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## Cognitive Development



# Children's reasoning about the temporal order of past and future events

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### ABSTRACT

Four- and five-year-olds completed two sets of tasks that involved reasoning about the temporal order in which events had occurred in the past or were to occur in the future. Four-year-olds succeeded on the tasks that involved reasoning about the order of past events but not those that involved reasoning about the order of future events, whereas 5-year-olds passed both types of tasks. Individual children who failed the past-event tasks were not particularly likely to fail the more difficult future-event tasks. However, children's performance on the reasoning tasks was predictive of their performance on a task assessing their comprehension of the terms "before" and "after." Our results suggest that there may be a developmental change over this age range in the ability to flexibly represent and reason about the before-and-after relationships between events.

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A number of researchers have argued that there is an important change between ages 3 and 5 in the way that children think about the past (McCormack & Hoerl, 1999; Perner, 2001; Suddendorf & Corballis, 2007) and the future (Atance & O'Neill, 2001, 2005; Russell, Alexis, & Clayton, 2009; Suddendorf & Busby, 2005). Some theorists have explicitly linked changes in past and future thinking by suggesting that a system emerges at this age that supports both episodic remembering of the past and a new type of future thinking, also episodic in nature (Atance & O'Neill, 2001; Buckner & Carroll, 2007; Suddendorf & Corballis, 2007). Children, they suggest, acquire a new ability to set aside the current state of affairs and mentally re-locate to a different time in the past or future, variously termed mental time travel (Suddendorf & Corballis, 2007), self-projection (Buckner & Carroll, 2007), or episodic thinking (Atance & O'Neill, 2001). This suggestion has been made in light of recently emerging evidence from research with adults that a common system may underpin past and future thinking

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(Buckner & Carroll, 2007; D'Argebeau & Van der Linden, 2004; Schacter & Addis, 2007; Spreng, Mar, & Kim, 2008). If there is an important cognitive change at this age that underpins improvements in both past and future thinking, we might expect to see a relation between developmental changes in these types of thinking (Busby & Suddendorf, 2005; Suddendorf, 2010; Suddendorf & Busby, 2005). However, as yet relatively few studies have simultaneously examined both types of thinking and the relation between them (however, see Busby & Suddendorf, 2005; Busby Grant & Suddendorf, 2009; Lemmon & Moore, 2001; McColgan & McCormack, 2008; Suddendorf, 2010).

Although this issue would appear to be relatively new, the idea that there is an important underlying cognitive change between ages 3 and 5 that might be expected to have an impact on both past and future thinking has existed in quite a different context for decades. Researchers in the domain of language acquisition have suggested that there may be a critical change at this age in temporal thinking that underpins changes in children's ability to use and understand temporal terms and certain tensed forms (Friedman, 1982; Harner, 1982; McCormack & Hoerl, 2008; Weist, 1986, 1989). One form this suggestion has taken is that at this age children become capable of "temporal decentering" (Cromer, 1971; Harner, 1980, 1982; Smith, 1980), defined as the ability to "adopt a temporal point of view that differs from one's own immediate temporal viewpoint" (Harner, 1982). It would be tempting to draw a parallel between the long-standing idea that children become capable of something like temporal decentering at this age, and more recent claims that something like mental time travel emerges at this age, because both suggest an ability to set aside one's current perspective on events. However, where these two suggestions diverge is in the emphasis that has been placed on the ability to represent and coordinate information about how events are organized in time.

Research on mental time travel has emphasized an emerging ability for mental projection into the relatively distant past or future – "pre-experiencing" the future (Gilbert & Wilson, 2007) or re-experiencing the past, whereas language researchers have tended to focus on children's abilities to represent, and thus linguistically code, the temporal locations of events with respect to different reference points in time. This latter focus comes from analyses that describe how temporal systems in language introduce a temporal context – often a time in the past or future – and code temporal relationships with respect to that context (Comrie, 1985; Smith, 1978). The most well articulated developmental account of this sort has been given by Weist (1986, 1989). His account is complex, but, at the risk of over-simplifying his ideas, we interpret his core suggestion as being that children's temporal thinking increasingly matures until they develop an ability between ages 3 and 5 to represent and coordinate in their language the temporal relations between at least three points in time: the present, and two other temporal locations in the past or future that need not always coincide with the times at which the events being discussed actually occurred (McCormack & Hoerl, 2008; Weist, 1986, 1989).

One of Weist's (1986, 1989) core claims is that between ages 3 and 5, temporal cognition becomes more flexible. As Weist (1989) acknowledges, the ability to represent temporally ordered sequences of events seems intact relatively early in development. However, the ability to mentally manipulate temporal sequences and thus explicitly consider the before and after relations that obtain between events seems to occur later. Thus, we can make a distinction between simply being able to represent temporally ordered sequences because one has had temporal structured experiences (e.g., because one has observed the events in a sequence occurring in a specific order) and being able to mentally construct a temporal sequence and flexibly arrange and re-arrange events' locations within such a sequence (Hoerl & McCormack, 2011; McCormack & Hoerl, 2011). Arguably, in the former case, the before-and-after relations between events are represented only implicitly. Such representations would allow a child to accurately predict what event might occur next or to produce an ordered sequence of actions. However, it is only once children can use temporal representations flexibly that they can reason about the before-and-after relations between events and construct temporally ordered representations that do not simply mirror the order in which they have experienced or observed them. An aim of the study reported here was to explore whether an important change in temporal thinking at this age may be characterized in this way. Children in our study completed tasks that involved reasoning about before-and-after relations between events in both the past and the future, and we looked at developmental changes on these tasks and interrelations among them.

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