Empathy and compassion

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As humans we are a highly social species: in order to coordinate our joint actions and assure successful communication, we use language skills to explicitly convey information to each other, and social abilities such as empathy or perspective taking to infer another person's emotions and mental state. The human cognitive capacity to draw inferences about other peoples' beliefs, intentions and thoughts has been termed mentalizing, theory of mind or cognitive perspective taking. This capacity makes it possible, for instance, to understand that people may have views that differ from our own. Conversely, the capacity to share the feelings of others is called empathy. Empathy makes it possible to resonate with others' positive and negative feelings alike — we can thus feel happy when we vicariously share the joy of others and we can share the experience of suffering when we empathize with someone in pain. Importantly, in empathy one feels with someone, but one does not confuse oneself with the other; that is, one still knows that the emotion one resonates with is the emotion of another. If this self–other distinction is not present, we speak of emotion contagion, a precursor of empathy that is already present in babies.

While shared happiness certainly is a very pleasant state, the sharing of suffering can at times be difficult, especially when the self–other distinction becomes blurred. Such a form of shared distress can be especially challenging for persons working in helping professions, such as doctors, therapists, and nurses. In order to prevent an excessive sharing of suffering that may turn into distress, one may respond to the suffering of others with compassion. In contrast to empathy, compassion does not mean sharing the suffering of the other: rather, it is characterized by feelings of warmth, concern and care for the other, as well as a strong motivation to improve the other's wellbeing. Compassion is feeling *for* and not feeling *with* the other. Given the potentially very different outcomes that empathic or compassionate responses to others' distress may have, it is of great importance to understand which factors determine the emergence of these different social emotions and to know more about whether and how such emotional responses can be trained and changed.

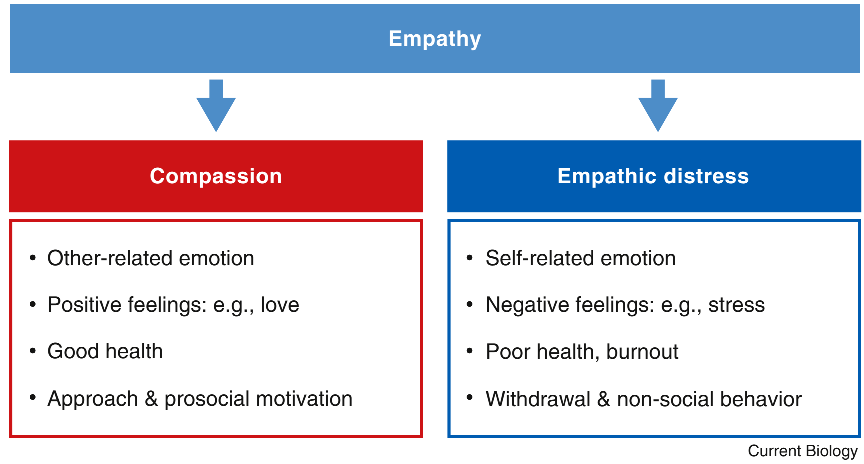

Figure 1. Compassion and empathic distress.
Schematic model that differentiates between two empathic reactions to the suffering of others.

Psychological perspective

Although the concepts of empathy and compassion have existed for many centuries, their scientific study is relatively young. The term empathy has its origins in the Greek word 'empatheia' (passion), which is composed of 'en' (in) and 'pathos' (feeling). The term empathy was introduced into the English language following the German notion of 'Einfühlung' (feeling into), which originally described resonance with works of art and only later was used to describe the resonance between human beings. The term compassion is derived from the Latin origins 'com' (with/together) and 'pati' (to suffer); it was introduced into the English language through the French word compassion. In spite of the philosophical interest for empathy and the fundamental role that compassion plays in most religions and secular ethics, it was not until the late 20th century that researchers from social and developmental psychology started to study these phenomena scientifically.

