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Mirroring Fictional Others

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Introduction

In this chapter, we discuss recent neuroscience evidence that suggests mechanisms for how we empathize with other people and with fictional characters. We propose that the same neural mechanisms we use to empathize with real people make us also empathize with fictional characters. Whilst these neural mechanisms enable us to empathize with fictional characters of all kinds, in movies, plays, literature, and so on, we focus, in this chapter, specifically on fictional characters from novels.

The neural mechanisms that we discuss here can be broadly defined as 'mirroring neural mechanisms.' Mirror neurons, as we will later discuss, are cells with motor properties that fire not only when we perform an action, but also when we observe somebody else performing the same action or an action somewhat related to the action we performed (Rizzolatti and Craighero 2004). These cells may enable our capacity to put ourselves into somebody else's shoes.

At the beginning of the last century, Theodor Lipps proposed a concept of empathy, or *Einfuhlung*, according to which we achieve the ability to share and understand the emotions and feelings of others by using some sort of projection of the self into the other. As he noted, 'When I observe a circus performer on a hanging wire, I feel I am inside him' (as cited by Gallese 2001: 43). Lipps proposed that at the basis of our ability to empathize there is a process of *inner imitation*. Mechanisms of neural mirroring have functional properties, as we discuss later, that seem ideally suited to support this process of inner imitation. Interestingly, Lipps adopted the concept of *Einfuhlung*—which can be translated as 'in-feeling' or 'feeling-into'—from Robert Vischer's doctoral thesis 'On the Optical Sense of Form: A Contribution to Aesthetics' (1873). Lipps himself was mainly concerned with conceptions of art and aesthetics.

We focus specifically on fictional characters taken from novels because the feeling of connecting with such fictional characters can be an authentic and enduring experience. In fact, it is not uncommon for readers to remark that they feel they know fictional characters as genuinely as people within their actual lives. We propose that the foundations of this sense of connection lie primarily in our profound capacity for empathy, where the reader comes to experience the thoughts, actions, and perceptions of the fictional characters as if they were experiencing themselves. Because of their functional properties, neural mirroring mechanisms may underlie the ability to connect emotionally with fictional others in the same way that they help us relate to real people in our daily lives. We also discuss here empirical evidence in support of some concepts that are critical to our claim. First of all, the role of mirror neurons in imitation and empathy. Second, the links between mirror neurons and language, a necessary link to empathize with fictional others described in novels. We also take several salient examples of passages from novels to explore the relationship between our current understanding of the properties of neural mirroring mechanisms and the process of connecting with fictional others.

1. Mirroring responses in individual neurons

Neuroscience practices are strongly limited by ethical, financial, and technical considerations. While in rather exceptional cases it is possible to obtain some data on individual neurons in the human brain, almost everything we know on cellular brain mechanisms derive from animal research. Indeed, almost everything we know about individual neurons exhibiting mirroring responses comes from depth electrodes studies in monkeys. The main facts and concepts that emerge from the monkey literature are as follows:

Mirror neurons are specialized for actions: Actions involving three body parts, the hands (di Pellegrino *et al.* 1992; Gallese *et al.* 1996), the mouth (Ferrari *et al.* 2003), and the eyes (Shepherd *et al.* 2009), have documented mirroring responses at the level of individual neurons. Mirror neurons for hand actions, such as grasping, tearing, holding, and manipulating, are the most frequently reported in the literature. Most frequently studied are the grasping mirror neurons, which can be divided in two main categories: mirror neurons for precision grip and mirror neurons for whole hand grasps. Precision grip is the type of grasp that is required to grab small objects with two fingers, for instance a peanut. Whole hand grasp is the type of grasp required to grab a large object like an orange. Mirror neurons for grasping obviously fire when the monkey grasps, but also when the monkey observes somebody else, either a human or another monkey, grasping. Precision grip mirror neurons fire at the sight of a precision grip, regardless the type of object grasped. Whole hand mirror neurons also fire at the sight of a whole hand grasp, regardless the type of object grasped (Rizzolatti and Craighero 2004).

