Can you tell me something that you did yesterday?”) and one that would happen tomorrow (e.g., “Can you tell me something you are going to do tomorrow?”). In a first experiment with 3- and 4-year-olds, both age groups were relatively good at generating a specific response to these questions, but significantly more of the 4-year-olds’ responses were judged as accurate by parents. Performance on both questions was positively correlated, with no difference in difficulty between each. Five-year-olds were tested in a second experiment and, consistent with the results of the first experiment, significantly more 4- and 5-year-olds than 3-year-olds produced responses that were judged as accurate on both the “yesterday” and “tomorrow” questions. Although the two questions had the same level of difficulty, there was no significant correlation between the two questions.

Outstanding Issues

Although researchers have a relatively clear picture of the trajectory of episodic memory development, much less is known about the trajectory of episodic future thinking. Thus, the first main goal of this research was to provide a more complete picture of episodic future thinking development using a modified version of Busby and Suddendorf’s (2005) method of asking
children to report events that will happen “tomorrow.” In addition, although semantic memory seems to develop prior to episodic memory, no studies have directly compared whether this same developmental pattern holds for episodic future thinking and semantic memory. More generally, no study has compared the development of semantic memory, episodic memory, and episodic future thinking using the same experimental task. While Busby and Suddendorf’s (2005) study suggests that there is a relation between episodic memory and episodic future thinking, more evidence is needed to support this claim. Asking the same children to provide reports of “yesterday” and “tomorrow” allows researchers to correlate performance on these two dimensions, but these questions may influence each other, making children’s responses appear more similar than they actually are. Thus, it is important to assess the developmental patterns across these dimensions by comparing reports about the past and the future from separate groups of children.

Our second main goal was to explore the effects of what we term “event control” on children’s mental time travel ability. Specifically, we theorized that young children’s lack of control, or decision-making, over many events in their day-to-day lives could impact the extent to which they engage in mental time travel. With respect to the future, in particular, young children may not spend a great deal of time contemplating upcoming events because their thoughts may have no bearing on how these events unfold. That is, there would be little motivation to think about future events if these are under the control of others (parents, in particular). Thus, one might predict that those events for which children have more control are the ones that they first begin to anticipate. As such, asking children about “high control” events may constitute an important means of studying the very beginnings of mental time travel ability.
The role of control is both an important and classic issue in the study of development. For example, Held and Hein (1963) showed that kittens that controlled their own movements had motor and perceptual advantages over those that did not. Similarly, Campos and his colleagues (e.g., Campos, Bertenthal, & Kermoian, 1992) showed that pre-crawling infants who received crawling experience using “baby walkers” developed a fear of heights earlier than infants who did not receive this experience. To our knowledge, the role of controllability on various aspects of children’s cognitive development has not been extensively studied.

**Current Study and Hypotheses**

To address the issues outlined above, we modified the method adopted by Busby and Suddendorf (2005) in several ways. First, rather than ask children open-ended questions about events that happened “yesterday” and events that would happen “tomorrow,” we asked them about eight specific events/activities (breakfast, supper, playtime, bedtime, going to the park, going grocery shopping, going to the mall, and eating at a restaurant). This methodological change allowed us to distinguish between a child who can only remember/project one event and a child who can remember/project multiple events. In addition, we felt that asking children about a specific point in time (e.g., breakfast) would guide children’s mental time travel, thus resulting in a more sensitive assessment of their abilities.

Second, we used a between-, rather than a within-, subjects design. Thus, separate groups of children were asked about the last time they did each of the events (“past” condition), the next time they would do each of the events (“future” condition), or to provide a script for each of the events (“semantic” condition). In this way, we hoped to reduce any response confusion or “contamination.” For example, Hudson and Nelson (1986) found that asking preschoolers to
provide a “general account” of an event followed by a “specific account” of this same event depressed performance on the latter.

Like Busby and Suddendorf (2005), we coded whether children were able to provide a specific response to our event questions, and whether this response was accurate. We also created a new code, labelled “temporal inaccuracy,” to determine whether a subset of children’s inaccurate responses were due to a difficulty mapping events onto conventional temporal markers such as “last time” or “tomorrow,” rather than to a difficulty thinking about the past and the future. We also coded the extent to which children’s talk about the past and future included what we termed “script indicators.” Various authors have suggested that children’s memory for the past and thought about the future may initially be guided by their script-based knowledge (Atance & O’Neill, 2005; Farrar & Goodman, 1990; Nelson, 1996).

