On the interaction of social affect and cognition: empathy, compassion and theory of mind

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Empathy, compassion and Theory of Mind (ToM) are central topics in social psychology and neuroscience. While empathy enables the sharing of others' emotions and may result in empathic distress, a maladaptive form of empathic resonance, or compassion, a feeling of warmth and concern for others, ToM provides cognitive understanding of someone else's thoughts or intentions. These socio-affective and socio-cognitive routes to understanding others are subserved by separable, independent brain networks. Nonetheless they are jointly required in many complex social situations. A process that is critical for both, empathy and ToM, is self-other distinction, which is implemented in different temporoparietal brain regions. Thus, adaptive social behavior is a result of dynamic interplay of socio-affective and socio-cognitive processes.

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As a social species, humans are continuously required to process complex social signals. Successful multifaceted social interactions are enabled by socio-affective and socio-cognitive capacities such as empathy, compassion and Theory of Mind (ToM). In this review we will first define these social functions and describe the neural networks associated with each of them. Further, we discuss the interaction of empathy and ToM and delineate the importance of one crucial process, that is, self-other distinction. Socio-affective and socio-cognitive processes are also essential for how (prosocially) we interact with others, particularly when faced with others' suffering. Two possible outcomes of empathic sharing of others' suffering are empathic distress on the one hand, which may be detrimental to the observer and to others and compassion, on the other hand, which is a feeling of warmth and concern for the other. We conclude with a concise summary and an opinion statement.

Defining and neurally characterizing empathy, compassion and Theory of Mind

Empathy describes the process of sharing feelings, that is, resonating with someone else's feelings, regardless of valence (positive/negative), but with the explicit knowledge that the other person is the origin of this emotion [1]. This socio-affective process results from neural network activations that resemble those activations observed when the same emotion is experienced first-hand (shared network hypothesis) [2–5]. The first studies in neuroscience targeting empathy investigated empathy in the domain of pain, showing that directly experiencing pain and witnessing another person receiving painful stimuli results in shared neural activations in the anterior insula (AI) and anterior middle cingulate cortex (aMCC) [6,7]. Meta-analyses have later identified these regions as a core network that is activated whenever we witness the suffering of others [8,9]. Furthermore, this network is modulated by individual differences in experienced negative affect and empathy [6,10]. While empathy refers to an isomorphic representation of someone else's affective state, compassion is a complementary social emotion elicited by witnessing the suffering of others and is rather associated with feelings of concern and warmth, linked to the motivation to help [2,11]. Empathy and compassion also differ on a neural level: compassion activates networks that have previously been associated with reward and affiliation processes including the ventral striatum (VS), the nucleus accumbens, the ventral tegmental area (VTA), the medial orbitofrontal cortex (mOFC) and the subgenual anterior cingulate (sgACC) [12,13,14•,15,16•,17]. Congruently with these activations in reward-associated and affiliation-associated networks, compassion generates positive affect towards others' suffering. In contrast to compassion, empathic distress, which is an alternative outcome of empathy, may be detrimental to the experiencer as well as to the suffering other [15,18].

In contrast to socio-affective processes, socio-cognition refers to taking another person's perspective (also referred to as ToM, mentalizing, or cognitive empathy). Rather than an emotional state, ToM yields abstract, propositional knowledge about the other's mental state. It describes the process of inferring and reasoning about

the beliefs, thoughts or emotions of others [19–22]. Crucial brain regions involved in ToM include the ventral temporoparietal junction (TPJ), superior temporal sulcus (STS), temporal poles (TP), medial prefrontal cortex (MPFC) and precuneus/posterior cingulate (PCC) [23].

Interactions of social affect and social cognition

Both socio-affective and socio-cognitive processes have been extensively investigated [6,8,9,23,24]. However, research has only recently begun to study how these processes are related and work together to achieve adaptive social behavior. Making use of a novel task (EmpaToM) [25••] that stimulates both functions concurrently (see Figure 1), the respective neural correlates can be directly compared. The EmpaToM clearly activates separable brain networks that can be replicated in resting state functional connectivity [25••] and on a brain structural level [26•]. Crucially, individual differences in empathy and ToM are unrelated on a behavioral and neural level, that is, strong empathizers are not

necessarily proficient mentalizers [27•]. In line with such independent functions, selective impairments in empathy or ToM have been observed in different psychopathologies such as autism and psychopathy. In autism, ToM is deficient [28–31], while no empathy deficits are observed when controlling for alexithymia [32–35]. In psychopathy or chronic aggression, in contrast, ToM is intact, but the propensity to empathize with others is reduced [36,37].