Mirror neurons for mouth actions have been associated with two main kinds of actions: ingestive (for instance, biting a banana) and communicative (for instance, lip-smacking, a gesture of lip protrusion with a positive communicative valence) (Ferrari *et al.* 2003). Mirror neurons for gaze have been recently reported in the literature and it is likely that other kinds of actions involving other body parts are associated with specific mirroring responses.

Mirror neurons are not simply monkey-see-monkey-do cells: While the term 'mirror' suggests a complete equivalence between the performed action and the perceived action, the majority of mirror neurons code the motor aspect of our own actions and the perceptual aspects of the actions of other people in more complex ways. Indeed, there are two major classes of mirror neurons: strictly congruent mirror neurons and broadly congruent mirror neurons. Strictly congruent mirror neurons—which correspond to approximately one-third of recorded mirror neurons—fire at the same action, either performed or perceived (say, precision grip). Broadly congruent mirror neurons—which correspond to approximately two-thirds of recorded mirror neurons—code also perceived actions that are different from the performed action. The perceived actions that trigger a response in broadly congruent mirror neurons are related to the performed action in two main ways: they either achieve the same goal or they belong to a motor sequence, as for instance grasping food and bringing it to the mouth (di Pellegrino *et al.* 1992; Gallese *et al.* 1996; Rizzolatti and Craighero 2004).

Mirror neurons code actions at a fairly abstract level: Mirror neurons do not respond only to seen actions. In fact, around half of mirror neurons that fire while performing or observing an action that produces a sound, also fire at the sound associated with that action (for example, the sound of breaking a peanut), even when the action is not seen (Kohler *et al.* 2002). Other mirror neurons, again approximately 50 per cent of the cells recorded in the relevant experiments, fire even when the action cannot be completely seen (mirror neurons for partially occluded actions) (Umiltà *et al.* 2001). Most importantly, the majority of mirror neurons, approximately three-quarters of recorded neurons in the relevant experiments, seem to code not simply the observed action, but rather the intention associated with it, the goal of the action (Fogassi *et al.* 2005). Taken together, all these properties suggest that mirror neurons code the actions of other people at a fairly abstract level.

Mirror neurons are defined by physiology, not anatomy: In the monkey, mirror neurons for hand and mouth actions have been recorded so far in two cortical areas: area F5 in the ventral premotor cortex and area PF/PFG in the rostral part of the inferior parietal lobule (Rizzolatti and Craighero 2004; Rizzolatti and Fabbri-Destro 2008). These two areas are anatomically connected, suggesting that mirror neurons belong to a specific neural system. Mirror neurons for gaze have been described in area LIP (Shepherd *et al.* 2009), within the intraparietal sulcus, a major sulcus dividing the posterior parietal cortex in superior and inferior parietal lobule. In principle, however, mirror neurons may be located in other cortical areas of the monkey brain. Indeed, detailed investigations of mirroring properties at single neuron level have been performed for years only in area F5. The recordings in area PF/PFG (Fogassi *et al.* 2005) and area LIP (Shepherd *et al.* 2009) of the parietal lobe are relatively recent. The neurophysiological exploration of other cortical areas may also reveal neurons with mirroring properties.

2. Mirroring responses in human neuronal ensembles

The neuroscience techniques used to study the human brain typically measure the activity of neuronal ensembles. Although these techniques present some interpretational limitations, the human studies seem compatible with the monkey data, suggesting the existence of a human mirror neuron system coding actions of the self and of other people, responding to action sounds, and coding the intention associated with observed actions (Iacoboni and Dapretto 2006). The human studies, however, have also linked activity in the mirror neuron system to imitation (Iacoboni *et al.* 1999; Koski *et al.* 2002; Koski *et al.* 2003; Iacoboni 2005) and investigated the relations between mirror neuron system activity and human behaviour. These studies suggest strong ties between the human mirror neuron system and empathy (Carr *et al.* 2003; Kaplan and Iacoboni 2006; Pfeifer *et al.* 2008).