Finally, to explore whether the amount of control that children exert over events in their lives has an impact on mental time travel ability, we first asked a separate group of parents ($N = 20$) to rate the amount of control their children have over each of the eight events that we asked about in our study. These parents rated “breakfast,” “play time,” “going to the park,” and “eating at a restaurant,” as high control events, whereas they rated “supper,” “bedtime,” “going to the mall,” and “going grocery shopping” as low control events. To ensure that any effects of event control that we later detected were not due to the frequency with which the events occurred, of the high control events, two occurred daily (breakfast, playtime) and two occurred less frequently (going to the park, going to a restaurant). Similarly, two of the low control events occurred daily (supper, bedtime) and two occurred less frequently (going to the mall, going grocery shopping).

Our main hypotheses were as follows:
1. Children of all ages will be able to provide a specific verbal response to the event questions. However, with age, responses in the past and future conditions will be more accurate.

2. Children’s responses in the semantic condition will not show these age-related accuracy differences, supporting the claim that the semantic system develops prior to the episodic one. As such, we predict an interaction between age and condition for children’s accuracy scores.

3. There will be no differences in accuracy between the past and future conditions. This prediction stems from evidence that both forms of mental time travel are relying on similar cognitive capacities.

4. Younger children’s responses in the past and future conditions will contain more script indicators than those of the older children, supporting the claim that the semantic memory system may initially guide children’s mental time travel ability.

5. There will be no differences in accuracy between the past and future conditions for high control events but, for low control events, children will be more accurate on the past questions than on the future questions. In other words, children will be less able (or likely) to project into future events for which they have little control.

Methods

Participants

Participants were 90 children, with 30 children in each of the following age groups: 3-year-olds (15 girls; mean age = 42.9 months, range = 37-47 months), 4-year-olds (15 girls; mean age = 54.2 months, range = 48-59 months), and 5-year-olds (15 girls; mean age = 64.5 months, range = 60-71 months). An additional four participants were tested but their data were excluded: one child was too shy to answer the questions, and three children were too distracted to complete
the session. Children were recruited from a large university city using newspaper advertisements, recruitment posters, and children’s fairs.

**Design and Procedure**

Participants were randomly assigned to one of three conditions: past, semantic, or future. There were 30 participants in each condition (ten from each age group). Each participant was asked eight questions about eight events: breakfast, grocery shopping, bedtime, going to the park, supper, restaurant, play time, and going to the mall. These events were presented to the children in eight orders. These orders were determined by using a random numbers table to form a square in which each question appears only once in each position (similar to a Latin Square). One of the low control events, “going to the mall,” was excluded from all analyses because almost half of parents indicated either that they “never” went to the mall with their child or that they used a different term to describe this event.

Participants were tested individually in one of two testing rooms with one of two female experimenters. Five of these participants did not want to be separated from their parents and so were accompanied by them in the testing room. Before asking children the questions, the experimenter said, “I am very curious about all the different things you do! So I would like to ask you some questions about some of the things you do and some of the places you go to. Okay, let’s start!” Prior to asking about a particular event, the experimenter said, for example, “Let’s talk about what you eat for breakfast” or “I want to ask you about bedtime.”

Depending on condition, questions were phrased either in the past, generalized present, or future tense. For the past condition, questions were phrased in the form “What did you do/get/eat…?” Temporal markers such as “last time,” “yesterday,” and “this morning” were used. For the semantic condition, questions were phrased in the form “What do you
do/get/eat…?” and so no temporal markers were used. For the future condition, questions were phrased in the form “What are you going to do/get/eat…?” For this condition, temporal markers such as “next time,” “tonight,” and “tomorrow” were used (see Appendix A for a complete list of the questions asked in each of the three conditions).

Similar to Busby and Suddendorf’s (2005) method, if a participant responded with “I don’t know,” or did not respond to the question at all, the experimenter provided a one-time prompt, “Let’s think really hard about…,” and then repeated the original question. If there was still no response, the experimenter proceeded to the next question. If children provided a general response such as “play” or “eat,” the experimenter prompted for a more specific response (e.g., “What did you/do you/are you going to play/eat?”). If there was again no response, or a repetition of the general response, the experimenter proceeded to the next question. Following each specific response, the child was provided with the one-time cue, “Anything else?”

