

PAIN AND EMPATHY: FROM PHYSICAL STIMULUS TO SOCIAL EMOTIONS.

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Summary

This article considers some aspects of empathy, commonly known as the ability to share the feelings of others. This sharing is essential for understanding aspects such as pain and suffering. Recent evidence indicates that perceiving the pain of others activates, in the observer, neural networks responsible for nociceptive processing, even without noxious stimulation being applied to the observer's body. It is also discussed here how the social context, gender, and even the administration of analgesics, can modulate the empathic perception of other people's pain and the induction of prosocial behaviors. The implications of these empathic changes in the health care environment and in academic life are also considered.

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Abstract

This article considers some aspects of empathy, commonly known as the ability to share others' feelings. This sharing is essential to understand aspects such as pain and suffering. Recent evidence indicates that when perceiving other people's pain, the neural networks responsible for nociceptive processing are activated in the observer, even without applying noxious stimulation to the observer's body. Here, it is also discussed how social context, gender, and even analgesic administration can modulate the empathic perception of others' pain and the induction of prosocial behaviors. The implications of these empathic changes in the health environment and academic life are also considered.

Key words: empathy, pain, social neuroscience, cognitive modulation of pain.

RECEIVED: 09-03-2023 ACCEPTED: 11-05-2023 PUBLISHED: 15-12-2023

How to quote Tortorici V. et al. (2023). Pain and empathy: From the physical stimulus to the social emotions. *Anales*, 39, 91-104.
<https://doi.org/10.58479/acbf.2023.16>

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General

Have you ever felt the need to express appreciation for someone else's performance? Have you ever had the urge to remedy a situation of someone who is suffering? If this has happened to you, you have experienced admiration and sympathy, two social emotions that are fundamental to promote and maintain interpersonal relationships and moral behavior (Immordino-Yang, Mccoll, Damasio, & Damasio, 2009). These emotions invite us to be virtuous or skillful, and even lead us to express gratitude, recognizing our good fortune for not experiencing, like others, an unpleasant situation.

The social burden of these emotions depends on the circumstances that others experience (Han et al., 2009), for example witnessing a bodily injury, intense enough to cause physical pain in someone other than ourselves, or the suffering of someone we know due to the loss of a family member (Immordino-Yang et al., 2009). Both circumstances are related to the way our body processes pain (physical and emotional, respectively), which would allow us to understand why the same painful situation can generate different emotional charge in different people.

Beyond admiration and compassion, the way we perceive the pain of others leads us to consider the concept of another social emotion, empathy: a complex form of psychological inference in which observation, memory, knowledge and reasoning are combined to understand the thoughts and feelings of others (Jackson, Meltzoff and Decety, 2005). Empathy implies an affective response to others, an emotional sharing, but it also inspires us to elaborate a cognitive comparison, a putting ourselves in the place of others, at least temporarily, without losing the perspective of who we are.

One of the elements to take into account when talking about empathy is the ability to detect the emotional state of the other person, which should be congruent with the feelings he/she is experiencing. The recognition of the other depends on a process of neural coding. Actions are interpreted according to the effect they generate, thus the behavior of another individual is compared with our own representation of that behavior, leading to the establishment of equivalences between self and non-self, and allowing us to understand the way others act (Jackson et al., 2005).

From this point of view, anyone would think that previous experience and memory are indispensable to achieve an effective recognition of that state (Jackson et al., 2005). Something like accessing a brain archive of emotions, which allows us to compare what we have experienced with what we are witnessing at the moment. This may sound logical when considering the

experiences of adult individuals, but as will be seen below, it does not necessarily apply in the case of the very young.