According to this line of psychological research, an empathic response to suffering can result in two kinds of reactions: empathic distress, which is also referred to as personal distress; and compassion, which is also referred to as empathic concern or sympathy (Figure 1). For simplicity, we will refer to empathic distress and compassion when speaking about these two different families of emotions. While empathy refers to our general capacity to resonate with others' emotional states irrespective of their valence — positive or negative — empathic distress refers to a strong aversive and self-oriented response to the suffering of others, accompanied by the desire to withdraw from a situation in order to protect oneself from excessive negative feelings. Compassion, on the other hand, is conceived as a feeling of concern for another person's suffering which is accompanied by the motivation to help. By consequence, it is associated with approach and prosocial motivation.

Research by Daniel Batson and Nancy Eisenberg in the fields of social and developmental psychology confirmed that people who feel compassion in a given situation help more often than people who suffer from empathic distress. Furthermore, Daniel Batsons' work showed that the extent to which people feel compassion can, for instance, be increased by explicitly instructing participants to feel with the target person. Interestingly, the capacity to feel for another person is not only a property of a person or a situation, but can also be influenced by training.

In order to train social emotions like compassion, recent psychological

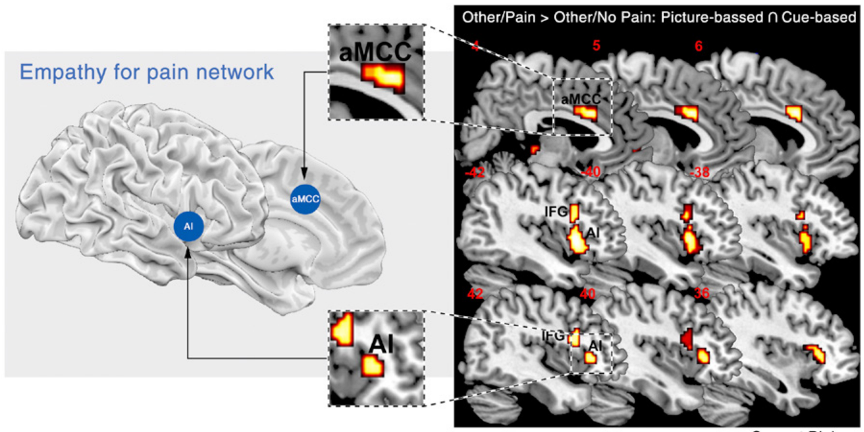

Figure 2. Neural network underlying empathy for pain.
Depicted functional neural activations on the right are the result of a meta-analysis based on nine fMRI studies investigating empathy for pain. AI, anterior insula; aMCC, anterior middle cingulate cortex; IFG, inferior frontal cortex. Right side of figure reproduced with permission from Lamm *et al.* (2011).

research has increasingly made use of meditation-related techniques that foster feelings of benevolence and kindness. The most widely used technique is called 'loving kindness training'. This form of mental practice is carried out in silence and relies on the cultivation of friendliness towards a series of imagined persons. One would usually start the practice by visualizing a person one feels very close to and then gradually extend the feeling of kindness towards others, including strangers and, at a later stage, also people one has difficulties with. Ultimately, this practice aims at cultivating feelings of benevolence towards all human beings.

Using this kind of training, researchers around Barbara Fredrickson have shown that several weeks of regular compassion training can have a beneficial impact on self-reported feelings of positive affect, personal resources, and well-being during everyday life. Interestingly, the beneficial effects of compassion training are not limited to the person who is training, but can also benefit others. More recent research in our lab has shown that participants who undergo loving kindness and compassion training increased their helping rates towards strangers in a computer game when compared to an active memory control group. Interestingly, the amount of time participants practiced compassion predicted how much a certain type of helping behavior increased, namely pure altruistic helping as opposed to reciprocity-based helping. This indicates that compassion training especially increases prosocial motivation rather than just norm-adherence.