Accuracy Check

Immediately following the testing session, the experimenter reviewed each of the child’s responses with the parent(s). Specifically, parents were reminded of their child’s responses and then asked whether these responses were accurate (for the past and semantic conditions) or likely accurate (for the future condition). Although there is a subtle difference between asking about “accuracy” and “likelihood,” it was necessary to phrase the questions in this way. It became evident from pilot work that parents were hesitant to judge their children’s responses as “accurate” in the future condition, because of the future’s inherent uncertainty. For this reason, we felt that asking parents about “likelihood” was more appropriate. Importantly, though, parents appeared to be very good at identifying events that, on the surface, may have seemed reasonable, but did not coincide with their child’s anticipated future. For example, one child stated that she
would have waffles for breakfast the next day, yet the parent rated this event as unlikely because waffles were only eaten on special occasions. Studies with adults have also used this type of rating scheme, for similar reasons (e.g., Dalla Barba, Cappelletti, Signorini, & Denes, 1997; Dalla Barba, Nedjam, & Dubois, 1999). Moreover, parents’ accuracy ratings in the past condition must also be considered to be “likelihood” judgments due to parents’ own memory limitations, as well as instances in which they did not witness the event in question (e.g., the last playtime the child had was at a friend’s house).

For the past and future conditions only, if parents said their child’s response was not accurate/likely, we immediately asked them to indicate the last/next time their child had done/would do the mentioned activities. We did this to distinguish a response that was altogether false from one that was temporally inaccurate (e.g., a child says he had toast and jam for breakfast this morning but the parent states that this happened two days ago).

Event Control Questionnaire

Prior to the start of the session, parents were asked to rate the amount of control their child has over the eight events we asked about in our study (see Appendix B).

Scoring

Responses to Questions

Participants’ responses to each of the seven event questions were scored on three dimensions: (1) whether a specific response was provided (“response specificity”), (2) whether the response was accurate/likely (“response accuracy”), and (3) the proportion of script indicators in the response (“script indicators”). Only those parts of the children’s responses that directly answered the question were coded. Thus, talking about unrelated events (e.g., “I want to tell you about my school”), talking about events that were not in response to the question (e.g.,
“After breakfast, then I’m going to play”), describing objects (e.g., “I have two trains and they are both made of wood”), or talking about feelings about objects (e.g., “I like grapes”) were not scored on any of the dimensions.

**Response specificity.** A score of 0 was given if the child was unable to provide a response (e.g., “I don’t know”), provided an irrelevant response (e.g., “elephants” for breakfast, or “I am going to the zoo this weekend”), or provided only a general response (e.g., “everything” or “play”). As mentioned in the Design and Procedure section, general responses were followed by a prompt to encourage specific responses. If children still failed to provide a specific response, then they received a score of 0. Specific responses (e.g., “play on the teeter totter” or “pizza” for supper) were assigned a score of 1. A mean response specificity score was computed by adding up individual scores for each of the seven event questions and dividing by the total.

**Response accuracy.** These scores were determined based on parents’ indication of the accuracy of their children’s responses. A score of 0 was automatically assigned to any response that received a score of 0 on the response specificity dimension or for any response in which some or all of the items/acts were deemed inaccurate by parents (e.g., “cereal and hotdogs” for breakfast). A score of 1 was assigned to responses that parents indicated were accurate (e.g., “I went down the slide” for the “park” question). A mean response accuracy score was computed by adding up individual scores for each of the seven event questions and dividing by the total.

Recall that we also created a “temporal inaccuracy” code to determine whether children had difficulty mapping past or future events onto temporal markers such as “yesterday” or “next time.” This code was thus assigned to inaccurate responses for which parents indicated that the event in question did not/would not happen during the timeframe asked about, but had occurred/would occur at some point in the past/future (e.g., a child states that she is going to eat
waffles for breakfast tomorrow, but her parent rates this as unlikely because waffles are eaten only on special occasions). Note that this particular code was only used for the past and future conditions, and only for one secondary analysis that we specify in the Results section below. In all other analyses, this type of response was considered inaccurate.

*Script indicators.* This variable was calculated by first identifying all script indicators, future temporal indicators, and past temporal indicators in each response. Script indicators included verbs in the present tense (e.g., “eat”, “go”, “play”), and words denoting how the event “typically” unfolds (e.g., “sometimes”, “usually”, “always”). Future temporal indicators included verbs in the future tense (e.g., “going to” and “will”), words indicating uncertainty (e.g., “maybe”, “might” or “if”), and words referring to the future (e.g., “tomorrow,” “next time”). Past temporal indicators included verbs in the past tense (e.g., “ate”, “went”, “played”) and words referring to the past (e.g., “yesterday,” “last time”).

