



Event-based prospective memory in mildly and severely autistic children



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ABSTRACT

Background: There is a growing body of research into the development of prospective memory (PM) in typically developing children but research is limited in autistic children (Aut) and rarely includes children with more severe symptoms.

Aims: This study is the first to specifically compare event-based PM in severely autistic children to mildly autistic and typically developing children.

Methods and procedures: Fourteen mildly autistic children and 14 severely autistic children, aged 5–13 years, were matched for educational attainment with 26 typically developing children aged 5–6 years. Three PM tasks and a retrospective memory task were administered. **Outcomes and results:** Results showed that severely autistic children performed less well than typically developing children on two PM tasks but mildly autistic children did not differ from either group. No group differences were found on the most motivating (a toy reward) task.

Conclusions and implications: The findings suggest naturalistic tasks and motivation are important factors in PM success in severely autistic children and highlights the need to consider the heterogeneity of autism and symptom severity in relation to performance on event-based PM tasks.

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1. Introduction

Prospective memory (PM) is distinguished from remembering past information or retrospective memory, and refers to the ability to carry out a planned action in the future without any explicit prompts, for example, remembering to take a medication, post a letter or pay bills on time (Einstein & McDaniel, 1990, 2005). Intact PM is crucially important for the management of everyday activities not only in adults but in children as well. Indeed, children are routinely expected to remember to deliver messages, to put books away at the end of reading time, or to do homework and take it to school by the deadline (Altgassen, Schmitz-Hubsch & Kliegel, 2010; Kvavilashvili, Messer & Ebdon, 2001). Autistic children³ are commonly reported to have difficulties in organizing and coordinating everyday activities and have a general impairment in the ability to plan ahead (Ozonoff & Strayer, 2001). These difficulties have been related to deficits in PM (Altgassen, Koban & Kliegel, 2012; Mackinlay, Charman & Karmiloff-Smith, 2006) and suggest that autistic children may be impaired in everyday PM tasks as well. However,

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³ The 'disability-first' terminology used here (i.e., 'autistic children'), and throughout the paper, reflects the preferences of autistic people, and their family and friends, reported recently in a large survey by Kenny et al. (2015).

there is a notable absence of studies on PM in autistic children. For example, in a recent comprehensive review of retrospective memory in autistic children, PM is not mentioned (Boucher, Mayes & Bigham, 2012). Interestingly, this review demonstrated a varied pattern of impairments in autistic children, with performance on some retrospective memory tasks (e.g., digit span, free recall of unrelated items and most notably cued recall) remaining intact when compared to controls. The review also emphasized the necessity of including children with more severe autistic symptoms in studies investigating memory.

Unlike retrospective memory, there are currently only a handful of studies on PM in autistic children and none have included a severely autistic group (Altgassen, Williams, Bölte & Kliegel, 2009; Altgassen et al., 2010; Brandimonte, Filippello, Coluccia, Altgassen & Kliegel, 2011; Henry et al., 2014; Jones et al., 2011; Williams, Boucher, Lind & Jarrold, 2013). These studies employed tasks based on the standard laboratory paradigm used in research with adults, i.e., based on Einstein and McDaniel (1990) and included autistic children and those with Asperger's syndrome, who were able to sit, and perform well in standard IQ tests. In the standard PM paradigm, participants are busily engaged in an ongoing cognitive task (often on a computer), which they have to interrupt on several occasions in order to carry out a PM task (e.g., pressing a key) either in response to a particular target event (e.g., a word) or at a particular time, which measure event- and time-based PM, respectively. The lack of severely autistic samples in these studies is therefore not surprising given: (a) that performance on standard IQ tests was employed as an exclusion measure, which may not be suitable or valid for those with severe autism (Burack, Larocci, Flanagan & Bowler, 2004) and (b) the challenges that such tasks may pose for these children. The importance of choosing tasks which are engaging, suitable and appropriate for the age of children in PM research was noted by Kvavilashvili, Kyle and Messer (2008), and this is particularly pertinent for severely autistic children for whom even simple everyday activities can be challenging. Therefore, in this study, we investigated performance on several simple and engaging event-based PM tasks in mildly and severely autistic children to add to the little that is currently known about this population, both theoretically and to inform therapy. In comparing mild and severe autism groups to non-autistic controls, knowledge of PM in typically developing children would also be broadened. Below, we will briefly review the available literature on PM in mildly autistic children, discuss issues concerning appropriate matching when including a group with severe autism into a study, and outline aims and hypotheses of the study.