A neuroscientific perspective on empathy

This purely behavioral psychological research is more and more supported and extended by recent findings from social neuroscience. Some years ago, this relatively new discipline embarked on the investigation of social emotions such as empathy and compassion and their plasticity. A multitude of neuroimaging studies using functional magnetic resonance imaging (fMRI) has, for example, shown that empathizing with another person's feelings relies on the activation of neural networks that also support the first-person experience of these feelings.

A very prominent way to study such 'shared neuronal networks' underlying empathic experiences is the domain of pain. In such 'empathy for pain paradigms', scanned participants typically either receive painful stimulation to body parts themselves or are presented with pictures or cues that indicate that another person is currently experiencing pain. By then comparing the brain activations that are elicited by the first-hand experience of pain with those purely elicited by the vicarious observation of another person in pain, researchers have repeatedly found evidence for the existence of such shared neuronal networks (Figure 2). For example, meta-analyses on empathy for pain studies have revealed that a portion of the anterior insula and a specific part of the anterior cingulate cortex were consistently activated, both during the experience of pain as well as when vicariously feeling with the suffering of others.

Importantly, the magnitude of these empathy-related activations was modulated by individual differences in the degree to which participants reported having experienced negative feelings while empathizing with the other. Although empathy has been studied most extensively in the domain of pain, similar paradigms have also been used for the study of touch, disgust, taste or social rewards. Depending on the emotion in question, such shared networks were observed in somatosensory cortex for vicarious neutral touch, medial orbitofrontal cortex for vicarious pleasant touch, ventral striatum for shared social rewards and parts of the anterior insula when empathizing with taste and disgust.

After having established this basic neural mechanism underlying our ability to share feelings with others, a second generation of empathy studies — again mostly focusing on vicarious pain — has investigated the modulation of such empathic brain responses by various factors. Indeed, the results reveal that empathic brain responses are modulated by factors that range from person-specific characteristics, such as gender, to context-specific factors. For example, in several fMRI studies in our lab we could show that perceived group membership or fairness of another person matters for how much empathy one will actually experience for the other. Thus, witnessing the suffering of a perceived in-group member (same football team) or of someone who played fairly in economic games beforehand evoked more pronounced empathy-related anterior insula activations than when witnessing an unfair person or an out-group member (rival football team) suffering pain. Importantly, the magnitude of the empathy-related signal in the anterior insula predicted the extent to which participants later engaged in altruistic helping behavior.

Plasticity of the socio-emotional brain

Despite existing psychological findings suggesting the possibility of transforming social emotions through training, it was only very recently that neuroscience began to investigate the neural plasticity underlying our capacity for empathy and compassion (Figure 3A). As usual in plasticity research, one begins with cross-sectional studies which compare experts in a given field to novices. In the case of studying the malleability of the compassionate brain, the experts were long-term meditators that had trained compassion over many years. The results of a study conducted by Antoine Lutz and Richard Davidson revealed that when exposed to distressing sounds, expert meditators reveal increased activations in middle insula as compared to novice meditators. These studies were then followed by longitudinal designs in which meditation-naïve subjects underwent short-term training of affective capacities.

In a series of studies performed in our lab, for example, the brains of meditation-naïve participants were scanned before and after they underwent either empathy or compassion training. During the scanning, participants were watching short film excerpts depicting others' suffering. Throughout the experiment, participants provided self-reports on their feelings in response to each of these film clips. These studies revealed that, in comparison to a memory control group, short-term compassion training of several days was able to increase positive affect and activations in a neural network usually related to positive emotions (spanning medial orbitofrontal cortex and striatum; Figure 3B). This finding underlines the malleability of social emotions as it shows that a short-term compassion training of several days can foster positive feelings and related brain activations, even when persons are exposed to the distress of others.