We identified these indicators for the “no response” (e.g. “I don’t know what we are going to get”), “general response” (e.g. “We got every food that we needed”), and “inaccurate response” (e.g. “I ate hotdogs for breakfast,”) categories, as well as for specific, accurate responses. However, we did not include indicators that referred to the child’s mental state at the time of answering the question (e.g. “I think…” or “I don’t know”). We calculated a script indicator proportion score by dividing the number of script indicators that children used across each of the seven events by the total number of script, future temporal, and past temporal indicators.

*Reliability*

Two coders independently scored 25% of the children’s responses. Reliability for the discrete dimensions of response specificity and response accuracy was assessed using Cohen’s
kappa. The mean kappa score was .98 (range = .89 – 1.00). Reliability for the “script indicator”
dimension (a continuous measure) was assessed using intraclass correlations. The mean
correlation was .93 (range = .70 – 1.00). Disagreements were resolved through discussion. The
remaining 75% of the sessions were scored by one of the coders.

Missing Data

There were missing data on at least one coding dimension of a single response for 12
participants. Reasons included a failure to determine the accuracy of a child’s response based on
the parental check, an inability to understand what the child had said, and an indication by
parents that their child did not participate in one of the given events (e.g., grocery shopping) or
that their child did not understand the term we used for one of the events (e.g., “supper” instead
of “dinner”). In all of these cases, the event for which information was missing was excluded and
means were calculated using the appropriate total number of events. There were two instances of
missing data on the Event Control Questionnaire and so the corresponding items were not
included in the preliminary analyses.

Results

Preliminary Analyses

To ensure that “high” control events were ones that parents in our sample rated as such,
we used the Event Control Questionnaire to compare the “high” control event with the lowest
mean control score (eating at a restaurant) to the “low” control event with the highest mean
control score (bedtime). A paired samples t-test revealed that these two scores were significantly
different, $t (88) = 4.64, p < .001$, which suggests that our division of “high” and “low” control
events was valid (see Table 1 for the mean parental control ratings for each event).
One-way ANOVAs indicated that children’s performance on each of the three scoring dimensions (i.e., response specificity, response accuracy, and script indicators) did not vary as a function of sex and thus the data were collapsed across this variable.

**Effects of Age, Condition, and Event Control**

We ran two separate mixed ANOVAs with age (3, 4, 5) and condition (past, semantic, future) as between-subjects variables and event control (high, low) as a within-subjects variable. The dependent variables were response specificity and response accuracy, respectively (mean response specificity and accuracy scores for each event are provided in Table 2). These analyses allowed us to test hypotheses about the development of episodic memory, episodic future thinking, and semantic memory; developmental similarities between episodic memory and episodic future thinking; and, the effects of event control on children’s episodic future thinking.

**Response specificity.** Children in all three age groups and in all three conditions performed close to ceiling on the response specificity dimension. Three-, 4-, and 5-year-olds were able to generate a specific response .89, .89, and .95 of the time, respectively. Neither these age differences nor the condition differences (.86, .96, and .90 for the past, semantic, and future conditions, respectively) were significant. The effect of event control approached significance, $F(1, 81) = 3.69, p = .06$, with children providing a higher proportion of specific responses to high control events ($M = .93$) than to low control events ($M = .89$).
Response Accuracy. The mean proportion of accurate responses across age, condition, and event control is shown in Table 3. The mixed ANOVA yielded a significant main effect of age, $F(2, 81) = 10.14, p < .001$, partial $\eta^2 = .20$. Post-hoc Tukey’s HSD comparisons revealed that 5 year-olds ($M = .81$) were significantly more accurate than both 3- ($M = .60$) and 4-year-olds ($M = .69$), $p < .001$ and $p < .05$, respectively. Three- and 4-year-olds did not differ significantly from one another. Analyses also revealed a significant main effect of condition, $F(2, 81) = 8.39, p < .001$, partial $\eta^2 = .17$, a significant main effect of event control, $F(1, 81) = 22.46; p < .001$, partial $\eta^2 = .22$, and a significant Condition x Event Control interaction, $F(2, 81) = 4.58, p < .05$, partial $\eta^2 = .10$. Follow-up analyses were thus conducted to test for condition differences at each level of event control and for event control differences at each condition.