A relatively early study (Carr *et al.* 2003) had suggested that neural mirroring may be relevant to our ability to empathize with other people. This early study tested a simulation-based model of empathy according to which when we see somebody else's facial emotional expression, activity in mirror neuron areas provides an inner imitation of the observed facial expression. Neural signals from mirror neuron areas are subsequently sent to emotional brain centres such as the limbic system, and activity evoked here make us feel what others feel. For instance, when we see somebody else smiling, our mirror neurons for facial expressions fire as if we were smiling ourselves (simulation or inner imitation of smiling) and send signals to the emotional brain centres to evoke the feeling that we typically have when we smile. More recently studies have confirmed this model and have demonstrated correlations between the tendency to empathize and activity in mirror neuron areas during observation and execution of facial emotional expressions (Pfeifer *et al.* 2008), observation of grasping actions (Kaplan and Iacoboni 2006), and even while listening to action sounds (Gazzola *et al.* 2006).

Relevant to our proposal that neural mirroring is critical in empathizing with fictional characters, is the body of research investigating the links between language and the human mirror neuron system. The anatomical location of area F5, where mirror neurons were originally discovered in the monkey, and the functional properties of mirror neurons, both suggested very early on that this neural system might have played a central role in language evolution (Rizzolatti and Arbib 1998). Indeed, an evolutionary hypothesis suggests that area F5 in the monkey is the homologue of Brodmann area 44 in the human brain (Rizzolatti and Arbib 1998). Brodmann area 44 corresponds to the posterior part of Broca's area in the left cerebral hemisphere. Broca's area is an important human brain area for language. Lesions in this area are typically associated with language disorders, and brain imaging studies using language activation tasks invariably activate this brain region.

There is also a functional argument linking mirror neurons to language. Indeed, well before mirror neurons were discovered, some linguists proposed that for communication to occur, there must be a common code between the sender and the receiver of a message (Liberman *et al.* 1967; Liberman and Mattingly 1985; Liberman and Whalen 2000). Mirror neurons, active during both production and perception, seem to provide an excellent neural substrate of such common code. For example, human studies have demonstrated that premotor areas active while we speak are also active while we listen to other people speaking and that the activation of these areas is essential to our *perception* of somebody else's speech (Wilson *et al.* 2004; Wilson and Iacoboni 2006; Meister *et al.* 2007; Iacoboni 2008).

Furthermore, research on how language conveys meaning has suggested that linguistic meaning must be grounded in perceptual and motor experiences associated with bodily activity. The abstract symbols of language cannot relate only to other abstract symbols, but must be mapped to the world, if they are to convey meaning (Glenberg and Kaschak 2002). This embodied semantic framework has generated many experiments providing links between language and action (Hauk *et al.* 2004; Pulvermüller *et al.* 2006; Tettamanti *et al.* 2005). After the discovery of mirror neurons, brain imaging studies investigated the links between neural mirroring and language. For instance, subjects watched actions performed with different body parts, the hands, the mouth, and the feet (Aziz-Zadeh *et al.* 2006). Action observation, as expected produced strong activation in premotor cortex, a finding typically interpreted as reflecting mirror neuron activation. Along the premotor cortex, the body maps—albeit fuzzy—show some level of separation, such that premotor activity associated with mouth movements is more ventral than premotor activity associated with hand actions, and in turn hand-related premotor activity is more ventral than the activity associated with foot movements. Premotor activity during action observation reflects such maps, suggesting that indeed this activity reflects mirroring of actions performed by specific body parts (Aziz-Zadeh *et al.* 2006; Buccino *et al.* 2001). When subjects are asked to read silently sentences that describe actions of the mouth, of the hand, and the foot, they specifically activate the sector of the premotor cortex that contains the map of the corresponding body part (Aziz-Zadeh et al. 2006). This suggests that while we read a sentence describing, say, a grasping action, our neural mechanisms of mirroring simulate (or produce an inner imitation of) the action we are reading about.

The same logic can also be applied to emotions. When we read about a fictional character experiencing a powerful emotion, neural mechanisms of mirroring may re-evoke the neural representation of the facial gestures and bodily postures typically associated with that emotion, and trigger activity in emotional brain centres such that we end up experiencing the emotion associated with those facial gesture and bodily postures.

