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Age effects on different components of theory of mind

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ABSTRACT

The effects of aging on the cognitive and affective dimensions of theory of mind (ToM), and on the latter's links with other cognitive processes, such as information processing speed, executive functions and episodic memory, are still unclear. We therefore investigated these effects in young ($n = 25$), middle-aged ($n = 20$) and older adults ($n = 25$), using separate subjective and objective assessment tasks. Furthermore, a novel composite task probed participants' abilities to infer both cognitive and affective mental states in an interpersonal context. Although age affected the objective ToM tests, results revealed a direct aging effect on the second-order ToM, but an indirect one on the first-order cognitive ToM, mediated mainly by age-related declines in executive functions. This study supports the notion of an age-related distinction between subjective and objective assessments of ToM, and confirms that ToM is a complex mental ability with several characteristics reliant to some extent on executive processes.

1. Introduction

Premack and Woodruff (1978) were the first authors to propose the concept of theory of mind (ToM) to describe the phenomenon whereby "*an individual imputes mental states to himself and others*" (p. 515). ToM is a complex cognitive function which enables us to deduce the cognitive and emotional states of other people from their attitudes and thus to anticipate and interpret their behaviors. Closely related to self-consciousness (Stuss & Anderson, 2004), ToM is essential for regulating social interactions and constitutes an important aspect of social cognition (Beer & Ochsner, 2006). "Social cognition" refers to the set of mental processes (e.g., perception of others and self, knowledge about social rules of interpersonal relationships, etc.), required to decode the social world, generating and regulating behavior and social interactions. Mindreading ability therefore plays a vital role in many situations of daily life.

Previous research on ToM has focused either on its development in children (Perner & Davies, 1991) or else on its impairment in populations with neurological or psychiatric disorders resulting in behavioral and social deficits, such as autism (Baron-Cohen, Wheelwright, Stone, & Rutherford, 2001), schizophrenia (Shamay-Tsoory, Aharon-Peretz, & Levkovitz, 2007) or brain damage (Shamay-Tsoory, Tomer, Berger, Goldsher, & Aharon-Peretz, 2005). These neuropsychological studies have brought dissociations between impaired and preserved ToM abilities to light, allowing us to distinguish between two kinds of ToM representations: cognitive and affective. "Cognitive" (or "cold") ToM concerns the cognitive states, beliefs, thoughts, or intentions of other people (Brothers & Ring, 1992; Coricelli, 2005). It can be assessed by means of several

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different tests, including *false belief* (understanding of a character's false beliefs about the reality of a situation), *attribution of intention* (deduction of the intention behind a character's action) and *social faux pas* (detection of a social blunder or lack of tact in a scenario). These usually feature short stories (verbal tasks) or comic strips (visual tasks). Within cognitive ToM, we can distinguish between first-order and second-order mental representations. "First-order" refers to representations of an individual's thoughts that are achieved by adopting the latter's own perspective (e.g., I think that Mr. X thinks that...). These implicitly allow us to understand that others have their own consciousness and that it differs from ours. "Second-order" representations, which could be likened to higher "metarepresentations" (Morin, 2006), correspond to more internal representations about ourselves, and involve simultaneously adopting two perspectives (e.g., Mr. X thinks that Miss Y thinks that...). This distinction has been confirmed both in the field of developmental psychology (Wimmer & Perner, 1983), where researchers have shown that mental representations of other people emerge first and mental metarepresentations second, and in studies in Alzheimer's disease, which have revealed that patients are only impaired on second-order tasks (Gregory et al., 2002).