For the following post-hoc comparisons, we applied a Bonferroni correction such that the alpha level was reduced to .01. One-way ANOVAs revealed no significant differences between conditions on high control events, but a significant difference between conditions on low control events, $F(2, 87) = 10.01, p < .001$, partial $\eta^2 = .19$. Tukey’s HSD post-hoc tests showed that, for low-control events, children in the past condition ($M = .45$) had a significantly lower proportion of accurate responses than children in the semantic ($M = .76$), $p < .001$, or future conditions ($M = .67$), $p < .01$. These last two conditions did not differ from one another. Paired-samples $t$ tests revealed that children in the past, $t(29) = 5.08, p < .001$, and future, $t(29) = 2.96, p < .01$, conditions gave a significantly higher proportion of accurate responses to high control events than to low control events (.74 vs. .45 and .78 vs. .67 for past and future conditions,
respectively). There was no significant difference between performance on high and low control events in the semantic condition (see Figure 1).

A separate univariate ANOVA with age (3, 4, 5) and condition (past, future) as between-subjects factors was run to determine whether rates of temporal inaccuracy varied as a function of condition or age. Recall that a temporally inaccurate response is one that did not/would not occur during the timeframe asked about. There was a significant effect of condition, $F(1, 54) = 7.16$, $p < .01$, partial $\eta^2 = .12$. Children provided more temporally inaccurate responses in the past condition ($M = .47$) than in the future condition ($M = .21$), but no effect of age, nor an Age x Condition interaction. For all three age groups, children’s responses were judged by parents as temporally inaccurate approximately one third of the time.

***Script Indicators.*** To test the hypothesis that younger children rely on the semantic memory system more than older children when asked to remember the past and project into the future, a univariate ANOVA with age (3, 4, 5) and condition (past, future) was conducted on children’s script indicator proportion scores. A significant main effect of age group, $F(2, 54) = 4.27$, $p < .05$, was obtained, partial $\eta^2 = .14$. Post-hoc Tukey’s HSD tests showed that 5-year-olds ($M = .35$) used a significantly lower proportion of script indicators than 3-year-olds ($M = .58$), $p < .05$. The difference between 4- ($M = .52$) and 5-year-olds did not reach significance, nor did the difference between 3- and 4-year-olds. The main effect of condition was also significant, $F(1, 54) = 42.02$, $p < .001$, partial $\eta^2 = .44$. Children in the past condition ($M = .27$) used significantly fewer script indicators than children in the future condition ($M = .70$). Figure 2
A Comparison shows the mean proportions of script indicators used by 3-, 4-, and 5-year-olds in the past and future conditions.

Discussion

This study comprehensively assessed preschoolers’ ability to remember past events, project into future ones, and describe how events typically unfold (i.e., provide a script). Asking children about the same events across these three different conditions allowed us to address questions pertaining to the development of these three capacities, the distinctiveness between the episodic and semantic memory systems, and the developmental similarities between episodic memory and episodic future thinking.

Consistent with previous research (e.g., Busby & Suddendorf, 2005), children did not have difficulty providing a specific, verbal response to questions about past, future, and scripted events. More interesting, however, was whether their responses were accurate. Although our accuracy data support the claim that episodic memory and episodic future thinking develop substantially during the preschool years, even 3-year-olds were beginning to accurately remember past events and project future ones. In fact, the 3-year-olds in our study were more accurate overall for the past and future conditions than those in Busby and Suddendorf’s study (2005). Whereas children in their study were accurate in recalling an event from yesterday and predicting an event for tomorrow approximately 30% of the time, our 3-year-olds’ accuracy rates were in the 50-60% range. This may be because we asked children about multiple events which resulted in a more sensitive assessment of their capacities. Alternatively, this difference may be due to the fact that Busby and Suddendorf’s questions were open-ended, whereas ours were
specific, thus providing children with a helpful cue to direct their memory/anticipation. Either way, our findings are consistent with theories that posit a gradual development of the episodic memory system during early childhood (e.g., Nelson & Fivush, 2004; Reese, 2002) (though it is important to note that such theories do not rule out the possibility that both quantitative and qualitative changes may co-exist in the development of this system).