3. Emotional response when connecting to a fictional character

Here we discuss some specific examples taken from the literature, and suggest that the description of actions and emotions that fictional characters perform and experience make us empathize with them through a simulation-based form of empathy that is enabled by neural mechanisms of mirroring. This feeling of being connected with the fictional others is a vicarious form of empathy that enriches the reading experience and likely underlies the great satisfaction people take from reading fictional literature.

Take for example, the following description from Tolstoy's *War and Peace*, of a gaze interaction between a mother and daughter:

> 'Speak, Mamma, why don't you say anything? Speak!' said she, turning to her mother, who was tenderly gazing at her daughter and in that contemplation seemed to have forgotten all she had wished to say.

Whilst clearly describing an eye gaze interaction, this passage also provides an emotional context towards which the reader can empathize. The 'tender' gaze of the mother towards her daughter depicts something many readers will themselves have experienced in their own lives. We have previously briefly discussed that mirroring mechanisms for gaze have been described in the neuroscience literature (Shepherd *et al.* 2009). Here, the daughter turns and looks at her mother, who is in turn tenderly gazing at her. Thus, it is possible that this scene produces simultaneously two forms of neural mirroring: on the one hand, the mirroring of the tender gazing of the mother; on the other hand, the mirroring of the daughter turning to her mother and looking at her and her 'tender gaze'. By activating eye gaze mirror neurons simultaneously from two different perspectives (the mother and the daughter), the readers have a powerful emotional experience, and deeply empathize with the two characters and feel attuned to the relationship that binds them together.

Primary social tools such as gaze following and eye contact often feature heavily in fictional literature. These kinds of social capacities fall far back in our evolutionary heritage, and provide us with a crucial means to share intentions and thoughts with others. It is therefore unsurprising that we find that descriptions of eye contact and gaze following enable the reader to gain a closer connection with the character in question.

Whilst emotive passages of course stimulate a strong emotional response in readers, passages simply detailing the actions surrounding a character's activities also serve to stimulate the mirroring process required for relating to fictional others. Take for example, the following passage from D. H. Lawrence's *Sons and Lovers* which describes a character in his workplace:

> Now he had the packing up and addressing to do, then he had to weigh the sacks of parcels on the scales. Everywhere voices were calling weights, there was the chink of metal, the rapid snapping of string, the hurrying of old Mr Melling for stamps. And at last the postman

came with his sack. Then everything slacked off, and Paul took his dinner basket, and ran to the station to catch the eight twenty train.

This passage provides a vivid picture of the activities of the workplace. The author achieves this by using numerous action-based descriptions which are likely to elicit mirror neuron activity in the brain. Thus, when we read 'he had to weigh the sacks of parcels on the scales', activity in our premotor cortex most likely simulates that action, as if we were actually weighing the parcels ourselves. An additional reason why a reader may be able to connect with this passage is the author's use of several onomatopoetic phrases, such as 'chink of metal' and 'snapping of string'. As well as being action-based, these kinds of phrases also make a direct link with sounds associated with those actions, and thus should in principle have the capacity to activate auditory mirror neurons in the brain, that we have also previously described briefly. Thus when we read the phrase 'snapping of string', our brain responds as if actual string could be heard snapping. With the same mirror neuron response, we therefore are able to experience this string snapping ourselves.

The discovery of auditory mirror neurons provides a neurobiological mechanism for why the use of sound-based phrases is a frequent tool adopted by authors to bring their readers into closer connection with their fictional characters. Obviously, the writers did not know about mirror neurons, but presumably had the intuition that sound-based sentences were very powerful. The following passage, taken from F Scott Fitzgerald's 'The Age of Jazz', is full of action-related sound descriptions, which presumably induce the activation of auditory mirror neurons in the reader, and help to paint a vivid scene of a character tensely waiting in darkness.

Long after midnight John's body gave a nervous jerk, he sat suddenly upright, staring into the veils of somnolence that draped the room. Through the squares of blue darkness that were his open windows, he had heard a faint far-away sound that died upon a bed of wind before identifying itself on his memory, clouded with uneasy dreams. But the sharp noise that had succeeded it was nearer, was just outside the room—the click of a turned knob, a footstep, a whisper, he could not tell; a hard lump gathered in the pit of his stomach, and his whole body ached in the moment that he strained agonizingly to hear.