The development of empathy

Some authors consider that empathic capacity begins very early, but it becomes evident “more formally” between the second and third year of postnatal life, when the infant begins to perceive what others experience (Decety and Michalska, 2010), coinciding with the early development of morality and prosocial behavior, which motivate to help and avoid attacking others. As the years go by, the different components that give structure to empathy begin to emerge sequentially (Lamm, Batson and Decety, 2007). Thus, the affective component develops before the cognitive component. It is automatic and is based primarily on imitation and sensory and motor “resonance” with others. A newborn can imitate facial expressions with obvious emotional charge (Jackson et al., 2005) and can also imitate the emotional component (Jackson et al., 2005) may show unmistakable discomfort after hearing another child cry. This, for obvious reasons, does not reflect prior learning, but it is a precursor of the recognition of “self and other”, which will eventually become the predictor of the disposition and intentions of other individuals. This primordial imitation process, which occurs from preverbal stages, is founded in the existence of the called “mirror neurons” (Kilner and Lemon, 2013), located in different regions of the cerebral cortex, whose activity increases when imitating actions during the observation of others’ behaviors. The above involves a gradual coupling between perception, action and emotion.

For its part, the cognitive component of empathy involves understanding the situation that challenges us emotionally, for which more complicated processing mechanisms are needed, allowing us to explicitly construct a representation of other people’s feelings, establish self-regulatory mechanisms to modulate the negative impact created in the viewer and define the limits of our own (Decety & Michalska, 2010; Lamm et al., 2007).

Brain changes involved with empathy

The aspects of control described in the previous paragraph depend on the maturation of the structures involved with the so-called executive functions, such as the prefrontal cerebral cortex, which begins gradually in childhood and is completed in late adolescence. This maturation allows the use of verbalization and inhibitory control to regulate thoughts, attention and action, in order to exercise emotional control.

As the child matures and becomes an adolescent, there is a change in the emotional response, which is based on the control exercised by the prefrontal cortex over more primitive structures, such as the cerebral amygdala, which is part of the reptilian brain that we also call the limbic system (Decety & Michalska, 2010). In other words, throughout life, from very early childhood to adulthood, there are important anatomical and functional changes in the neural structures

involved in empathy. This implies that the brain changes and prepares itself progressively to evaluate the social context and to ensure interactions with others. It is an emotional learning system that migrates from the automatic-instinctive to the rational-controlled. Possibly, the existence of failures in this maturation process may explain socio-cognitive dysfunctions and alterations in moral reasoning in some individuals.

A common ground for grief and empathy

From an evolutionary point of view, having an alarm signal that warns us of something that could injure us is indispensable. That alarm signal is pain and it can affect us both when it is experienced in our own body and when it is perceived in other individuals. Our reaction to the pain of others is a clear demonstration of empathy which, as we have already seen, can occur automatically and can even evoke in us the appearance of avoidance-type motor behaviors (turning our head to avert our gaze, placing our hands in front of us to try to block the visual, frowning, etc.), but it can also inspire in us compassionate approach behaviors to try to help those who are suffering. It is in this way that pain places us empathically in the place of others, thanks to a combination of sensory and perceptual, as well as affective and emotional components (Jackson et al., 2005).

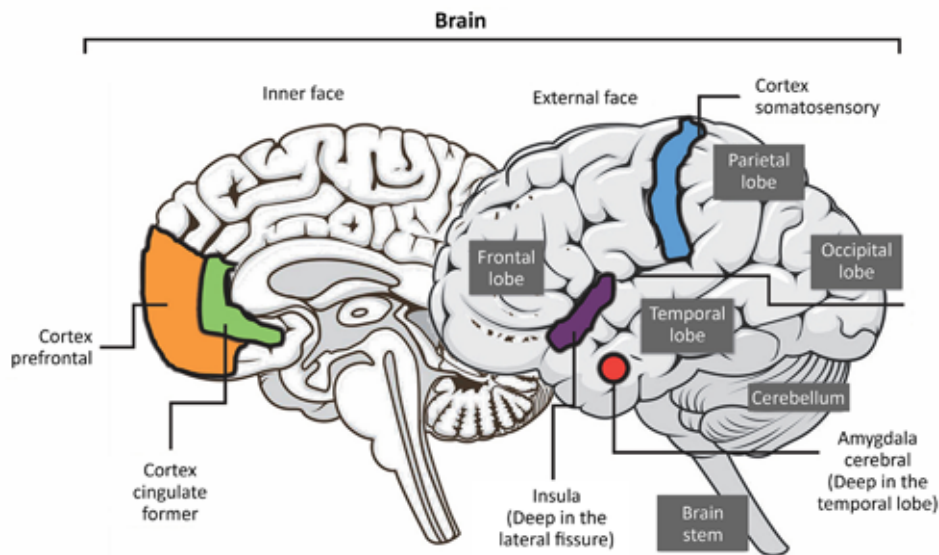
Our brain processes the sensory and the affective differently (Jackson et al., 2005; Lamm, Decety and Singer, 2011). In fact, topographically speaking, the sensory cortex (located in the postcentral or postrolandic gyrus), is fundamentally involved with what our different bodily receptors pick up and with the discriminative; that is, with those characteristics that define the intensity, duration and location of different stimuli, including those that generate pain. What is related to the affective and emotional (for example, what is linked to the unpleasant component of pain) is processed mainly in the anterior cingulate cortex and in the insula. However, the existence of reciprocal neural connections between these structures makes it very difficult to separate the sensory from the affective when talking about pain (Jackson et al., 2005; Lamm et al., 2011).