Despite being separable, empathy and ToM are jointly required in many complex social situations. An indirect source of evidence for such co-activation is a meta-analysis on different empathy for pain paradigms, which suggests that the core region of the ToM network is co-activated in empathy paradigms when additional inferring from a cue is required to understand the other's state. [8]. The paradigms investigated in this meta-analysis varied depending on the information provided to the participants. In picture-based paradigms, they were presented with visual depictions of someone in a painful situation,

Figure 1

The EmpaToM task. This figure presents the experimental set-up of the EmpaToM task (previously published here [25••]). The design is a 2 (emotionality of video) × 2 (ToM requirements) design, resulting in four different video types. Each actor presented each video type: emotional negative and neutral videos, as well as videos with ToM requirements or factual reasoning demands. Each video was followed by various ratings, a valence rating (ranging from negative to positive) and a compassion rating (ranging from none to very much compassion they felt for the person in the video. Afterwards they answered a question that either probed for ToM or factual reasoning. After each question, participants were asked how confident they felt about their answer. For further information on this task, please refer to Kanske et al. [25••].

whereas in cue-based paradigms, participants were presented a cue/hint that someone else is receiving painful stimulation. Common activations were observed in the typical empathy related core network. However, the two paradigm types resulted in different co-activations. As the cue-based paradigms require additional inference of the other's affective state from an abstract cue, the ToM related network is co-active [8]. The pictorial presentation of someone in a painful situation, on the other hand, co-activates the action-observation network to decode the potential affective consequences of a certain action. These findings suggest that, dependent on the provided information in a given context, different networks will be co-activated together with the core empathy-related network.

The two networks associated with empathy and ToM are also jointly activated for complex evaluations of someone else's feelings such as empathic accuracy, the ability to infer what someone else is feeling [38]. Here, participants are asked to continuously rate another person's emotions over an extended period of time; so the emotion of the other may be empathically shared, but it is also critical to acquire abstract knowledge about that emotion to complete the task accurately.

When activated together in complex social situations, the two networks may also directly influence each other. Indeed, when confronted with others' distress, the AI, which is activated for negative affect sharing, inhibits activity in TPJ, an important hub of the mentalizing network [27•]. This reduction in TPJ activity is related to impaired ToM performance [27•]. The adaptive value of this inhibitory mechanism in salient, emotional situations may be to prepare for immediate action in the external world [39]. It has, however, also been discussed as important in psychopathology, for instance in borderline personality disorder for which a stress related mentalizing deficit has been hypothesized [40].

Self-other distinction
The distinction of self and other constitutes an important element of both empathy and ToM, as it enables the differentiation between one's own emotional or mental states and the states shared with others. Failure of self-other distinction results in a blending of these states, thereby inducing an egocentricity bias, the tendency to project one's own emotional or mental state on someone else [41,42], or an altercentric bias, the influence of others' states on judgments about oneself [43]. Cognitive egocentricity occurs when the own knowledge about a situation influences the reasoning about what someone else thinks about the situation [42], but can also affect simple decisions about the visual perspective of another [44]. Emotional egocentricity occurs when one's own emotional state influences the judgment of someone else's affective state [41]. On a neural level, the right TPJ seems to be critical to overcome cognitive egocentricity [45•]. It is also functionally connected to other parts of the ToM neural network, such as the medial and ventrolateral PFC and the PCC [45•,46]. Overcoming emotional egocentricity involves a slightly anterior temporoparietal region in the right supramarginal gyrus (rSMG) [41]. Correspondingly, disruption of rSMG activity using transcranial magnetic stimulation leads to increased emotional egocentricity [41]. Interestingly, the SMG (see Figure 2) is also part of a different functional connectivity network with extensive connections to the AI [47]. Moreover, increased coupling of SMG to dorsolateral PFC has been related to a reduction in emotional egocentricity in development

Figure 2
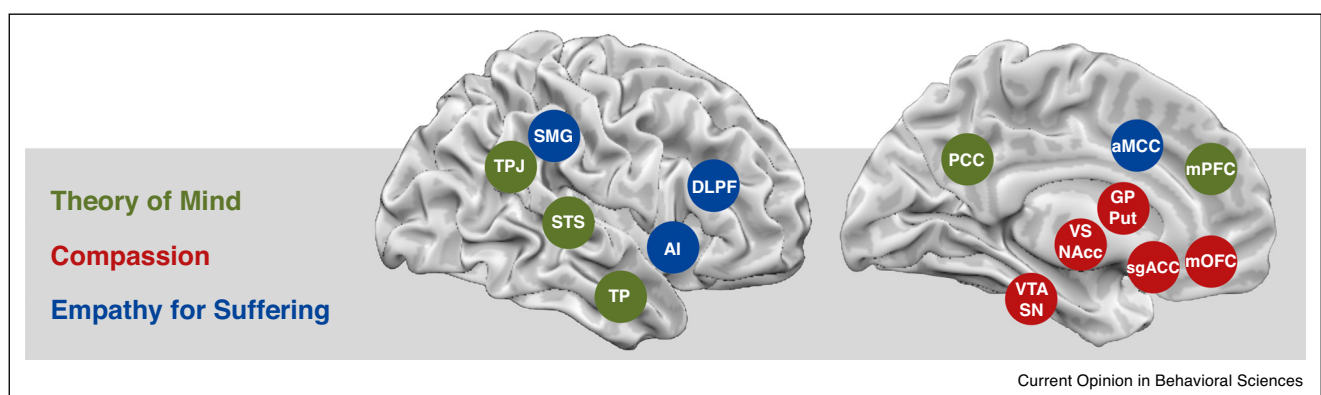
Neural networks underlying empathy, compassion and Theory of Mind. The separable neural networks underlying empathy (blue), compassion (red), and Theory of Mind (green) are presented. Abbreviations: AI, anterior insula; aMCC, anterior middle cingulate cortex; dlPFC, dorsolateral prefrontal cortex; GP, globus pallidus; mOFC, medial orbitofrontal cortex; mPFC, medial prefrontal cortex; NAcc, nucleus accumbens; PCC, posterior cingulate cortex; Put, putamen; sgACC, subgenual anterior cingulate cortex; SN, substantia nigra; STS, superior temporal sulcus; SMG, supramarginal gyrus; TP, temporal poles; TPJ, temporoparietal junction; VS, ventral striatum; VTA, ventral tegmental area.

