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General review

Theory of mind, empathy and emotion perception in cortical and subcortical neurodegenerative diseases

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INFO ARTICLE

Article history:

Received 7 February 2017

Received in revised form

15 June 2017

Accepted 4 July 2017

Available online xxx

Keywords:

Social cognition

Neurodegenerative diseases

Theory of mind

Empathy

Emotion recognition

Neuropsychology

ABSTRACT

Although the impact of neurodegenerative diseases on everyday interactions is well known in the literature, their impact on social cognitive processes remains unclear. The concept of social cognition refers to a set of skills, all of which are essential for living in a community. It involves social knowledge, perception and processing of social cues, and representation of mental states. This report is a review of recent findings on the impact of cortical and subcortical neurodegenerative diseases on three social cognitive processes, namely, the theory of mind, empathy and processing emotions. The focus here is on a conceptual approach to each of these skills and their cerebral underpinnings.

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1. Social cognition: definition

Human relationships require adaptations to others through the intervention of sociocognitive and emotional processes to regulate behavior in interactions. These processes represent the field of research into social cognition, which is of growing interest in the scientific literature. In recent decades, studies of social neuroscience have been developed, particularly after the start of the new millennium (Fig. 1).

This enthusiasm is not surprising, considering that social relationships lie at the heart of human activities and that some behavioral disorders demonstrated by brain-damaged patients are likely to be explained by impairment of social cognitive processes. In fact, most research has focused on defining the cognitive architecture of social cognitive processes, and their dissociation from and relationship to other components (for example, executive functions), and most results have tended to show that a deficit in social cognition

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<https://doi.org/10.1016/j.neurol.2017.07.013>

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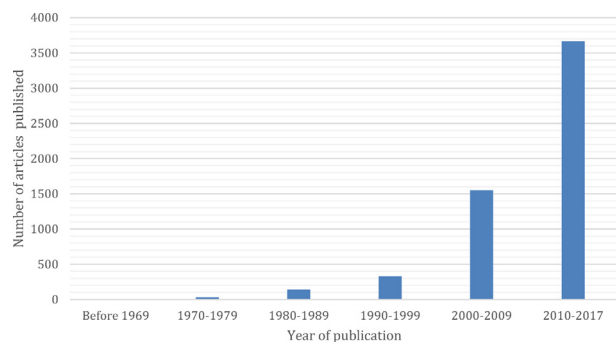


Fig. 1 – The massive increase in the number of articles in PubMed containing the term ‘social cognition’ in their titles from 1967 to 2017.

leads to a behavioral disorder in a neurological [1] or psychiatric disease [2].

Social cognition includes all the socioemotional capacities that enable monitoring of behavior in an interactive situation. In our view, Frith’s [3] definition of social cognition brings together most of these key points: “Social cognition concerns the various psychological processes that enable individuals to take advantage of being part of a social group. Of major importance to social cognition are the various social signals that enable us to learn about the world.”

Thus, according to this definition, social cognition is composed of several different concepts, with theory of mind (ToM), empathy and emotion regulation seemingly the most studied in the literature.

1.1. Theory of mind (ToM)

There is no consensus on the definition of ToM in the literature. Some authors see it as the ability to access the mental states of others, whereas others define it as the ability to adopt the point of view of others [4]. In neuropsychology, although the term ToM has several meanings, it is generally considered to represent the metacognitive abilities that facilitate implementation of social interactions. These meta-representational capacities are enabled by an inference system leading to the attribution of mental states, such as thoughts, intentions, beliefs and feelings.

Several dissociations of the components of ToM have been identified. A major one refers to automatic and controlled processes, and echoes the proposals of Sabbagh et al. [5] and Apperly and Butterfill [6]. Automatic processes are thought to be rapid and not necessarily requiring language, in contrast to controlled processes, which are slower and effortful [7,8]. In this review, our focus is only on controlled processes.

Another dissociation was defined by Coricelli [9], who distinguished cognitive ToM, making inferences about the epistemic mental states of others with no emotional involvement, from emotional ToM, which defines empathy as the cognitive ability needed to understand the emotional feelings of others (see below).

Concerning the neuroanatomical substrates thought to underlie the ToM process, they have been the subject of numerous researches and are still a matter of debate (for

reviews, see Schurz et al. [10] and Bejanin et al. [11]). However, it is apparently possible to identify and classify into three groups the brain structures frequently mentioned in these studies. The first group refers to the limbic and paralimbic regions, which include the orbitofrontal cortex, amygdala and anterior cingulate gyrus. These regions underpin the skills associated with the emotional side of ToM [12]. Stone et al. [13] confirmed these results, showing that patients affected in the orbitofrontal regions were less efficient than patients with dorsolateral frontal lesions in Faux Pas Recognition Test tasks [13] requiring emotional responses. However, the former patients were able to verbalize the emotional states or beliefs of the protagonists, unlike those with dorsolateral lesions. Thus, this metarepresentational aspect, comparable to the cognitive side of ToM, appears to depend more on dorsolateral prefrontal structures [9].

The second group involves the medial prefrontal regions. Gallagher et al. [14] reported activation of the medial frontal gyrus only when the processing patterns required mobilization of cognitive ToM abilities (answers regarding beliefs or intentions of protagonists) compared with neutral patterns (see also Brunet et al. [15]).

The third group involves the posterior brain regions that include the right posterior parietal system and, in particular, the inferior parietal lobule, and right superior temporal sulcus and temporal poles. Although there is a consensus on most of these neuroanatomical substrates, there are highly contrasting views in the literature concerning one area. Many authors agree that the temporoparietal junction (TPJ) is involved in ToM, but there is some debate over lateralization. Based on case studies and meta-analyses, authors cannot agree as to whether the right TPJ [16–18] or left TPJ [19–21] is essential for ToM. Thus, there is clearly a need for further studies of this topic.

In short, functional imaging data tend to confirm the dissociation between cognitive and affective ToM: the cognitive aspect is supported by the dorsomedial and dorsolateral prefrontal cortex, while the emotional aspect is supported by the ventromedial and orbitofrontal regions [22]. More recently, it was proposed that the dorsal striatum, dorsal temporal pole and dorsal anterior cingulate cortex underlie the cognitive ToM network, whereas the ventral striatum, amygdala, ventral temporal pole and ventral anterior cingulate cortex underpin the affective ToM network [23].

1.2. Empathy

Empathy refers specifically to the process of developing inferences on the emotional states of others in order to share and/or feel their emotions. Decety and Lamm [24] defined empathy as the ability to understand what others think, but also to experience it with no confusion within oneself. Like ToM, empathy is a process involving several components, which has led some authors to distinguish emotional (also referred to as ‘emotional contagion’) and cognitive empathy [25,26]. Cognitive empathy is defined as the ability to take the perspective of others and to understand what they feel without experiencing it, while affective empathy refers to the ability to actually feel the emotional states of others. The emotional component (a low-level process) is directly asso-

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