When we read 'the click of a turned knob, a footstep, a whisper' we presumably activate the premotor areas controlling the hand (turned knob), the leg (footstep), and those speech areas that are activated during both speech production and perception, as we have discussed earlier.

4. Mirroring fictional others may be modulated by experience

Perhaps one of the most alluring properties of fictional literature is its capacity to meaningfully mirror real life events that the reader themselves has previously experienced. This is perhaps why classic literary plots and characters endure through time, as they manage to touch on deeper themes that flow through many people's lives.

There is growing evidence that experience plays an important role in shaping the human mirror neuron system. When observing someone performing a familiar action, your mirror neuron system automatically simulates these already well-practised actions internally, which then reactivates the emotional systems related to that action. The notion of experience-dependent mirroring has been demonstrated in a recent fMRI study examining the brain activity of experts and novices watching a series of specialized activities. Ballet dancers and capoeira dancers were studied with fMRI while they observed classical ballet and capoeira videos (Calvo-Merino *et al.* 2005). Activity in premotor areas was higher when subjects were looking at the activity they were more familiar with. In a more controlled follow-up study, male and female ballet dancers (who tend to make different kinds of moves during ballet) demonstrated the same patterns of activity (Calvo-Merino *et al.* 2006). Male dancers had higher premotor activity while watching male-specific ballet moves, whereas female dancers had higher premotor activity while watching female-specific ballet moves.

Being rich in descriptions of actions, perceptions, and emotions that a reader will have themselves already experienced, the concept of experience-dependent mirroring can be easily mapped onto our relationship towards fictional others. For example, we can take a smoker's mirror neuron response to experiencing somebody else, real or fictional, smoking a cigarette. Preliminary data from our lab suggest that mirror neuron activity in smokers is stronger when observing somebody smoking, than for a non-smoker. Thus, when a smoker, or even ex-smoker, reads a passage describing somebody smoking, as a result of their previous experience, there may be a stronger mirroring response compared to non smokers.

We will use the following passage from Cormac McCarthy's *All the Pretty Horses* as an example:

> John Grady sat up and took his tobacco from his shirt pocket and began making a cigarette. He wet the cigarette and put it in his mouth and took out his matches and lit the cigarette and blew the match out with the smoke.

This passage is rich in descriptions of the sequence of actions involved in preparing and smoking a hand-rolled cigarette. As the imaging literature on language and mirroring and on experience and mirroring suggests all these sentences should induce premotor activity associated with the representation of those actions, in particular the explicit description of the hand-to mouth action of smoking. By internally imitating the already well-practised action of smoking, smokers (particularly those who hand-roll themselves) are able to directly relate their own experiences to those on the page.

As with this previous example, many people have habits in their daily lives that require a series of well-practised but specialized skills. Owing to our current understanding of experience-dependent activity of mirror neurons, the disparity between readers' prior experience with an activity described in a book is likely to alter the level at which they respond to the passage.

We could take, for example, a horse rider versus a non-horse rider reading another passage from Cormac McCarthy's *All the Pretty Horses*, describing actions associated with saddling a horse.

> He lifted the blanket and placed it on the animal's back and smoothed it and stood stroking the animal and talking to it and then he bent and picked up the saddle and lifted it with the cinches strapped up and the off stirrup hung over the horn and sat it on the horse's back and rocked it into place. He bent and reached under and pulled up the strap and cinched it. The horses ears went back and he talked to it.

Even to a non-horse rider, the copious use of action-based descriptions of saddling a horse potentially elicits a strong simulative response in the mirror neuron system. This is because many actions using the same body part share similar features. However, as well as describing the actions required, the author also highlights the sensitive manner in which the character behaves towards the horse. As anyone experienced with horses knows, the manner in which you behave around horses is as important as the actual actions you perform. This is a sensitivity that can only be gained after acquiring experience interacting with horses. Thus, although the actions described in this passage should trigger a response in the average reader, this passage would be particularly salient to somebody already experienced with the activity of saddling a horse.