This anatomical-functional relationship is less clear when considering how we perceive the pain of others. However, some experimental evidence suggests the existence of common neural circuits that are activated both for the processing of our own pain and for the pain of others. For example, the recording of neural activity in the anterior cingulate cortex of patients who would later undergo ablative surgery to remove that area of the brain revealed a significant increase in activity when experiencing their own pain caused by the controlled application of a noxious stimulus and also when witnessing that same stimulus being applied to a stranger, indicating that this region is equally related to the perception of the pain of others (Jackson et al., 2005; Lamm et al., 2011).

The ability to feel pain and to perceive signals indicative of the pain of others (without experiencing one's own pain at the time) has allowed the design of different experimental protocols to study the different aspects of empathy generated by pain and suffering. The experiments typically include images of hands and feet exposed to situations that would be

painful, reflecting a false sensation in the first person (as if they were our own limbs), or images of faces equally exposed to noxious stimuli, reflecting situations in the third person (in which it is clearly the other who is exposed to a painful situation).

Figure 1. Schematic representation of the external and internal face of the brain, showing some of the main structures involved in the achievement of the empathic response (see details in the text).



V. Tortorici. Empathy and pain figure.

In some of these experiments, the electrical activity of facial muscles has been recorded (by electromyography), showing that the visualization of emotionally charged images produced changes in facial expression in the individuals who saw them and simultaneously awakened an empathic emotional charge in these participants (Jackson et al., 2005). Interestingly, in neuroimaging studies conducted in individuals with cortical lesions (located in areas related to facial expression and recognition), no such emotional empathy was generated (Jackson et al., 2005), indicating the existence of complex neural processing networks associated with the achievement of empathy, which also share information with neurons that process pain evoked by bodily injury.

The aforementioned allows inferring that the cortical representation of pain, as well as the corresponding empathy, involves a process of brain localization. Moreover, it has been suggested that for empathy to be generated, the physical pain of the other must activate equivalent areas of the observer's brain. That is, if the noxious stimulus is applied to one of a person's lower limbs, his brain must localize the effect in the part of his sensory cortex responsible for receiving

information from precisely that limb. In the person observing, the situation must also activate the same cortical area, as if he were receiving the same noxious stimulus in his humanity (Voisin, Marcoux, Canizales, Mercier, & Jackson, 2011). All this has important implications. For example, it could lead to neurophysiological changes with serious consequences in patients, caregivers, medical and paramedical personnel, who are overexposed to the pain of others, suggesting that empathy implies much more than a simple affective sharing, and that it is capable of modifying, in observers, the mental representation of their own body schema according to what they detect in others (Preusche and Lamm, 2015).

These experimental designs usually include the simultaneous assessment of different biometric parameters such as pulse, blood pressure and skin electrical response, as well as the determination of the level of cerebral blood flow, which reflects the degree of activity of the different areas involved with pain processing and empathy (Jackson et al., 2005). Pain intensity is usually determined by using the so-called visual analog scale, a type of Likert scale ranging from 0 to 10, where 0 indicates total absence of pain and 10 indicates the greatest degree of pain imaginable. With this type of experimental paradigm, studies of “Empathy and Pain” are being carried out as part of a new line of research of the Neuroscience Laboratory, attached to the Department of Behavioral Sciences of UNIMET.

