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# The empathic brain: how, when and why?

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**Recent imaging results suggest that individuals automatically share the emotions of others when exposed to their emotions. We question the assumption of the automaticity and propose a contextual approach, suggesting several modulatory factors that might influence empathic brain responses. Contextual appraisal could occur early in emotional cue evaluation, which then might or might not lead to an empathic brain response, or not until after an empathic brain response is automatically elicited. We propose two major roles for empathy; its epistemological role is to provide information about the future actions of other people, and important environmental properties. Its social role is to serve as the origin of the motivation for cooperative and prosocial behavior, as well as help for effective social communication.**

## Introduction

Ten years after the discovery of mirror neurons in monkeys [1], we now also have evidence for shared affective neuronal networks underlying our ability to empathize. Brain imaging studies have shown overlapping brain activation patterns when subjects feel their own emotions and observe the same emotions in others [2–8]. It has been suggested that: (i) shared affective neuronal networks explain how we feel the emotions of others as if they were our own and (ii) these networks are activated automatically whenever we observe others displaying emotion. But is empathy really automatically triggered every time we observe someone else displaying emotion? Here, with the combined perspectives of neuroscience, psychology and philosophy, we question the assumption of automatic empathy and propose several factors that might modulate when and to what extent we feel empathy. In addition, we provide preliminary answers to the question concerning why empathy might have evolved.

## What is empathy and how do we empathize: the shared network hypothesis

Before suggesting some answers to the how, the when and the why of empathy, we attempt to shed light on what empathy means. There are probably nearly as many definitions of empathy as people working on the topic. There are two main trends: some argue for a broad definition of empathy as an understanding of another person's feelings, affect sharing [9] or as 'an affective response more appropriate to another's situation than one's own' [10]. So defined, empathy subsumes phenomena such as emotional contagion, sympathy, personal distress or even cognitive perspective-taking. However, this definition does not enable precise claims to be made about the nature of empathy or its automaticity because one can always reply that it depends on the level of empathy [11]. Others, ourselves included, prefer to narrow down the concept of empathy [12,13]. There is empathy if: (i) one is in an affective state; (ii) this state is isomorphic to another person's affective state; (iii) this state is elicited by the observation or imagination of another person's affective state; (iv) one knows that the other person is the source of one's own affective state.

This narrower definition of empathy still leaves some questions open (Box 1). However, it enables us to distinguish empathy from other related phenomena. Cognitive perspective-taking, for example, does not meet the first condition. One represents the mental states of others, including affective states, without being emotionally involved (e.g. based on my knowledge of you, I infer from your behavior that you are anxious but I do not feel anxious). Similar to empathy, sympathy refers to an affective state related to the other and is therefore often taken as being synonymous [13]. However, it does not meet the condition of isomorphism (e.g. I feel sorry for you because you feel jealous, depressed or angry but I am not jealous or depressed myself). Finally, emotional contagion involves affect sharing but does not meet the condition of self–other distinction (e.g. the baby starts crying because other babies cry but the baby is not necessarily aware that the other is the source of their affective state).

The narrow definition of empathy proposed above was partially motivated by the investigation of the neuronal basis of empathy. Recent functional magnetic resonance imaging (fMRI) studies have shown that observing another person's emotional state activates parts of the neuronal network involved in processing that same state in oneself, whether it is disgust [2], touch [3] or pain [4–8] (Figure 1).

Some authors have suggested that shared circuits such as these are formed by associative learning or Hebbian learning mechanisms in the domains of actions [14,15], emotions and sensations [15]. In the view of these authors, shared networks might result from associations between simultaneously firing, coactivated neurons. Hence,

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**Box 1. Open questions about empathy: consciousness and isomorphism**

Controversy exists as to whether empathic responses are necessarily conscious. Some philosophers argue that empathy is a conscious experience of what it is like to feel what the other feels through 'online simulation' [43,44]. By contrast, neuroscientists promote the view that affective states are automatically and unconsciously shared with others. Although it is possible to study empathy independently of this problem, this phenomenological dimension still remains to be acknowledged.

Another open question concerns the degree to which the empathic response is isomorphic to the original affective state. Is it a coarse-grained congruency (e.g. only the same valence) or a more fine-grained equivalence (e.g. same valence, intensity and components)? Neuroscience has started to tackle this question but cannot yet provide an unambiguous answer. Most of the recent fMRI studies on pain, for example, have suggested that empathic responses are associated with activity in the affective component of the pain network (ACC and AI) rather than with its sensorimotor properties (primary and secondary somatosensory cortices). However, using transcranial magnetic stimulation, Aglioti's group revealed reduced motor excitability specific to the muscle that the subjects observed being penetrated deeply by needles in another person [21]. Likewise, a recent study of 'empathy' for touch revealed activation of primary sensorimotor cortex that was somatotopically mapped [45], contrasting with another study showing only secondary somatosensory cortex activity [3]. A challenge for future research will be to isolate the factors determining the degree of isomorphism in empathy.

whenever a percept (e.g. the sight of an angry face) or symbolic cue (e.g. the word 'pain') is accompanied by a certain emotional, visceral or somatosensory activation, a connection between the cue and the neural representation of the internal sensation is formed. Later, the mere presentation of these cues can trigger the emotional, visceral or sensorimotor representation associated with it. According to this view, empathic responses are automatically elicited by the mere perception of these cues. But is empathy really always automatic?