5. Romance and physical intimacy: internal mirroring of our deepest drive to connect with a loved one

Romance and intimacy are some of the most enduring themes in fictional literature, and our capacity for empathy can leave readers with a profound sense of connection to the fictional characters involved. The foundations of our literary obsession with romance lie in the fact that, thanks to our capacity to empathize with fictional others, romantic fictional relationships serve to tap into our deeper human drive to connect with loved ones. The small gestures that lovers perform to each other, and that are often described in detail in novels, are the vehicles that make such connection possible. Thus when readers follow the intrinsic and extrinsic perceptions of the fictional lovers, the activation of internal mirroring mechanisms in the brain enables the reader to fully engage and empathize with fictional others.

Take the following example, an excerpt relating an interaction between two characters in the book *War and Peace* by Leo Tolstoy

> Natasha without knowing it was all attention: she did not lose a word, no single quiver in Pierre's voice, no look, no twitch of a muscle in his face, nor a single gesture. She caught the unfinished word in its flight and took it straight into her open heart, divining the secret meaning of all Pierre's mental travail.

. . . Pierre finished his story. Natasha continued to look at him intently with bright, attentive, and animated eyes, as if trying to understand something more which he had perhaps left untold. Pierre in shamefaced and happy confusion glanced occasionally at her, and tried to think what to say next to introduce a fresh subject.

This passage captures a brief but intense moment of connection between two characters. Through his perceptive use of language, Tolstoy enables the reader to able to fully empathize with the subtle communicative interactions between these two fictional characters. The neural mechanism underlying this kind of empathic connection relates to the internal mirroring taking place within the reader. This passage is rich in language that could potentially stimulate mirror neuron activity across multiple modalities within the reader's brain. For example, facial expressions, hand gestures, and speech perception all feature heavily, with the reader being privy to these both from the listener and the speaker's perspective. All three of these processes are demonstrated as being intimately related to mirror neuron activity in the brain. Indeed, as previously discussed, mirror neurons specialized for facial expressions most likely play a crucial role in the process of empathizing with others. By internally imitating the facial expressions of others, mirror neurons enable the reader to activate the neural pathways for the associated emotions and directly 'feel what the character feels'. This mirroring process is what enables us to gain an understanding of the mental states of another individual, whether they are real or fictional. Furthermore, not only is the reader able to connect with each of the characters individually; the explicit descriptions of the facial expressions of both Natasha and Pierre enable the reader to fully engage with the bi-directional flow of mirroring activity that creates the special connection between these characters themselves.

The following is an example of an intense moment captured between lovers and it also gives us the opportunity to discuss an open issue in the neuroscience literature on mirror neurons:

As she stood under the drooping thorn tree, in the darkness by the roadside, he kissed her, and his fingers wandered over her face. In the darkness, where he could not see her, but only feel her, his passion flooded him. He clasped her very close.

This passage is clearly emotionally evocative in its use of phrases such as 'fingers wandered over her face', 'feel her', and 'passion flooded him'. Furthermore, it may also tap into our neural capacity for tactile mirroring. Brain imaging studies have suggested that while we watch somebody else touched, we activate the areas in our brain that are active when we are touched ourselves (what is called the 'somatosensory cortex'; see Keysers *et al.* 2004). However, given that the monkey literature has not yet reported mirroring responses for touch, it is currently unclear whether neural mirroring for touch does exist. Assuming that it does, as the imaging literature suggests, when we read that the man in question is unable to see his lover, so instead feels her using touch and embrace, the mirroring mechanisms at work in the human brain should also evoke in the reader the feeling of being touched. By providing the neural simulation of the actions and perceptions performed on the page, mirroring mechanisms make us able to fully engage with the emotionally intimate moment between the two fictional characters that are interacting in complete darkness.

Even when the language of a novel is seemingly focusing on desires and beliefs, rather than concrete actions, brief descriptions of acts and feelings seem to provide the bridge for a strong emotional connection between the character and the readers. What follows in taken from *The English Patient* by Michael Ondaatje.