[46]. Thus, temporoparietal regions seem to play a crucial role in overcoming egocentricity, possibly contributing to self-other distinction. The activation of SMG and TPJ in complex empathy and ToM paradigms, respectively [25••], corresponds with the crucial role of self-other distinction for both capacities.

Social behavior

Empathy and ToM provide us with an understanding of our interaction partners' emotional and cognitive states, thereby forming the basis for flexible interactive behavior and social decision making. Lately, neuroscientific research has focused on the relationship between social emotions and social cognition in predicting prosocial behaviors [48••,49]. For instance, using donation choices for charity organizations, a recent study [48••] showed that an extensive cortical network is involved in forming such prosocial decisions. Specifically, AI activity predicted generous donations when participants reported empathic feelings for the charity's goal before, while TPJ activity predicted donations, when participants took the perspective of the organization's cause [48••]. Remarkably, empathy and ToM measurements from an independent task, were also related to these functions' role in donation decisions, suggesting that stable individual propensities are involved in prosocial behavior. In contrast, impairments in empathy or ToM have been associated with antisocial behavior, for instance to hyper-aggression [18,37,50]. While empathy may be related to prosociality, a particular outcome of empathy — empathic distress — describes the intense sharing of other's emotions and may be detrimental, because it can result in own suffering as well as in asocial or even antisocial effects, such as aggressive verbal behavior [18]. Short-term contemplative training in compassion increases helping, even when it is costly [51]. In contrast to empathic distress, compassion reduces punishment behavior in long-term compassion meditation practitioners even when they were themselves the victim of fairness violations [52]. The critical property of compassion may be that it counteracts negative emotion elicited by experiencing others' suffering through positive emotion generation, thereby acting as an emotion regulation strategy [14•,15,53]. The direct comparison of compassion to the most widely investigated emotion regulation strategy — reappraisal — showed that in well-trained long-term meditators, cognitive reappraisal was most efficient in reducing negative affect, but compassion induction worked through up-regulation of positive affect and associated networks in the brain [14•]. On a neural level, compassion was accompanied by activations in reward and positive emotion related networks [14•]. Reappraisal on the other hand yielded activity in a fronto-parietal network associated with cognitive control and attention regulation [54]. The different brain activation patterns are, thus, in line with the hypothesis that reappraisal down-regulates negative affect mainly via executive and cognitive control

networks and compassion increases positive affect to buffer negative affect through the active generation of positive emotions via reward-related and affiliation-related brain circuitries.

Concluding remarks

In the present paper, we have suggested that the social brain is supported by different functions and underlying neuronal networks and that it is important to differentiate between socio-affective versus socio-cognitive routes to the understanding of others. Sharing affective states with another person (empathy), feeling concern for another (compassion) and reasoning about another person's mental state (ToM) are separable on a conceptual, behavioral and neural level; strong empathizers are not necessarily proficient mentalizers and each domain may be selectively impaired in psychopathologies such as autism or psychopathy. Furthermore, an original adaptive empathic response to the suffering of others can lead to a maladaptive response, that is, empathic distress which can be reversed by learning how to turn empathy into compassion. Compassion can thus be viewed as an emotion-regulation strategy that buffers negative affect through the active generation of positive affect relying on reward-related and affiliation-related brain circuitries. Despite the separability of socio-affective and socio-cognitive functions, these social capacities are jointly activated and interact in complex social situations. In synthesis, the evidence supports a detailed view of the social mind, not as a monolithic 'social intelligence', but as dynamic interplay between different functions and subserving neuronal networks that enable in different ways to engage in prosocial behavior.

Conflict of interest statement
Nothing declared.

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