## When do we empathize: automatism and modulatory factors

As Figure 1 illustrates, common neural networks involved in empathy are activated by the perception not only of loved ones in pain [4], but also of unknown people in pain [8], or even of a needle penetrating the back of someone's hand [6]. Furthermore, subjects have not always been told the goal of the study [2–4,6,7]. These results suggest that we always automatically empathize with others when exposed to their emotions, regardless of who they are. Is this true? Or are we more selective?

At the phenomenological level, we are obviously not constantly empathizing with the people around us [16]. In real life, we constantly witness people displaying contradictory emotions. If we were to consciously feel what they feel all the time, we would be in permanent emotional

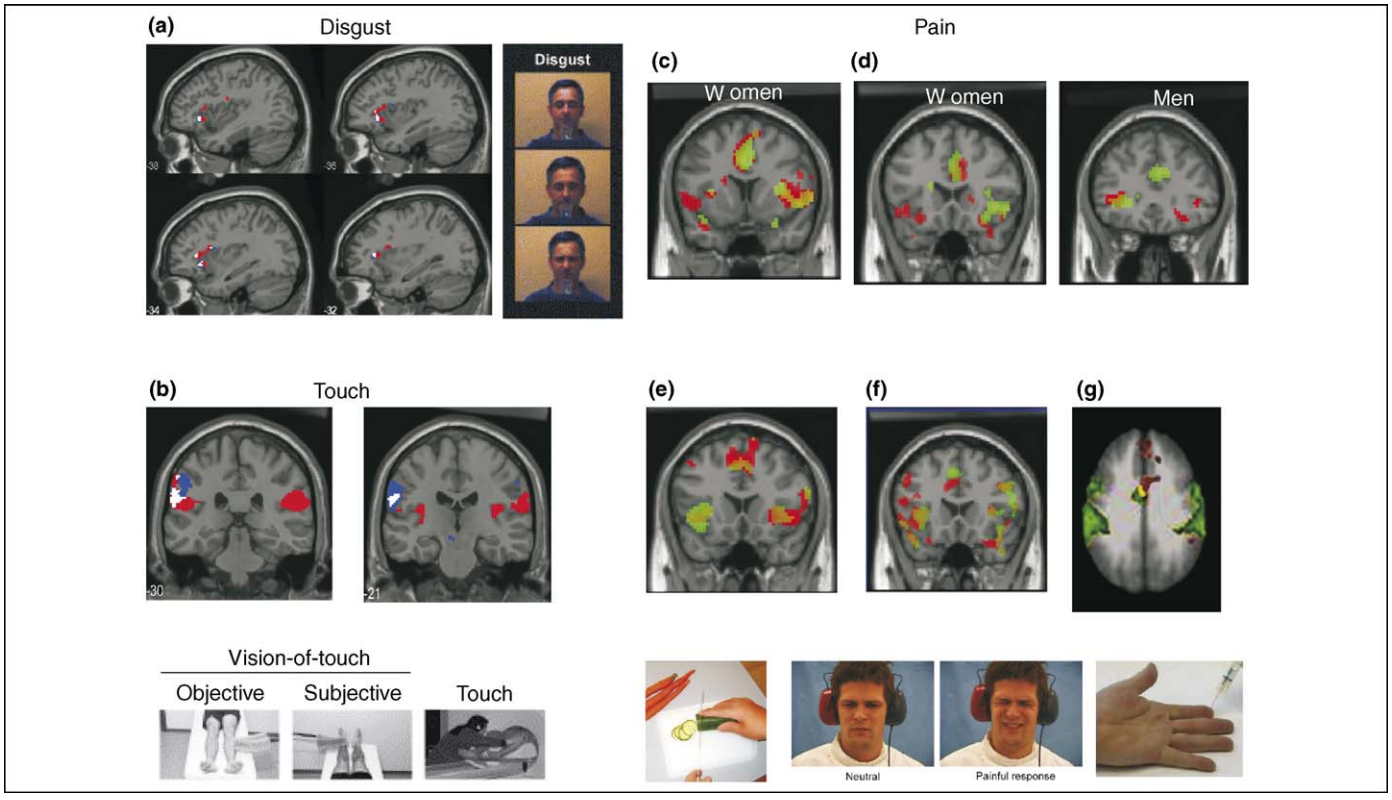


**Figure 1**. Shared brain networks, as revealed in fMRI studies on empathy for disgust, touch and pain. **(a)** A common brain activation in the AI elicited by the smell of disgusting odors (red) and the sight of someone else smelling disgusting odors [2]. **(b)** Common activation in SII associated with being touched on a leg (red) or watching videos showing a leg being touched (blue) [3]. **(c–g)** Overlapping brain activity in the AI and ACC when receiving painful stimulation oneself (green) or when empathizing with another person feeling pain (red), whereby (c) shows the activation of women perceiving cues indicative of their male partners feeling pain [4], (d) depicts the involvement of the same network when women (right) or men (left) observe an unknown but previously fair player receiving painful stimulation [22] and (e–g) illustrate brain responses of subjects viewing still images of potentially painful situations [50], facial expressions of pain [8] and needles pricking a human hand [6]. For all further details regarding methods and analysis of these studies, see papers cited.