Pain as a social stimulus

One of the key aspects of the study of empathy generated by pain is related to understanding that the perception of another’s pain represents a “social stimulus” in the other (Han et al., 2009; Jackson et al., 2005), which promotes a different affective state in the observer, from which the empathic perception is derived. What is interesting is that such a social stimulus is capable of producing changes similar to those induced by a physical stimulus, which has the potential to generate tissue damage, and that despite these differences both types of stimuli could activate the same neural processing areas. However, the latter is still in question. Some laboratories have not observed activation of the sensory cortex (which allows characterization of the stimulus) when an individual witnesses the application of noxious stimuli to others. Under these circumstances they have only reported activation of the cingulate cortex (related to the affective/emotional aspect). However, if the stimuli are applied to the observing individual, simultaneous activation of the sensory cortex and the cingulate cortex occurs. These results might seem logical, given that in the first situation, where the individual is an observer at a distance, there is formally no noxious stimulation on his person, but they also lead us to think that the social stimulus somehow informs us of the quality of the other’s pain and that this is something that deserves to be investigated (Hein and Singer, 2008). In other words, the sensation of pain is not restricted to the physical aspect of the noxious stimulus, but also occurs as a consequence of the observation of the emotional state of another person who suffers. Hence we can understand that sometimes social relationships are painful. It could even be considered that social pain would represent the neurocognitive analogue of physical pain (Jackson et al., 2005).

Perhaps the perception of the pain of others requires the consideration of other factors that are not yet being included. Witnessing the pain of others puts our nervous system in a state of alert and this could generate the appearance of fear and distress (Jackson et al., 2005), with which other brain regions could be integrated into the cast of protagonists, as is the case of the cerebral amygdala, which as already mentioned is part of this more primitive system of emotional control. In fact, the amygdala has been considered by many as the emotional center where fear resides (Lamm et al., 2007; 2011). On the other hand, the amygdala has also been implicated among the structures involved in the processing of pain that persists over time (Lamm et al., 2007; 2011); that is, chronic pain, playing a special role in the so-called anticipatory behavior, thanks to which a patient preemptively assumes analgesic positions (that seek to avoid pain), in order to protect the region of the body that is affected. To understand the latter, it would help to imagine, for example, the “analgesic adventure” of a possible patient with a painful shoulder pathology, trying to board a subway car during rush hour.

Types of empathy and their implications

For some authors empathy can be viewed from two different points of view (Mischkowski, 2019). If empathy is derived from the good fortune, pleasant experiences, trust, intimacy and good health of others, it should be considered as positive empathy, producing interpersonal benefits for both the one who generates it and the one who receives it. From the point of view of these authors, negative empathy would be that derived from the pain and suffering of others. What is still not clear is whether the neural fingerprint, i.e., the anatomical-functional basis of these two variants is the same, or whether each depends on different brain regions.

This subdivision has even been considered from a pharmacological point of view. Recent research using the analgesic acetaminophen, also known as paracetamol, one of the most popular analgesics globally, indicated that this drug, in addition to decreasing pain (which is the desired analgesic effect), also reduced personal pleasure and other positive feelings towards others (unwanted effects), indicating that both types of empathy can coexist and that the nervous structures in charge of that type of processing may be common (Mischkowski, 2019). In fact, neuroimaging studies showed that, compared to the placebo group, acetaminophen caused a reduction in the level of activity in the anterior cingulate cortex and insula, both during physical pain and emotional pain. These results indicate the existence of a common neurochemical basis, but also warn of an undesirable side effect of this analgesic, whose worldwide consumption is very high, related to the social impact of indifference to the emotionality and pain of others; or what is the same, to a reduction in prosocial behavior with important interpersonal consequences (Mischkowski, 2019).

Experiences such as this lead us to consider whether from a pharmacological point of view there are “social analgesics”, which in addition to reducing pain can affect feelings of compassion towards others and the desire to share their positive experiences.

