Research report

Exploring theory of mind after severe traumatic brain injury

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Abstract

Previous studies have reported a dissociation between social behavioral impairments after severe traumatic brain injury (TBI) and relatively preserved performances in traditional tasks that investigate cognitive abilities. Theory of mind (ToM) refers to the ability to make inferences about other’s mental states and use them to understand and predict others’ behavior. We tested a group of 15 patients with severe TBI and 15 matched controls on a series of four verbal and non-verbal ToM tasks: the faux pas test, the first-order and second-order false belief task, the character intention task and the Reading the Mind in the Eyes Test. Participants with severe TBI were also compared to controls on non-ToM inference tasks of indirect speech act from the Montreal Evaluation of Communication (M.E.C.) Protocol and empathy (Davis Interpersonal Reactivity Index – I.R.I.) and tests for executive functions. Subjects with TBI performed worse than control subjects on all ToM tasks, except the first-order false belief task. The findings converge with previous evidence for ToM deficit in TBI and dissociation between ToM and executive functions. We show that ToM deficit is probably distinct from other aspects of social cognition like empathy and pragmatic communication skills.

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1. Introduction

Changes in the social behavior of an individual following severe traumatic brain injury (TBI) have long been noted (Levin and Eisenberg, 1991). Impairments of social behavior after severe TBI are often problematic and difficult to assess and manage, with few models addressing evaluation, treatment options and prognosis. The neuropsychological consequences of TBI (disorders of attention, executive functioning, and memory and information processing) are strongly related to poor social outcome (Ponsford et al., 1995). Previous studies have reported a dissociation between social behavioral impairments and relatively preserved performances in traditional tasks that investigate cognitive abilities (Eslinger and Damasio, 1985; Shallice and Burgess, 1991). There is therefore a need for more detailed examination of the ability of people with TBI to use social information.

Much of the research has focused on one aspect of social intelligence, namely “theory of mind (ToM)”. ToM is a cognitive process which refers to the ability to make inferences about others’ mental states (beliefs, intentions and desires) and use them to understand and predict others’ behavior (Premack and Woodruff, 1978). Neuroimaging studies with healthy controls have reported that performance on ToM tasks is supported by a widely distributed neural system, involving frontal and temporal lobes (Gallagher et al., 2000;...
Between ages 6 and 7, they begin to be able to understand ToM. Between ages 3 and 4, children develop the ability to understand first-order false beliefs, i.e., “beliefs about beliefs” (Perner and Wimmer, 1985). The faux pas test and the Reading the Mind in the Eyes Test represent the most developmentally advanced ToM tasks, so they are considered as good measures of subtle ToM deficit. Comprehension of social faux pas develops around 9–11 years (Baron-Cohen et al., 1999) and the Reading the Mind in the Eyes Test is used with adults (Baron-Cohen et al., 1997).

Although ToM is first considered as a cognitive ability, some authors have argued for a distinction between “cognitive” ToM and “affective” ToM (Shamay-Tsoory and Aharon-Peretz, 2007). Some ToM tasks may involve a more complex affective emotional dimension than others. The false belief tests could assess “cognitive ToM” because they do not involve complex emotional ToM. The faux pas task and the Reading the Mind in the Eyes test could assess “affective ToM” because they have both a strong emotional component. These cognitive and affective aspects of ToM raise the question of the relationship between ToM and another aspect of social behavior, namely “empathy”. Whereas ToM refers to the attribution of mental states such as desires, intentions and beliefs, to others, empathy has been described as the ability to infer and share the emotional experiences of another (Davis, 1983; Spinella, 2005). It has been shown that the recognition of emotion in other people’s speech and facial expressions are disturbed for people with TBI (McDonald and Flanagan, 2004; Milders et al., 2008) and some authors have reported impaired empathy following brain injury (Eslinger, 1998; Shamay-Tsoory et al., 2003). The relationships between ToM and empathy remain controversial and still to be determined.

Several authors propose a theoretical model which postulates the possibility of shared processes between these two psychological concepts. In this model, there are both cognitive and emotional components of empathy (Davis, 1983; Spinella, 2005). The cognitive component of empathy is akin to ToM while the emotional component involves the actual emotional reaction. Shamay-Tsoory and Aharon-Peretz (2007) found that performances in “affective” ToM tasks of patients with lesions that involve the ventral medial and orbital frontal lobe were positively related to their empathic abilities, indicating that the ability to make affective representations of others’ mental states is associated with the ability to empathize. In a recent functional magnetic resonance imaging (fMRI) study, Vollm et al. (2006) compared networks associated with both empathy and a ToM task using cartoon stories derived from Sarfati et al. (1997). They concluded that ToM and empathy stimuli are associated with overlapping as well as distinct neuronal networks. They both engage a common neuronal circuit including the medial prefrontal cortex, temporoparietal junction and temporal poles. However, empathic responding requires the additional recruitment of the amygdala and the cingulate cortex involved in emotional processing. Several authors have performed objective and subjective measurement of empathy in individuals with frontal lobe injury, in the context of acquired sociopathy and moral judgments (Tranel et al., 2005; Koenigs et al., 2007). According to Spinella (2005), the most developed scale psychometrically is Davis’ Interpersonal Reactivity Index (I.R.I.) with scales rating both the cognitive and emotional components of empathy.

There has been debate over whether the ability to infer others’ mental states is a true implicit “theory” or the result of...
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