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Relations between theory of mind and executive function in middle childhood: A short-term longitudinal study

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ABSTRACT

Studies with preschool children have shown significant links between children's executive function (EF) and theory of mind (ToM), but few studies have examined these associations in primary school children. To address this gap, we designed a three-wave cross-lagged longitudinal study in which we followed a group of 113 children (61 boys) across three time points from age 9.5–10.5 years (mean age at Time 1 = 112.3 months, *SD* = 4.18; mean age at Time 2 = 118.3 months, *SD* = 4.15; mean age at Time 3 = 124.7 months, *SD* = 4.06). At each time point, we measured EF (working memory and inhibitory control), ToM, and language. Our analyses showed (a) moderate rank-order stability of individual differences in both EF and ToM and (b) growth in ToM task performance across time. Cross-lagged longitudinal analyses revealed an asymmetric developmental relation between ToM and working memory. Early working memory predicted later ToM but not vice versa. Our results suggest a specific role for working memory in the ongoing development of ToM in middle childhood.

Introduction

The ability to infer others' mental states or theory of mind (ToM) has long fascinated researchers from a wide range of disciplines. Individual differences in children's ToM are striking and related to important

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social outcomes (Banerjee, Watling, & Caputi, 2011) and cognitive outcomes (Lecce, Caputi, & Hughes, 2011). Specifically, children who excel in reasoning about others' mental states are better equipped to face the demands of formal schooling because they are more academically able (Blair & Razza, 2007; Lecce, Caputi, & Pagnin, 2014), have greater metacognitive knowledge (Lecce, Bianco, Demicheli, & Cavallini, 2014; Lecce, Zocchi, Pagnin, Palladino, & Taumoepeau, 2010), and are more socially competent (Imuta, Henry, Slaughter, Selcuk, & Ruffman, 2016). To date, most of the progress made on understanding ToM has concerned dramatic developments in mind reading in the preschool years (i.e., false-belief understanding). While interest in infants' and adults' ToM has grown, the study of middle childhood is more recent (Hughes & Devine, 2015). This expansion of research on ToM into middle childhood raises important questions about the nature of developmental changes in ToM and associations with age-related improvements in domain-general cognitive skills. To address these issues, the current study adopted a short-term longitudinal design. This approach has merits from both theoretical and practical perspectives. Theoretically, our short-term longitudinal design enables us to test the role of executive function (EF) in the development and expression of ToM in middle childhood and to examine whether results found in preschoolers can be extended to older children (see sections below). At a practical level, we hoped that our findings would yield insights into how to promote ToM development.

Explaining the relations between theory of mind and executive function

Numerous studies have shown that individual differences in EF independently predict variation in ToM in early childhood (Devine & Hughes, 2014). Executive function is an umbrella term describing the higher-order processes for controlling, directing, and monitoring cognitive function (Diamond, 2013; Zelazo, Carlson, & Kesek, 2008). Thus, EF encompasses a rather heterogeneous collection of skills that include inhibitory control (IC), working memory (WM), set shifting, and planning (Miyake & Friedman, 2012). Correlational studies have consistently shown moderate associations between individual differences in EF and ToM even when the effects of age and verbal ability are controlled (Carlson & Moses, 2001; Hughes, 1998). In a meta-analysis drawing together data from nearly 10,000 children aged between 3 and 6 years, Devine and Hughes (2014) reported a moderate association between EF and false-belief understanding that was similar for children belonging to different cultures and consistent across distinct EF tasks.

One interpretation of these results is that the relation between EF and false-belief understanding is peripheral and arises from the incidental demands that standard false-belief tasks place on EF (e.g., Perner, Lang, & Kloo, 2002). According to this *expression* account, children need EF to display their ToM understanding. At least four strands of evidence challenge the expression account. First, meta-analysis demonstrates significant correlations between early EF and later ToM even when initial ToM scores are taken into account (Devine & Hughes, 2014). Second, cross-cultural research shows that cultural groups (e.g., Chinese children) who show higher levels of EF relative to North American or British children do not exhibit a parallel advantage in ToM (Wang, Devine, Wong, & Hughes, 2016). Third, individual differences in EF remain correlated with performance on false-belief tasks in which executive demands are reduced (Henning, Spinath, & Aschersleben, 2011). Fourth, EF shows similarly strong associations with first- and second-order false-belief tasks even though the latter place greater demands on EF (Devine & Hughes, 2014). These four strands of evidence support the view from the *emergence* account (Russell, 1996) that EF contributes to the *development* of ToM and suggest that there is a deep and unique relationship between ToM and EF that cannot be explained by considering only the executive demands of ToM tasks.

Because most of what is known about the relations between EF and ToM is based on data from early childhood, the next step for research is to examine these relations in middle childhood and beyond. Adopting the principle of parsimony, we predicted that, as in the preschool years, EF would contribute to the *emergence* rather than *expression* of ToM in middle childhood.

Development of theory of mind and executive function in middle childhood

The dearth of research on the links between ToM and EF in middle childhood is surprising given that important age-related improvements across middle childhood have been reported for both