> He sweeps his arm across plates and glasses on a restaurant table so she might look up somewhere else in the city hearing this cause of noise. When he is without her. He, who has never felt alone in the miles of longitude desert towns. A man in a desert can hold absence in his cupped hands knowing it is something that feeds him more than water.
>
> . . .
>
> He lies in his room surrounded by the pale maps. He is without Katharine. His hunger wishes to burn down all social rules, all courtesy.
>
> Her life with others no longer interests him. He wants only her stalking beauty, her theatre of expressions. He wants the minute and secret reflection between them, the depth of field minimal, their foreignness intimate like two pages of a closed book.

The gesture of 'sweeping his arm' and the feeling of being alone 'without her' set the tone for what follows, and make the reader attuned with the character wanting the stalking beauty, the intimate foreignness. Not a lot happens here, but we still feel a strong emotional resonance with the character. This seems all prepared by the initial gesture, by sweeping his arm across the restaurant table. The simulation or inner imitation of that sweeping gesture that is provided by neural mirroring mechanisms makes us ready to feel the intense feeling of loneliness and longing of the character.

6. Is mirroring the only way of relating to fictional others?

Readers' empathic responses to fictional others are certainly complex and nuanced. A critical question here is whether the mechanisms of mirroring discussed so far can support all these complex empathic responses. A survey of the philosophical, psychological, and neuroscience literature on mind-reading reveals that in all these fields there is often a dichotomy between mirroring processes (or low-level mind-reading) and mentalizing (or high-level mind-reading) (Goldman 2006). Some have proposed that these processes are fundamentally different and may rely on different neural structures. Mentalizing or high-level mind-reading would be more reflective and less reflexive than mirroring, more controlled and less automatic, and rely on medial frontal cortex structures often implicated in 'theory of mind' sort of tasks (Goldman 2009). In other words, high-level mind-reading would be qualitatively different from mirroring, or low-level mind-reading. While this is possible, parsimony invites us to consider the possibility that both high- and low-level mind-reading may rely on relatively similar mirroring mechanisms. But how can this work?

We propose that mirroring can implement complex and nuanced forms of empathy via three mechanisms: layers of mirroring, varieties of mirroring, and control of mirroring. With layers of mirroring we mean that some mirror neurons may exhibit more complex responses than previously described. Indeed, ~~preliminary~~ data suggest that some mirror neurons respond to execution and observation of the same action with opposite firing rate changes, a neuronal behaviour never reported previously (Mukamel *et al.* ~~2007~~). That is, a cell may increase its baseline firing rate of, say, 5 Hz to, say, 10 Hz, during grasping execution. The same cell, during grasping observation, may decrease its firing rate to 1 Hz or to zero (no spiking activity at all). These opposite mirroring responses (that have been called super mirrors), recorded in humans with depth electrodes implanted for a medical procedure, at the very least seem to provide a simple neuronal mechanism for the control of unwanted imitation and for self/other differentiation. Their existence, however, also suggests that the mirror neuron system may be organized in neuronal layers, with a layer composed of the more ‘classical’ mirror cells and another layer composed of these more complex neurons. Complex interactions between the elements of these two layers can in principle support more complex forms of empathy.

Furthermore, there is also ~~preliminary~~ evidence—from the same depth electrode recordings in human neurological patients—that mirror neurons may be located in many different neural systems (Mukamel *et al.* ~~2008).~~ The functional significance of mirror neurons may vary according to the location of neurons in brain areas. For example, mirror neurons in the insula may support the capacity to understand a specific emotion (disgust) in others, whereas mirror neurons in the classical mirror neuron areas (the parieto-frontal circuit PF/PFG-F5) may help understanding the goal of observed actions and the intentions behind them. Mirror neurons in brain areas important for movement selection and sequences of movements, as in the supplementary motor area (SMA) may mirror those aspects of human behaviour, whereas mirror neurons in memory-related brain areas, such as the medial temporal lobe, may be relevant to memory mechanisms (the sight of two people kissing may evoke the memory of a kiss in the observer).

Finally, while they have not yet been clearly identified, there must be mechanisms of control for mirroring outside the mirror neuron system itself. The main question here is whether this putative mechanism of control is a general purpose cognitive control mechanism or is specifically dedicated to the control of mirroring responses. Given that mirror neurons are specialized cells for actions, it is tempting to speculate that they require also specialized mechanisms of control. Large lesions in the prefrontal cortex are associated with imitative behavior (Lhermitte *et al.* 1986; De Renzi *et al.* 1996), suggesting that the lesion may have disrupted a mechanism of control specific to imitation.