One of the first studies to investigate processes related to PM in autistic children was conducted by Mackinlay et al. (2006). Fourteen high functioning autistic children, including those with Asperger's syndrome, (mean age, 12 years) were given a test of multitasking (Battersea Multitask Paradigm) and were found to have deficits in the prospective organization of activities compared to younger, typically developing children with a mean age of 11 years. The few subsequent studies that followed this initial investigation have used mostly the standard Einstein and McDaniel (1990) laboratory paradigm to study event- and time-based PM in autistic children.

In one such study, Altgassen et al. (2009) examined time-based PM in 11 children with high functioning autism and Asperger syndrome (aged 7–15) and 11 typically developing children (aged 7–16) who had to remember to press a specific key on the keyboard once in every 2 min during the computer-based visuospatial working memory test (the ongoing task). Results showed that autistic children checked the time less frequently and produced significantly less correct PM responses than controls. In another study, using the same computer-based ongoing task, Altgassen et al. (2010) investigated event-based PM in 19 high functioning autistic children, including those with Asperger's syndrome, with a mean age of 10.5 years. The event-based PM task involved interrupting the ongoing visuospatial working memory task by pressing a key when the background changed to a certain color. Compared to the neurotypical control group, matched for age, gender and cognitive ability, no differences between groups were found. It was concluded that event-based PM may be preserved in autistic children, in contrast to impairments in time-based PM, demonstrated by Altgassen et al. (2009), indicating that autistic children may have problems with self-initiated time checking rather than responding to target events.

This initial pattern was replicated by Williams et al. (2013) in one study using both an event-based and time-based tasks. Twenty-one high functioning autistic children, including those with Asperger's syndrome, with good social response ratings and a mean age of 10.6 years were compared to 21 age and IQ matched neurotypical children. The ongoing task was modified to a more game-like context where coins were collected for points as a car was to be driven down a road on screen. The PM tasks involved pressing a key when a lorry appeared (event-based) and remembering to refuel the car every 60–80 s (time-based). Results showed that autistic children demonstrated impaired performance compared to controls only on time-based task, suggesting that event-based PM may be preserved in autistic children.

However, Brandimonte et al. (2011) found that 30 mildly to moderately autistic children, based on a mean Childhood Autism Rating Scale (CARS) score of 35.46 (Schopler, Reichler, DeVellis & Daly, 1980; Schopler, Reichler & Renner, 1988), performed less well than their age and IQ matched non-autistic peers ($n=30$) on event-based PM. In this study, the computer-based ongoing task presented line drawings of objects including food and animals (80 trials in total), and children had to press a red key when they saw an animal and a green key when they saw an image of food. The PM task was to press a yellow key on presentation of the two target items (one from food and one from animal category), which occurred four times each. The discrepant findings of Brandimonte et al. (2011) may be explained by differences in memory and attentional demands of the tasks (i.e., two PM targets instead of one, the length of trials and motivation to do the task), or due to the slightly younger age of the children (some as young as 6 years). It may also be due to the differences in the symptomatology of the autistic children as, in this study, none of the children had Asperger's syndrome and some had moderate symptomatology.

Apart from Brandimonte et al. (2011) the only other study to test children with a range of autism diagnoses, including some children with more severe symptomatology, was conducted by Jones et al. (2011). They investigated everyday memory including PM tasks in 94 autistic children with a mean age of 15.6 years. This group included 49 children with a diagnosis of

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