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## Theory of mind and switching predict prospective memory performance in adolescents



Mareike Altgassen<sup>a,b,\*</sup>, Nora C. Vetter<sup>b,c</sup>, Louise H. Phillips<sup>d</sup>, Canan Akgün<sup>b</sup>, Matthias Kliegel<sup>e</sup>

<sup>a</sup> Donders Institute for Brain, Cognition, and Behaviour, Radboud University Nijmegen, 6500 HE Nijmegen, The Netherlands

<sup>b</sup> Department of Psychology, Technische Universität Dresden, 01062 Dresden, Germany

<sup>c</sup> Department of Psychiatry and Psychotherapy, Technische Universität Dresden, 01062 Dresden, Germany

<sup>d</sup> School of Psychology, Aberdeen University, Kings College, Old Aberdeen AB24 3FX, UK

<sup>e</sup> Department of Psychology, University of Geneva, 1205 Geneva, Switzerland

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### ABSTRACT

Research indicates ongoing development of prospective memory as well as theory of mind and executive functions across late childhood and adolescence. However, so far the interplay of these processes has not been investigated. Therefore, the purpose of the current study was to investigate whether theory of mind and executive control processes (specifically updating, switching, and inhibition) predict prospective memory development across adolescence. In total, 42 adolescents and 41 young adults participated in this study. Young adults outperformed adolescents on tasks of prospective memory, theory of mind, and executive functions. Switching and theory of mind predicted prospective memory performance in adolescents.

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### Introduction

Remembering to call your best friend when you get home from school and remembering to complete an assignment for school for Monday are typical examples of prospective memory tasks during

\* Corresponding author at: Donders Institute for Brain, Cognition, and Behaviour, Radboud University Nijmegen, 6500 HE Nijmegen, The Netherlands. Fax: +31 24 3616066.

E-mail address: [a.altgassen@donders.ru.nl](mailto:a.altgassen@donders.ru.nl) (M. Altgassen).

adolescence. Prospective memory refers to the realization of delayed intentions at a certain time (time-based prospective memory) or when a certain event occurs (event-based prospective memory) (Brandimonte, Einstein, & McDaniel, 1996; Kliegel, McDaniel, & Einstein, 2008). Prospective memory tasks usually require that the intended actions be remembered and performed while the individual is engaged in another ongoing activity. The development of prospective memory skills is considered to be one of the major challenges children and adolescents face in their cognitive development (Kvavilashvili, Kyle, & Messer, 2008; Meacham & Colombo, 1980) and an essential precursor to independent living (Kliegel, Jäger, Altgassen, & Shum, 2008).

Despite this suggested importance, research on prospective memory development in children and adolescents is still rather limited and studies vary greatly in terms of the age ranges investigated, which reduces their comparability. However, most studies indicate age-related increases from early childhood (2–6 years: Kliegel, Brandenberger, & Aberle, 2010; Mahy & Moses, 2011; Somerville, Wellman, & Cultice, 1983) to middle and late childhood (7–13 years: Kerns, 2000; Mackinlay, Kliegel, & Mäntylä, 2009; Rendell, Vella, Kliegel, & Terrett, 2009; Shum, Cross, Ford, & Ownsworth, 2008). Overall, older children show more correct prospective memory responses relative to younger children.

So far, only a handful of studies have explored possible developmental effects on prospective memory from late childhood to adolescence and into adulthood, and all have looked at event-based tasks. Somewhat conflicting results have been reported. Using a word categorization task as ongoing activity and asking participants to remember to respond to word pairs in specific colors, Zöllig and colleagues (2007) observed lower prospective memory performance in 12- and 13-year-old adolescents as compared with 20- to 23-year-old young adults. Wang, Kliegel, Yang, and Liu (2006) found that 13- to 16-year-old adolescents showed lower prospective memory performance levels (remembering toe tick statements containing negative words) than 19- to 22-year-old young adults during an ongoing task that requested participants to agree or disagree with statements. However, when the importance of the prospective memory task was stressed, adolescents performed as well as young adults and no age effects emerged. In contrast to those findings, Ward, Shum, McKinlay, Baker-Tweney, and Wallace (2005) reported no difference between 13- to 16-year-old adolescents and 18- to 21-year-old young adults in their prospective memory performance (remembering to respond to words written in italics). Interestingly, this trend held even when the cognitive demands of the ongoing task (lexical decision task) were increased by varying the presentation time of items and varying the importance of the prospective memory task. Similar findings were obtained by Zimmermann and Meier (2006). Using a picture comparison task as ongoing activity, they found no age differences between adolescents (13- and 14-year-olds) and young adults (19- to 26-year-olds) in prospective memory performance (remembering to press a specific button whenever animal pictures were presented).

These studies differ in both the nature of samples compared and the prospective memory paradigms used. One task factor that might be important is the extent to which different prospective memory tasks require executive control functions such as inhibition, working memory, and attentional switching. Adolescents may have the most difficulty with prospective memory tasks that heavily load on executive control processes because executive functions are still under development during adolescence (e.g., Huizinga, Dolan, & van der Molen, 2006). In prospective memory tasks, a major way in which executive load can be manipulated is by varying how focal the cues are (for details on the focal/nonfocal debate, see the multiprocess framework) (Einstein & McDaniel, 2005; McDaniel & Einstein, 2000). If a prospective memory cue is focal to the processes involved in the ongoing activity, the cue automatically initiates retrieval of the intention. In contrast, nonfocal cues that are not central to the ongoing task impose greater demands on executive attentional and working memory resources to monitor for the cue. Indeed, improvements in prospective memory across adolescence were seen in those studies using nonfocal cues that are likely to load on executive function (e.g., Wang et al., 2011, in the nonfocal condition; Wang et al., 2006; Zöllig et al., 2007). In contrast, other studies that did not find any developmental effects across adolescence (Ward et al., 2005; Zimmermann & Meier, 2006) tended to use focal cues in the prospective memory task.

Direct evidence on this issue comes from Wang and colleagues (2011), who explicitly manipulated the cue focus of a prospective memory task. During a visuospatial working memory task, prospective

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