Race and empathy to pain

An important aspect to consider has to do with the racial influence on the achievement of empathy to pain (Xu, Zuo, Wang, & Han, 2009). In experiments involving Caucasian and Chinese subjects as part of the sample, in which videos were shown of individuals of both races being subjected to noxious stimulation applied to their faces, it was observed that the empathic response decreased significantly when the participants saw the faces of a race other than their own. This was inferred by the decrease in the level of activity evoked in the anterior cingulate cortex and insula, revealing an empathic bias, which was influenced by racial status and affected both ethnic groups similarly (Xu et al., 2009). These results invite reflection on the importance of empathy in professional performance. For example, let us consider the empathy that a health professional may feel in his or her consultation with a patient of another race and how this empathic bond may influence the diagnosis made. Even beyond ethnic identity, other social conditions, such as cultural or religious differences, could also affect the perception and treatment of other people's pain. This would be a clear expression of a change in the neural response, which would be modulated by the affective bond that develops socially, which could even be sustained by coalitions and/or alliances generated historically between peoples and nations.

Gender and empathy to pain

Some research suggests that women tend to be much more empathetic than men. The above could be the result of a social reflex (Baez et al., 2017), a maxim through which the female sex is expected to be more compassionate towards the others. We may have heard that women are more emotional and sensitive, or that men don't cry. However, neuroimaging studies show that women have larger frontal structures than men, including those involved in generating the empathic response, such as the anterior cingulate cortex, insula and cerebral amygdala. These differences are not only in size. The degree of amygdala activation, due to negative stimuli associated with observing other people under painful conditions, is also greater in women than in men (Tracy and Giummarra, 2017), which is a functional requirement for the achievement of empathy.

The brain regions that are activated when there is an empathic response to the pain of others also play an important role in the regulation of our autonomic nervous system, which is responsible for regulating our visceral responses. For example, the autonomic nervous system is responsible for controlling our heart rate in different situations, such as pain, and therefore this cardiovascular parameter has become an excellent predictor of our empathy for others.

Under the stress of another's pain condition, women tend to show an increase in parasympathetic tone (which slows the heartbeat), while men tend to show a predominance of sympathetic activity (which increases the heartbeat). The latter may be, in part, the explanation for the differences between the two sexes, justifying that while women tend to respond in a more relaxed manner (vagal tone) to stressors such as the pain of others, seeking the empathic maintenance of the social relationship, men react in a more explosive, almost binomial way,

responding to the “face it or run away” principle (Tracy and Giummarra, 2017). These findings constitute a clear demonstration of psychophysiological differences between the two sexes with regard to pain and empathy. However, they also call into question whether a phlegmatic, almost indifferent female gender response to others’ pain can represent a congruent relationship, proempathic in nature. These results should also consider the effect of the sociocultural context (Baez et al., 2017), which generates stereotypes that could lead to hasty conclusions.

The differences between sexes with regard to others’ pain may also be due to the type of instrument used to make the measurements (Preis and Kroener-Herwig, 2012). In fact, women tend to achieve higher scores than men in questionnaires measuring empathy, but they also outperform men in their electroencephalographic parameters during the observation of both neutral and painful situations, which does not contribute to a good discrimination of the empathic condition. On the other hand, the sex of the observer participating in this type of studies also affects the estimation of pain and thus of the induced empathy (Preis and Kroener-Herwig, 2012). For example, women tend to evaluate other people’s pain as significantly higher compared to that detected by men. All these variables, rather than discouraging, positively motivate the search for more and better evaluation parameters that allow reliable conclusions to be drawn.

Final considerations

As can be seen from the above, empathy refers to the ability to understand and share the emotions of others and plays a key role in social relations, as it induces the emergence of altruistic behaviors and feelings towards others. The pain of others has the intrinsic benefit of behavioral reinforcement. Through the observation of the negative consequences of the pain of others we can learn to avoid potentially dangerous situations for our integrity, without having to pay the price of experiencing them in ourselves. In addition, consideration of the pain of others has an important consequence on the behaviors that underpin interpersonal relationships. The latter is of high value in professions where consideration of the suffering of others represents the basis of the care that can be provided. It is enough to consider that physicians, psychologists, or any other health professional, fail to establish the empathic connection with those who come to them for help. It is also interesting to consider, in an academic environment such as ours, the value of the variables empathy and pain (and all their conditioning elements) when establishing relationships of value judgment in the teaching and learning processes, without any type of bias.

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