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Taken together, the three mechanisms briefly discussed above (layers of mirroring, varieties of mirroring, and control of mirroring) can conceivably implement more complex and nuanced forms of empathy. While it is entirely possible that higher forms of empathy for fictional others may be implemented via non-mirroring mechanisms, we believe it is more parsimonious to propose a model that relies entirely on some forms of mirroring and their control. For instance, in some cases authors seem to encourage the reader not to empathize with specific characters. We propose that the reader first feels what the unsympathetic character feels, and then suppresses the mirroring either via control mechanisms or via 'super mirror neurons' (or 'anti-mirror neurons').

For instance, in this example from *War and Peace*, Pierre in interacting with a rather unsympathetic character:

> 'I'll kill you!' he shouted, and with a strength as yet unknown to him, he seized the marble slab from a table, took a step towards her, and swung. Hélène's face became frightful; she shrieked and sprang away from him. His father's blood told in him. Pierre felt the enthusiasm and enchantment of rage.

With the clear descriptions of facial expressions in this passage we are quite able to feel what this 'unsympathetic' character is feeling: 'Hélène's face became frightful; she shrieked and sprang away from him.'

It seems that even in order to be unsympathetic towards a fictional character, the reader must first mirror how the character feels and then most likely modulate this mirroring in order to feel unsympathetic towards the character.

7. Intensity of mirroring: the written page vs. the screen

An interesting issue relates to the degree or intensity of mirroring evoked by the written page compared to the sight and the sounds of actions of other people. As we have discussed above, written sentences describing actions activate premotor areas most likely containing mirror neurons. However, both spatial extent and magnitude of activation differed slightly when compared to activation of the same areas in response to videos (Aziz-Zadeh *et al.* 2006). One of the problems in making these comparisons is that while we watch somebody grasping a cup of coffee, we perceive a specific hand, a specific cup, and a specific grasping action. In contrast, when we read the sentence 'He grasped the cup of coffee', we are given a much more abstract description of somebody grasping a cup. Indeed, while there is a large overlap in premotor activation for both videos showing actions and sentences describing actions, the activation associated with the latter tends to shift slightly anteriorly and is slightly reduced in magnitude. This may be due to the fact that when reading the sentence describing a grasping action, we may simulate only some aspects of the grasping action without simulating the action in all its details.

Does this mean that novels will always be second best in evoking the mirroring of fictional others, for instance when compared to movies? Not necessarily. Indeed, the dimension of time should be taken into account. Whilst the intensity of evoked mirroring may be very high during the roughly two-hour period of a typical movie, readers take much longer to read a novel across multiple time periods. Whenever they resume reading, they most likely evoke the memories of what they have read previously. The longer temporal unfolding of reading a novel may completely offset the reduced intensity of mirroring produced by the more abstract nature of language. Thus, while less intense than in movies, the mirroring induced by reading novels is more extended in time, and may even result in a stronger 'neural signature' of this form of mirroring.

8. Conclusions

We have argued here that the recent discovery of mirroring neural mechanisms in the primate brain suggests a unitary framework for empathizing with both real people and fictional others. The automatic, pre-reflective form of empathy that mirror neurons enable is most likely at work also when we are engaged in one of the most typically reflective behaviours, reading a novel. While there is no direct data in support of our claim (and most likely there won't be direct data in the near future, given the constraints of neuroscience investigations and the complexity of real life behaviours such as reading a novel), the well-controlled data obtained in the lab make our claim quite plausible.

Neural mechanisms of mirroring map extremely well with philosophical claims that were proposed almost a century before neuroscience discoveries. While the level of description of the inner workings of the brain provided by neuroscience studies cannot yet be fully translated into psychological mechanisms at work during the appreciation of art, the concept of *Einfuhlung* proposed by Theodore Lipps seems highly compatible with the functional mechanisms that mirror neurons most likely support.[1]

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