Mirror Neurons and Consciousness: A Meta-synthesis

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Neuroscience has documented the activity of mirror neurons to explain action understanding and imitation, evolution of language, experience of emotions, and mind reading abilities. The present study is a meta-synthesis of available literature on the mirror neuron system in an attempt to understand the process of consciousness through underlying functional mechanisms such as embodied simulation, intersubjectivity and intentional attunement. Relevant research studies and theoretical papers were identified, and important concepts were extracted to derive overarching themes that summarized the examined literature on the mirror neuron system.

Keywords: mirror neuron system, neuroscience, consciousness, meta-synthesis

Introduction

Mirror neurons refer to a group of neurons that fire in an individual as an indication of an action having been performed. Also, a part of these neurons fire when the individual observes another person perform the same action, thus helping the observer in understanding and recognising the action being performed. Neuroscientist Giacomo Rizzolatti pioneered the research on mirror neurons and suggested that mirror neurons could be the key to understanding why we empathise with other people or 'read' their minds (Rizzolatti et al., 1996).

Activation of mirror neurons requires the presence of a biological agent performing the given action. In order to be activated, mirror neurons require both a targeted object and an action being performed. However, they do display a high degree of generalization. The same neurons are fired upon presentation of various different kinds of visual stimuli like a human or a monkey biological effector, given that these stimuli represent the same behaviour such as eating, pulling, pushing etc. Thus, the properties of a given object do not affect the activation of these neurons, i.e. the presentation of a banana instead of a bottle does not increase or decrease the intensity of activation experienced by these neurons. Further, the activation of the mirror neuron system is not contingent upon the response received as a result of the action that has been performed. Thus, mirror neurons get activated in a similar manner across various situations, regardless of whether the action gets positively or negatively reinforced, is punished or simply goes unnoticed.

Numerous research studies have been undertaken to provide evidence for the existence of mirror neurons in human beings. Direct evidence in regard to the existence of mirror neuron systems in human beings has been accumulated using transcranial magnetic stimulation (TMS). A number of studies (Buccino et. al., 2004; Rizzolatti et. al., 2001) have shown that the occipital, temporal, parietal and visual areas and two cortical regions, namely the rostral part of the inferior parietal lobule and the lower part of the precentral gyrus plus the posterior part of the inferior frontal gyrus (IFG) are the core areas involved in the functioning of the mirror neuron system in human beings (Rizzolatti & Craighero, 2004).

There has been a tremendous amount of research to understand the properties of the mirror neuron system in human beings. One of the first functions of the mirror neuron system, as suspected by researchers is *action observation*. Direct evidence about the same has been obtained through an experiment by Mukamel et. al. (2010). According to Mukamel's findings, there exist neuronal mechanisms in human beings that are actively involved in the integration and differentiation of execution and observation of actions. Secondly, mirror neurons in human beings assist in *action-imitation*, an ability that is unique to human beings. They learn from imitating the behaviour of others in their society (Rizzolatti et. al, 2001). Upon observing motor behaviour that is represented in an observer's own repertoire, the individual gets primed to repeat the behaviour. The stronger the motor repertoire, the stronger is the priming that occurs (Prinz, 2002). Thirdly, the sudden evolution of a sophisticated system of communication that developed within the human system is created to the evolution of the mirror neuron system which enabled imitation learning and therefore the ability to imitate communicative gestures and sounds (Gallese,

2007). And lastly, the mirror neuron system of human beings is also suspected to play an important role in the higher cognitive functions of understanding emotions and sensations (Mullen, 2011). Research evidence supporting this claim has been provided in the form of indirect studies of the mirror neuron mechanism by Wicker et. al. (2003).