Recall that we predicted that age would not affect children’s accuracy in the semantic condition, but would in the past and future conditions. Our results were only partly consistent with this hypothesis. That is, increases in performance spanned all three conditions (see Table 3), and there was no indication that episodic memory or future thinking underwent more development during the 3 to 5 age range than did semantic memory. Although this finding is at odds with the claim that the semantic system develops prior to the episodic one, it does suggest what may be an important bi-directional relationship between these two forms of thought. For example, as children gain more knowledge about how a particular event (e.g., going to the park) unfolds, they may become better equipped to predict any one future instance of this event. Similarly, as children gain more experience with specific event episodes, this may help them to build up semantic knowledge, including all the different items/acts that pertain to the event (e.g., going to the park can include going on the swings, playing in the sand, or sliding down the slide).

Despite the fact that children’s episodic and semantic thinking showed similar developmental patterns during ages 3 to 5, was there any evidence for differences between the two? We obtained an interaction between condition and event control for children’s accuracy scores. Specifically, if we consider only “low control” events, then children’s semantic memory was superior to their episodic memory (but not episodic future thinking). And, whereas children in the past and future conditions gave significantly more accurate responses for high control
events than they did for low control events, there was no such difference in the semantic condition. This finding suggests that having low control over events impairs the episodic system (i.e., episodic memory and episodic future thinking), but not the semantic system. However, contrary to our prediction that having low control over events would specifically impair episodic future thinking, both types of mental time travel were impaired.

As we suggested in the Introduction, children may not spend much time thinking about a future event over which they exert little control. But, it may be that this process affects both episodic memory and episodic future thinking. For example, if a child lacks control over what she will eat for supper tonight, she may not engage in episodic future thinking about this event. As a result, once the event has occurred, it may be more difficult for her to recall it episodically. High control events, in contrast, may benefit from what could be termed “anticipatory” encoding. Similarly, researchers in the area of source monitoring in preschoolers have suggested that increased anticipation of future actions through collaboration may lead to greater learning and memory of these actions (Sommerville & Hammond, 2007) and that children’s source memory reflects their anticipatory processes (Foley & Ratner, 1998). Therefore, event control may similarly affect episodic memory and future thinking because anticipation of future events may play an important role in the encoding of these events.

Although both episodic memory and episodic future thinking were affected by control, we found that, for low control events, children in the past condition were less accurate than those in either the future or semantic conditions. How can we explain the finding that episodic memory, and not episodic future thinking, was most affected by event control? It may be important to consider this finding in combination with the analyses on children’s use of script indicators. Specifically, children in the future condition used a higher proportion of script
indicators than children in the past condition. This suggests that children draw on semantic memory to a greater extent when projecting into the future than when remembering the past. This claim is consistent with recent theorizing that the past may in fact provide the “raw material” for envisioning future scenarios (e.g., Suddendorf & Corballis, 2007; Schacter & Addis, 2007), and again highlights the important relationship between the semantic and episodic systems (episodic future thinking, in particular). Thus, it may be that when a child is asked about a future event for which he has little control, he may predominantly draw on the semantic memory system (i.e., “knowledge” about the past) to guide his response. In some cases, this prediction may be accurate. In contrast, it is less likely that children rely on semantic memory to guide their memory for a specific, past event. It is interesting to note that parents may also influence the extent to which children rely on semantic memory when making predictions about the future. For example, Hudson (2006) has found that when parents talk to children about the future (especially about everyday events) they tend to draw on general event knowledge (or semantic memory) to elicit input from their children.

It is important to acknowledge that the effects of event control that we detected could be explained in other ways. For example, the level of enjoyment that children have for each of the different events could explain our findings. Specifically, children may think more about events that they enjoy, both in anticipation of the event and following its occurrence. To explore this possibility we re-analyzed our data by first comparing two events that we felt would be similarly enjoyable for children, but that differed in parents’ control ratings: supper and breakfast. A paired samples t-test showed that children were more accurate about breakfast than supper ($p < .001$); a result that is consistent with our claim that control is playing a role. We also compared the three high control events that we assumed to be highly enjoyable for children (playtime,
going to a restaurant, and going to the park) to the high control event that may be less so (breakfast). Children responded significantly more accurately to questions about going to the park and playtime than to questions about breakfast ($p < .01$ in both cases). Although these results suggest that children may indeed be better able to remember/project events that they find enjoyable, it is important to note that going to the park and playtime were also rated by parents as the two events over which their children had the most control (see Table 1).

