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Editorial

Emerging themes in the development of prospective memory during childhood

Introduction

Six years ago, Kvavilashvili, Kyle, and Messer (2008) called for more research in the area of children's prospective memory (PM), defined as the ability to remember to carry out delayed intentions (Einstein & McDaniel, 1990). At that time, the literature on PM in children was scant, although a few well-developed paradigms were available to measure PM in preschool-age children (Kvavilashvili, Messer, & Ebdon, 2001) and older children during middle childhood (Kerns, 2000). Although there is still much work to be done, the last few years have seen a steep rise in the number of studies on the topic of PM during childhood examining children as young as 2 years using a wide variety of time- and event-based PM paradigms. This recent increase in research activity in children's PM was reflected in the high number of initial submissions for this special issue (20 manuscripts). The current special issue on the development of PM during childhood offers an overview of this burgeoning area of research, studying children from toddlerhood to adolescence, who are typically and atypically developing, using a wide variety of methods, including naturalistic tasks, experimental tasks, and parent report measures. In what follows, we first discuss the four sections of this special issue: PM research during early childhood, PM and episodic future thinking, PM in clinical populations, and PM during adolescence. We then highlight some emerging themes in this collection of articles that cut across these sections and highlight the contribution such topics will make to the field of PM.

PM during early childhood

The first five articles of this special issue examine the development of PM as well as the factors that influence PM during the preschool years, including the independence between PM and retrospective memory and the development of PM using a quasi-naturalistic task (Walsh, Martin, & Courage, 2014), the negative impact of carrying out a PM task on ongoing task performance supporting the idea that controlled processes might be necessary in PM even during the preschool years (Leigh & Marcovitch, 2014), the strong effect of an inherently motivating intention compared with a less motivating intention and the differential role that theory of mind and executive functions play in low- and high-incentive PM tasks (Causey & Bjorklund, 2014), the role of executive function in PM showing that inhibition, in particular, fully mediates the age-related improvements in PM in 4- and 5-year-old children (Mahy, Moses, & Kliegel, 2014), and the impressive high accuracy of 5-year-old children's predictions of their PM performance in contrast to their poor accuracy in predicting their performance on a retrospective memory task (Kvavilashvili & Ford, 2014). All of these articles highlight understudied aspects of young children's PM development and provide results that contribute to conceptual and/or theoretical

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aspects of the development of children's PM. Furthermore, these studies all use different PM tasks that encapsulate more experimental contexts (multiple trials within a task where the action is rather arbitrary) as well as more naturalistic contexts (single PM trial where the action is a meaningful real-world action).

PM and episodic future thinking

Episodic future thinking and planning have long been suggested to play a role in children's PM (see Atance & Jackson, 2009; Mackinlay, Kliegel, & Mäntylä, 2009), but very little research has provided empirical support for a relation in very young children. Both articles in this section provide evidence that young children's episodic future thinking and planning ability (particularly representing a goal and a subgoal) may contribute to PM. Whereas Nigro, Brandimonte, Cicogna, and Cosenza (2014) examined the relation between 4- and 7-year-old children's performance on a PM task and that on an episodic future thinking task and found relations after controlling for age and retrospective memory, Prabhakar and Hudson (2014) examined precursors to PM, namely the ability to construct future scenarios to accomplish goals, and found developmental changes between 3- and 4-year-olds in the ability to accomplish temporally ordered goals with high working memory demands and a complex goal structure. Both studies suggest that there are important developmental changes in episodic future thinking and planning that may contribute to successful PM.

PM in clinical populations

Deficits in PM ability are often seen in children with autism spectrum disorders (e.g., Altgassen, Schmitz-Hübsch, & Kliegel, 2010; Altgassen, Williams, Bölte, & Kliegel, 2009; Brandimonte, Filippello, Coluccia, Altgassen, & Kliegel, 2011; Williams, Boucher, Lind, & Jarrold, 2012) and attention deficit disorders (e.g., Brandimonte et al., 2011; Kerns & Price, 2001; Kliegel, Ropeter, & Mackinlay, 2006). The two articles in the current issue use novel PM paradigms: the "Virtual Week" computerized board game to examine PM in children with autism (Henry et al., 2014) and the Cyber Cruiser-II, a computerized game in which children must guide a spaceship through outer space to examine PM in children with attention deficit/hyperactivity disorder (ADHD) (Talbot & Kerns, 2014). Both articles document deficits in PM in these populations, but with important caveats. In 8- to 12-year-old children with autism, time-based PM performance was worse compared with controls, but no differences were shown in event-based PM. Similarly, 8- to 13-year-old children with ADHD performed worse on both time- and event-based PM, but ADHD symptomology was related to performance only on time-based PM and not on event-based PM. These studies both suggest that time-based PM is impaired in children with autism and ADHD, whereas event-based PM seems to impair only children with ADHD. In addition, both studies demonstrated that PM performance in the laboratory is related to functional outcomes in daily life measured by parent reports, supporting the ecological validity of these measures.

PM during adolescence

PM, like several other cognitive abilities that rely on prefrontal functioning, continues to develop into adolescence (e.g., Shum, Cross, Ford, & Ownsworth, 2008; Wang, Kliegel, Yang, & Liu, 2006). Altgassen, Vetter, Phillips, Akgun, and Kliegel (2014) show that both theory of mind and task switching, two abilities that rely on prefrontal cortex, predict PM into adolescence. These abilities have been shown to predict PM in much younger children (Ford, Driscoll, Shum, & Macaulay, 2012; Mahy, Moses, & Kliegel, 2014), so this is an important finding illustrating that executive and social abilities continue to contribute to PM into adolescence. Furthermore, Robey, Buckingham-Howes, Salmeron, Black, and Riggins (2014) examine the impact of prenatal drug exposure on PM abilities and brain structures related to PM. There was no effect of drug exposure on PM during mid-adolescence (around 15.5 years), although cortical thickness in frontal and parietal regions and volume of subcortical regions (i.e., putamen and hippocampus) were related to PM performance. These studies, taken together, suggest that frontal brain regions support important abilities that affect PM into adolescence,