The information stated above summarizes neuro-scientific experimental research on mirror neurons that provide evidence for the role of mirror neurons in action-observation, action-imitation, development of language and communication, and understanding of emotions. This is corroborated by the embodied simulation theory proposed by Gallese (2001, 2007, 2009, 2012), which states that a process of intentional attunement occurs on observing others due to which, in addition to the activation of our sensory apparatus enabling us to see these actions, there occurs the activation of internal representations of bodily states that accompany these observed actions. This allows the observer to personally experience the phenomenon being observed i.e. the observed behaviour gets mapped in an isomorphic format enabling social identification between members of the society (Gallese, 2009). Gallese (2009) believes that the neural substrate experienced by someone while experiencing an action, emotion or performing an intentional act is similar to the neural substrate that gets activated while observing these experiences in someone else.

The ability of an individual for embodied simulation creates opportunity for the creation of a 'shared manifold' i.e. a meaningful shared inter-personal space (Gallese, 2012). Thus, not only do we embody their emotions, actions and intentions through our own neural mechanisms, but also form a meaningful relationship between the 'I' and 'YOU' by accompanying the neural correlates with actual bodily states that would accompany such actions, intentions or emotions were they occurring within us (Gallese, 2012). Gallese adds that the intentional relation between the acting objects and the observing subject is relatively neutral to the identity of the subject i.e. as seen through various experiments performed on the mirror neuron system in human beings, there occurs an activation of the mirroring mechanism of human beings upon observing the actions of other human adults and babies as well as actions performed by monkeys. Thus, no matter who the other agent is, it gets recognized as another 'functioning self' like oneself.

The main objective of the current research is to conduct a meta-synthesis study on research done in the area of mirror neurons and consciousness from the year 1990 to 2015, and to draw out overarching themes that underlie contemporary research on mirror neurons.

Method

A systematic review of literature on Mirror neuron system in human beings and macaque monkeys was undertaken by examining research studies and other publications available on the web using search engines such as Google Scholar, Scopus, and online research journal publications such as Sage Publications and Wiley India. After the completion of the initial literature review, a meta-synthesis of the research on the mirror neuron system in human beings was conducted.

Meta-synthesis was seen as an appropriate method to be used for the current study. It allows the researcher to not only review the qualitative research, but also to extrapolate beyond the written content and analyse the deep-rooted meaning behind the given information in order to attain a better understanding of the same.

Sampling

Since meta-synthesis is a process of synthesizing a number of studies, relevant research on the mirror neuron system with a special emphasis on its function in consciousness was identified, using a narrow, specific search on the search engine SCOPUS with two key words, "Mirror neuron system" and "consciousness". The result displayed 19 research studies/articles. Several criteria were identified for the selection of the articles to be analysed in the meta-synthesis study:

- The article should, directly or indirectly, deal with the question of mirror neuron system in human beings.
- It should focus upon the implications of the presence of mirror neurons on various conscious and unconscious processes in human beings.
- The studies included in the synthesis had to be published in English from the year 1990 to the year 2015 in renowned journals.
- Studies that were mainly theoretical reviews were included in the literature review.

The selection of the final seven studies occurred through the following steps:

- Out of the 19 studies, only 2 research studies were found to fit into the inclusion criteria.
- Snowballing technique, using references of the primary studies were examined to find more studies that would be appropriate for synthesis and that fit the inclusion criteria. 3 more relevant studies were discovered using this method.
- Another search, using the same key words was conducted on JSTOR, Taylor & Francis, and Wiley India.
- Few new articles were found, out of which 2 articles were seen as relevant for the analysis.
- Thus 7 studies were finally identified for the meta-synthesis study, and their titles along with the year of publishing and authors were listed (Refer Table 1)

Table 1: Articles reviewed for meta-synthesis of mirror neurons

Author and year of publication	Title
Ramachandran & Brang, 2009	Sensations evoked in patients with amputation from watching an individual whose corresponding limb is being touched
Gallese, Eagle & Migone, 2007	Intentional Attunement: Mirror neurons and the neural underpinnings of interpersonal relations.
Shapiro, 2009	Making sense of mirror neurons
Gallese, 2007	Before and below, 'theory of mind': embodied simulation and the neural correlates of social cognition
Runehov, 2012	Imago dei and Simulatio or Imitation dei: A philosophical essay on empathy
Gallese, 2001	The 'shared manifold' hypothesis: From mirror neurons to empathy
Gallese, & Goldman, 1998	Mirror neurons and the simulation theory of mind-reading