The effects of event control may also be confounded with event distinctiveness; that is, highly distinctive experiences may be easier for children to think about episodically than less distinctive ones. As a post-hoc test of this possibility, we examined high control events only, and compared events we judged as highly distinctive (restaurant and park) to ones we felt were less so (breakfast and playtime). There was no significant accuracy difference between these two groups of events. We also examined less distinctive events only, and compared high control (breakfast and playtime) to low control (supper and bedtime) events. Children were more accurate for the high control events ($p < .01$). Although these findings suggest that event distinctiveness may not be a critical factor in children’s accuracy, this statement remains tentative given that “distinctiveness” judgments were subjectively made by us (this was also the case with judgments about whether a given event is enjoyable for children). In contrast, our “event control” factor was more objectively determined by parental ratings. Nonetheless, our findings with respect to event control must be considered preliminary (yet arguably intriguing) until further research that more thoroughly controls for such factors as event enjoyment and distinctiveness can be carried out.

Was there any evidence that children’s inaccurate memory of the past, or projection into the future, resulted from an inability to correctly map this information onto temporal markers
such as “yesterday” and “tomorrow,” for example? At all three ages, children’s rates of temporal inaccuracy hovered around 30%, suggesting that, in some cases, children are recounting/projecting a genuine event, but are limited in their ability to map it onto conventional time units. Interestingly, a larger proportion of children’s inaccurate responses were due to temporal inaccuracy in the past condition than in the future condition. That is, children in the past condition were more likely to make errors about when an event occurred (e.g., saying that they had gone on the swings the last time they were at the park when really this happened another time). This may be because the event to which parents referenced their child’s response had already occurred in the past condition, thus giving them a concrete comparison event. In contrast, in the future condition, parents were asked if their child’s response was likely and compared it to a hypothetical event. As such, parents may have been less likely to report that the response was temporally inaccurate, resulting in a more flexible criterion for accuracy in the future condition, as compared to the past condition.

Although this limitation is difficult to address due to inherent differences between the past and the future, a potential modification would be to have parents take home a form and assess the accuracy of their child’s response after the event in question has occurred. For example, if a child states that she will eat oatmeal and bananas for breakfast tomorrow, her parent could assess the accuracy of this prediction based on what her child actually ate for breakfast the following morning. One drawback to this modification is that a failure to accurately predict a future event does not mean that an individual has not engaged in episodic future thinking. For example, we might predict that we will buy fresh pasta at the grocery store tomorrow evening, only to discover that there is none left (or perhaps we have changed our minds about what to eat). Nonetheless, as we argued earlier, even parents’ judgments about the
accuracy of their children’s responses to past questions are, to a certain extent, likelihood judgments, so it is unclear whether these scoring differences fully account for our findings.

Conclusions

We addressed three main themes in this paper: the development of episodic memory and episodic future thinking, similarities between the two, and their distinctness from semantic memory. In addition, we identified “event control” as a theoretically important factor that might influence children’s mental time travel ability. Consistent with previous research, there was substantial episodic memory and episodic future thinking development across the preschool years. However, rather than these capacities showing abrupt changes around age 4, our data suggest a more gradual development during the preschool years. In particular, the 3-year-olds in our study showed a superior ability than previously documented to remember past events and to project into future ones. Results also indicated that event control had a particular effect on the episodic memory system. Although episodic future thinking was more accurate than episodic memory for low control events, overall, the episodic memory system was more affected by event control than was the semantic memory system. Further research is needed to replicate and extend upon this unique finding, but it does suggest another fundamental difference between how we remember and project events, versus our knowledge of these same events.
References


Footnotes

1Autobiographical memory is argued to be a kind of episodic memory that consists of a collection of personally-relevant events that defines us as individuals (Bauer, 2007). Although very young children can report single episodes from their lives, linking these episodes into a coherent autobiography is a later development. In this study, we focus on children’s memory and anticipation of single episodes (whether these eventually become part of any one child’s autobiography is only possible through longitudinal study).
Table 1

*Mean Parental Control Ratings for Each Event*

<table>
<thead>
<tr>
<th>Event</th>
<th>Mean Control Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Control</strong></td>
<td></td>
</tr>
<tr>
<td>Breakfast</td>
<td>2.46 (0.57)</td>
</tr>
<tr>
<td>Playtime</td>
<td>2.83 (0.38)</td>
</tr>
<tr>
<td>Eating at a restaurant</td>
<td>2.24 (0.72)</td>
</tr>
<tr>
<td>Going to the park</td>
<td>2.86 (0.38)</td>
</tr>
<tr>
<td><strong>Low Control</strong></td>
<td>1.72 (0.66)</td>
</tr>
<tr>
<td>Supper</td>
<td>1.66 (0.64)</td>
</tr>
<tr>
<td>Bedtime</td>
<td>1.83 (0.62)</td>
</tr>
<tr>
<td>Going grocery shopping</td>
<td>1.68 (0.73)</td>
</tr>
</tbody>
</table>