Interestingly, this compassion-related brain network differed from the above-mentioned networks implicated in empathy for pain (encompassing anterior insula and anterior middle cingulate cortex). In order to formally compare whether plasticity involved in empathy training differs from plasticity involved in compassion training, we conducted another longitudinal study in which participants first engaged in empathy training before receiving compassion training in a second step (Figure 3C). This study revealed that several days of empathy training led to an activation increase in insula and anterior middle cingulate cortex, as well as to an increase in self-reported negative affect. In contrast, subsequent compassion training in the same participants could reverse this effect by decreasing negative affect and increasing positive affect. In line with previous results, compassion training again led to an increase in a non-overlapping brain network, including medial orbitofrontal cortex and ventral striatum (Figure 3C). The comparison of the effects of both training regimes on observed functional brain plasticity thus indicates that empathy and compassion training indeed elicited changes in differential brain networks associated with opposed patterns in experienced affect.

Taken together, these results underline the important distinction between empathy and compassion,

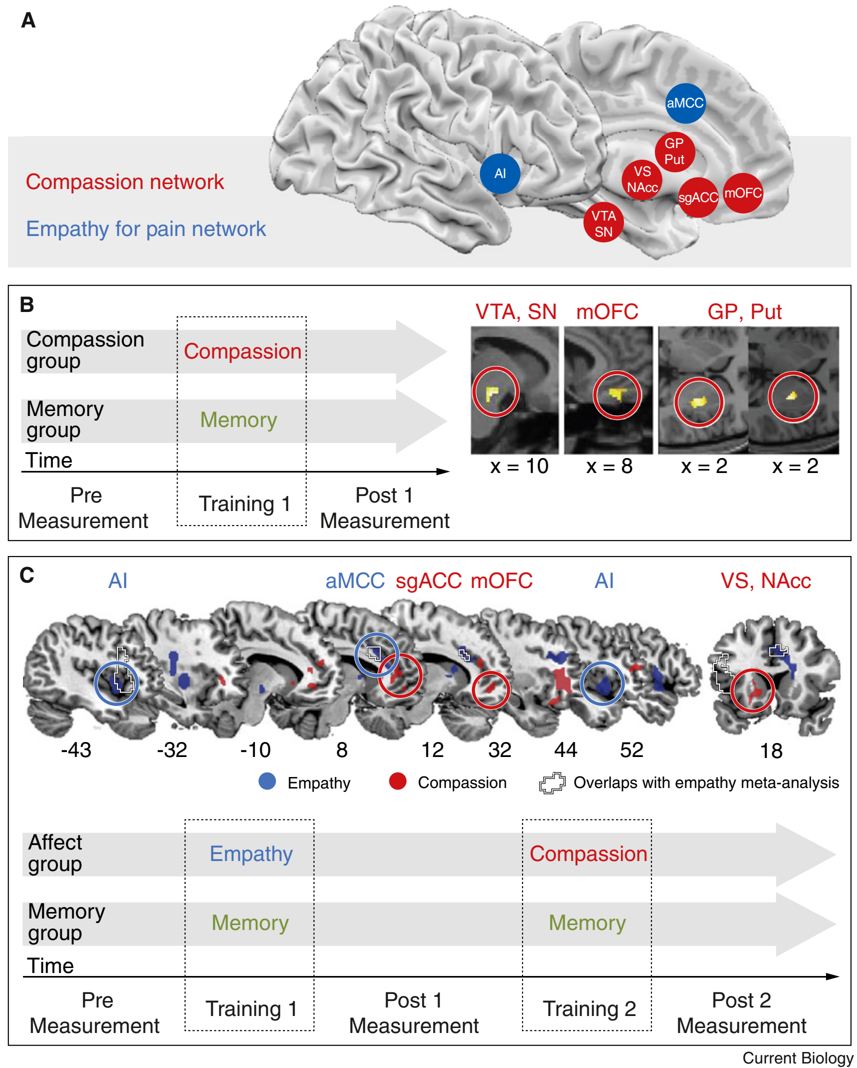

Figure 3. Differential neural networks for empathy and compassion.
(A) Training compassion or empathy leads to differential plasticity in neural networks. (B) Compassion training compared to memory training augments activations in ventral tegmental area/substantia nigra (VTA/SN), medial orbitofrontal cortex (mOFC), and striatum, the latter spanning globus pallidus (GP) and putamen (Put). (C) Empathy training (in blue) leads to increased activations in anterior insula (AI) and anterior middle cingulate cortex (aMCC), while subsequent compassion training (in red) augments activations in medial orbitofrontal cortex (mOFC), subgenual anterior cingulate cortex (sgACC) and the ventral striatum/nucleus accumbens (VS, NAcc). Original brain data in (B) and (C) adapted with permission from Klimecki *et al*. (2013).

both on a psychological and neurological level. Accordingly, exposure to the distress and suffering of others can lead to two different emotional reactions. Empathic distress, on the one hand, results in negative feelings and is associated with withdrawal. When experienced chronically, empathic distress most likely gives rise to negative health outcomes. On the other hand, compassionate responses are based on positive, other-oriented feelings and the activation of prosocial motivation and behavior. Given the potentially detrimental effects of empathic distress, the finding of existing plasticity of adaptive social emotions is encouraging, especially as compassion training not only promotes prosocial behavior, but also augments positive affect and resilience, which in turn fosters better coping with stressful situations. This opens up many opportunities for the targeted development of adaptive social emotions and motivation, which can be particularly beneficial for persons working in helping professions or in stressful environments in general.

Future outlook