Analysis

Theme Extraction and translation: Upon completion of the selection of the studies to be included in the review, the process of theme extraction was carried out. The subthemes extracted out of the various individual studies were then translated into each other. This step contributes towards the formation of a synergistic understanding of a given concept. At the end of this stage, various overarching themes that summarized complementary as well as contrasting ideas and concepts emerging out of the synthesized studies were obtained. These themes are presented in Table 2 and are further analysed in the discussion.

Results

Table 2: Translated themes that emerged out of the meta-synthesis study

New, over-arching, synthesised theme	Original sub-themes (along with author and year of publication)

Mirror neurons promote learning through action imitation and assist in action understanding.	▪ Action imitation is a major function of mirror neurons (Gallese, Eagle & Migone, 2005) ▪ Sensing and imitating action are functions of mirror neurons (Shapiro, 2007) ▪ Action imitation via embodied simulation can occur (Gallese, 2007) ▪ Action observation implies action simulation (Gallese, 2001) ▪ Mirror neurons promote learning through action imitation (Gallese, & Goldman, 1998)
Mirror neurons establish implicit links consisting of shared neural states between two individuals.	▪ Only epistemic barriers exist between individuals (Ramachandran & Brang, 2009) ▪ Shared neural circuits exist between individuals (Gallese, Eagle, & Migone, 2007) ▪ Same neural mechanisms underlie self and other's actions, sensations and emotions (Runehov, 2012) ▪ Direct implicit link between actor and observer can be established (Gallese, 2001) ▪ Observer getting into the mental shoes of another (Gallese & Goldman, 1998)
Mirror neurons are innate in their presence and functioning.	▪ Default intention-ascription occurs due to mirror neurons (Gallese, 2007) ▪ Mirror neurons mechanisms are innate (Runehov, 2012)
Mirror neurons display flexibility of function.	▪ Tactile receptors provide input to mirror neurons (Ramachandran, & Brang, 2009) ▪ Mirror neurons assist in tactile simulation (Gallese, Eagle, & Migone, 2007) ▪ Mirror neurons display flexibility in their function (Shapiro, 2009) ▪ Communicative mirror neurons exist (Gallese, 2007) ▪ Mirror neurons are flexible in the functions they perform (Gallese, & Goldman, 1998)
Mirror neurons lead to occurrence of shared body states between individuals.	▪ Dynamic reciprocal equilibrium exists between individuals (Ramachandran & Brang, 2009) ▪ Shared body states between actor and observer (Gallese, Eagle, & Migone, 2007) ▪ There exists a multiplicity of states shared with others around us (Gallese, 2001) ▪ Mirror Neurons assist in simulating other's mental states (Gallese & Goldman, 1998)
Mind reading capabilities of human beings are assisted by mirror neurons.	▪ Human beings are mind readers (Runehov, 2012) ▪ Mind reading as a result of a long evolutionary process (Gallese, 2001) ▪ Capacities for mind reading are affected by mirror neuron systems (Gallese, 2007)

Residual sub-themes	▪ Mirror neuron system leakage occurs in some instances (Ramachandran & Brang, 2009) ▪ Experiential line between actor and observer can be established (Gallese, Eagle, & Migone, 2007) ▪ Mirror neurons are bi-modal in nature (Shapiro, 2009) ▪ Dishabituation occurs in mirror neurons (Shapiro, 2009) ▪ Social cognition has traceable neural correlation (Gallese, 2007) ▪ Automatic mirroring and synchronicity increasing with longer duration and close proximity (Runehov, 2012)

Discussion

The present research has been undertaken to understand the mirror neuron system in human beings with an emphasis on its role in embodied consciousness. A meta-synthesis study on the mirror neuron system was undertaken and the major themes drawn out of this. Sub-themes extracted from the reviewed research studies/theoretical papers were translated and the major themes that emerged from the meta-synthesis study were identified. The major themes extracted upon a final translation are now discussed.