*Note.* Standard Deviations are in parentheses.
### Table 2

*Mean Specificity and Accuracy Scores for Each Event*

<table>
<thead>
<tr>
<th>Event</th>
<th>Specificity</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
<td>.93 (.25)</td>
<td>.69 (.47)</td>
</tr>
<tr>
<td>Playtime</td>
<td>.91 (.29)</td>
<td>.88 (.33)</td>
</tr>
<tr>
<td>Eating at a restaurant</td>
<td>.91 (.29)</td>
<td>.70 (.46)</td>
</tr>
<tr>
<td>Going to the park</td>
<td>.96 (.21)</td>
<td>.85 (.36)</td>
</tr>
<tr>
<td>Supper</td>
<td>.80 (.40)</td>
<td>.41 (.50)</td>
</tr>
<tr>
<td>Bedtime</td>
<td>.94 (.23)</td>
<td>.83 (.38)</td>
</tr>
<tr>
<td>Going grocery shopping</td>
<td>.91 (.29)</td>
<td>.63 (.49)</td>
</tr>
</tbody>
</table>

*Note.* Standard Deviations are in parentheses.
Table 3

*Mean Proportion of Accurate Responses as a Function of Age Group, Condition, and Event*

**Control**

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Past</th>
<th>Semantic</th>
<th>Future</th>
<th>Past</th>
<th>Semantic</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>.63 (.13)</td>
<td>.68 (.26)</td>
<td>.68 (.26)</td>
<td>.43 (.27)</td>
<td>.60 (.34)</td>
<td>.57 (.32)</td>
</tr>
<tr>
<td>4</td>
<td>.71 (.25)</td>
<td>.83 (.21)</td>
<td>.78 (.25)</td>
<td>.42 (.21)</td>
<td>.80 (.17)</td>
<td>.63 (.29)</td>
</tr>
<tr>
<td>5</td>
<td>.88 (.18)</td>
<td>.93 (.12)</td>
<td>.90 (.17)</td>
<td>.50 (.32)</td>
<td>.87 (.17)</td>
<td>.80 (.22)</td>
</tr>
</tbody>
</table>

*Note.* Standard Deviations are in parentheses.
Figure Captions

*Figure 1.* Proportion of Accurate Responses as a Function of Condition and Event Control. Error bars = standard errors.

*Figure 2.* Proportion of Script Indicators as a Function of Age Group and Condition. Error bars = standard errors.
Appendix A

Questions

Past Questions
What did you eat for breakfast this morning?
What food did you get the last time you went grocery shopping?
What did you do at bedtime last night?
What did you do the last time you went to the park?
What did you do the last time you went to the mall?
What did you eat for supper yesterday?
What did you eat the last time you went to a restaurant?
What did you do at playtime yesterday?

Script Questions
What do you eat for breakfast?
What food do you get when you go grocery shopping?
What do you do at bedtime?
What do you do when you go to the park?
What do you do when you go to the mall?
What do you eat for supper?
What do you eat when you go to a restaurant?
What do you do at playtime?

Future Questions
What are you going to eat for breakfast tomorrow?
What food are you going to get the next time you go grocery shopping?
What are you going to do at bedtime tonight?
What are you going to do the next time you go to the park?
What are you going to do the next time you go to the mall?
What are you going to eat for supper tonight?
What are you going to eat the next time you go to a restaurant?
What are you going to do at playtime tomorrow?
Appendix B

Event Control Questionnaire

1.) Please circle the number that corresponds to the amount of control that your child has over the following decisions:

<table>
<thead>
<tr>
<th>Decision</th>
<th>None</th>
<th>Very Little</th>
<th>Some</th>
<th>A Lot</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) what food he/she eats for breakfast</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>b) what he/she does at bedtime</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>c) what food he/she eats for supper</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>d) what he/she does at playtime</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>e) what food you buy at the grocery store</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>when he/she is with you</td>
<td>none</td>
<td>very little</td>
<td>some</td>
<td>a lot</td>
</tr>
<tr>
<td>f) what he/she does at the park</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>g) what food he/she orders at a restaurant</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>h) what he/she does at the mall</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>