"Affective" (or "hot") ToM concerns the affective states, emotions or feelings of others (Brothers & Ring, 1992). It can be tested using verbal short stories specifically describing an individual's emotions (Hynes, Baird, & Grafton, 2006), an expressive face recognition test featuring basic emotions (e.g., happy, sad, fearful, etc.) as ToM precursors (Sommer, Dohnel, Meinhardt, & Hajak, 2008) or the Reading the Mind in the Eyes test (Baron-Cohen et al., 1999; Baron-Cohen et al., 2001) featuring complex emotions (e.g., scheming, guilty, threatening, etc.). Indeed, Baron-Cohen, Wheelwright, and Jolliffe (1997; Adolphs, Baron-Cohen, & Tranel, 2002) have found that basic and complex emotions are differently addressed: while "basic emotions" are automatically, cross-culturally recognized and probably rely on an innate mechanism (Izard, 1994), "complex emotions" express blends of mental states or social emotions which arise within an interpersonal context. Although some researchers hold that affective ToM is similar to empathy, these two concepts are actually somewhat different. The term "empathy" refers solely to the feeling and experiencing of another person's emotion, like a wave of felt emotion, without necessarily understanding the reason behind that feeling. Conversely, affective ToM refers to the genuine understanding of mental affective states and thus to the ability to adopt the other person's point of view, or put oneself in his/her place (Pacherie, 2004), without necessarily experiencing any emotion. That said, some theoretical conceptions of empathy distinguish between the "emotional empathy" described above and "cognitive empathy", which is synonymous with affective ToM (Davis, 1980; Eslinger, 1998; Shamay-Tsoory, Tomer, Goldsher, Berger, & Aharon-Peretz, 2004). Consequently, cognitive empathy overlaps with affective ToM (Shamay-Tsoory et al., 2005).

As mentioned above, the dissociation between cognitive and affective ToM has been highlighted both in studies of healthy young adults (Hynes et al., 2006) and in studies of patients with brain diseases. For example, in Asperger syndrome, the affective component has been shown to be more impaired than the cognitive one (Shamay-Tsoory, Tomer, Berger, & Aharon-Peretz, 2003; Shamay-Tsoory, Tomer, Yaniv, & Aharon-Peretz, 2002). The same pattern has been observed in schizophrenia, particularly in patients with negative symptoms like abulia and social withdrawal (Shamay-Tsoory et al., 2005). Moreover, the authors showed that patients with localized ventromedial prefrontal cortex damage exhibit impaired performance on tasks involving affective ToM, but not on tasks probing cognitive ToM. Lastly, Gregory et al. (2002) found that early-stage Alzheimer's patients performed poorly on cognitive ToM tasks but had no difficulty inferring emotions from faces (affective ToM). Zaitchik, Koff, Brownell, Winner, and Albert (2006) have since reported a similar pattern. Overall, ToM is defined as a high-level mentalizing ability made up of different dimensions. However, these need to be explored in greater depth, in order to provide clearer insight into the organization of the ToM system.

Numerous authors have tried to delineate the links between ToM and other cognitive processes, such as executive functions (EFs). Some have deemed ToM to be a unitary construct, given the existence of double dissociations between it and EFs (Fine, Lumsden, & Blair, 2001; Varley, Siegal, & Want, 2001). Others have shown that EFs involved in goal-directed behavior and cognitive control mechanisms contribute to ToM processing and may thus be responsible for its impairment. A number of studies have assessed the association between individuals' performances on cognitive ToM tests and different EF measures (Bull, Phillips, & Conway, 2008). Early studies of ToM in children found that executive abilities were associated with ToM performance and were indeed necessary for its functioning (Carlson & Moses, 2001), especially for second-order representations (Ozonoff, Pennington, & Rogers, 1991). Moreover, increases in executive demands have been found to result in systematically poorer ToM performances by both younger and older adults (German & Hehman, 2006). These two cognitive systems appear to develop almost simultaneously, with EFs paving the way for ToM abilities (Pellicano, 2007), hence the overlap of EF and ToM processes in the completion of ToM tasks (Bull et al., 2008). Finally, some authors have found a relationship between working memory impairment and ToM deficit in autism (Bennetto, Pennington, & Rogers, 1996; Gokcen, Bora, Erermis, Kesikci, & Aydin, 2009).

Above and beyond the relationship between ToM and EFs, Perner (2000) postulated that episodic memory development depends on the infant's developing ToM. In turn, Perner, Kloo, and Gornik (2007) concluded that ToM acquisition is linked to the growth of episodic memory. While some studies have found no such interrelation (Melinder, Endestad, & Magnussen, 2006; Rosenbaum, Stuss, Levine, & Tulving, 2007), others have reported links between episodic memory and specific ToM processes, such as the understanding of representational change (Naito, 2003). Otherwise, when they studied the brain areas subtending both ToM and memory processes (notably the medial prefrontal cortex) in an amnesic patient, Frith and Frith (2003) suggested that episodic memory might be involved in mindreading. It is interesting to note that episodic memory and ToM share mental travel processes (Rosenbaum et al., 2007). While this set of data can certainly help us to understand