Despite these recent advances in the neuroscientific study of social phenomena such as empathy and compassion and their plasticity, many questions remain to be answered. Currently, researchers are investigating the longer-term effects of different types of such socio-affective training techniques, focusing not only on their effect on functional brain plasticity but also on changes in brain structure, health-related variables (stress hormones, immune parameters, neurogenetic markers) as well as ecologically valid everyday behavior and cognition (thoughts, prosocial actions, relationships to others).

Longitudinal follow-up studies will also have to determine how long such beneficial changes can be maintained and how these changes can be sustained. In addition, future research is needed to delineate in more detail the neurobiological mechanisms underlying the differential changes observed after empathy and compassion training. One such question relates to the neurotransmitters that are involved. And finally, future developmental neuroscience research may be able to determine critical periods throughout ontogeny which indicate when it is best to teach these socially relevant skills during development. Such knowledge could help to assure an effective education fostering subjective wellbeing, adaptive emotion-regulation, meaningful relationships and human prosociality.

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Cochlear implants

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Cochlear implants are the first example of a neural prosthesis that can substitute a sensory organ: they bypass the malfunctioning auditory periphery of profoundly-deaf people to electrically stimulate their auditory nerve. The history of cochlear implants dates back to 1957, when Djourno and Eyriès managed, for the first time, to elicit sound sensations in a deaf listener using an electrode implanted in his inner ear. Since then, considerable technological and scientific advances have been made. Worldwide, more than 300,000 deaf people have been fitted with a cochlear implant; it has become a standard clinical procedure for born-deaf children and its success has led over the years to relaxed patient selection criteria; for example, it is now not uncommon to see people with significant residual hearing undergoing implantation. Although the ability to make sense of sounds varies widely among the implanted population, many cochlear implant listeners can use the telephone and follow auditory-only conversations in quiet environments.

The core functions of a cochlear implant are to convert the input sounds into meaningful electrical stimulation patterns, and then to deliver these patterns to the auditory nerve fibers. In this primer, we shall describe how these two steps are performed, show how the original information present in the sounds is degraded as a result of both device and sensory limitations, and discuss current research trends aiming to improve speech perception, particularly in challenging listening conditions.

Normal and impaired hearing

In normal hearing, sound pressure waves travel down the ear canal and cause the eardrum to vibrate. These vibrations are directly transmitted to the entrance of the cochlea by the small bones of the middle ear (Figure 1). The cochlea is responsible for transducing these mechanical vibrations into action potentials that will further propagate towards the brain and eventually elicit a sound