Mirror neurons promote learning through action imitation and assist in action understanding

Action imitation refers to the ability of an individual to copy an action of another individual. The role of the human mirror neuron system in action imitation and learning can be seen in an article by Gallese, Eagle, & Migone (2007). According to the authors, the mirror neuron system in human beings is involved in the imitation of not only simple finger movements but also in the imitation of complex motor acts. Their role in human beings in the realm of action imitation also extends to the function of intention ascription. Upon observing a given behaviour, the premotor areas that have been usually thought of as being simply involved in understanding a given action also work towards understanding the 'why' aspect of the behaviour. Also, in many instances, this ascription of intention and action understanding is innate and occurs without explicit instructions to the observer. According to Shapiro (2009), the discovery of mirror neurons can be viewed as the discovery of a new sense. These assist humans in sensing goal directed behaviour and action and thus enable human beings in eliciting appropriate behaviour in response to the observed behaviour.

In his paper on the shared manifold hypothesis, Gallese (2001) puts forward the view that mirror neurons assist in action observation via action simulation. He writes that observing a given action/goal related behaviour not only leads to the activation of the visual centers of the brain but also lead to the activation of the motor cortex which leads to the occurrence of a virtual reality simulation of the observed action, thus explaining how the activation of the mirror neuron system leads to action observation and in a way, action understanding due to action simulation.

Thus, from a detailed review of the studies on mirror neuron system, it can be said that the mirror neuron system plays an important function in understanding actions performed by others, imitation of these actions as well as intention ascription. Through all these processes, the mirror neuron system assists in learning certain behaviours and actions

Mirror neurons establish implicit links consisting of shared neural circuits between two individuals

Another major theme that arises from the meta-synthesis is related to the presence of shared neural states between two individuals, namely, the observer and the observed, due to the presence and activation of the mirror neuron system in human beings. Shared neural states refer to the tendency of human beings to employ common neural representations for themselves as well others (Lombardo, et al., 2010).

Gallese, Eagle, & Migone (2007) inherently accept the view that shared neural circuits exist in human beings, and their studies conducted using TMS and fMRI technology provide evidence that these shared neural circuits modulate in the degree and nature of their activation based on the kind of task and situation in which they function. Thus, in cases where the subject is made to observe painful stimuli being

provided to a body part of a stranger, the sensory stimulus gets mapped on their own somatosensory system. However, in cases where the participants were requested to imagine painful stimulation of a body part of their spouses who were not present in their visual vicinity, only the areas related to mapping the affective quality of the pain got activated. Thus, the study provides evidence that shared neural circuits exist in human beings. However, their activation depends upon the quality and nature of stimuli presented to the observer.

Runehov (2012) discusses the role of mirror neurons in divine empathy, the human belief and relationship with God. She examines the role and presence of shared sensations, emotions, and actions that are involved in the processing of the actions, emotions, and sensations of the self as well as the other. She goes on to argue about the functionality of these circuits in higher level of empathy and lower level of empathy, and concludes upon the possibility of the centrality of the open mirror neuron circuits in higher level empathy. Gallese (2001) suggests that a direct implicit link is established between an actor and an observer during the process of being observed, in order for them to embody a given shared goal.

Ramachandran & Brang (2009), in their case study with individuals who have undergone the amputation of any limb of their body, propose the existence of epistemic barriers between individuals. In their study, the subjects reported the occurrence of a touch referral in their amputated limb upon observing touch on the corresponding limb of the experimenter. According to the authors, upon the amputation of the given limb, there is a removal of the tactile receptors that enable the differentiation in touch performed on the self or the other, and upon the elimination of this epistemic barrier, the demarcation between the self and the other disappears i.e. individuals are linked to each other at a mental/neural level.

Thus, from the above discussion, it can be seen that the function of mirror neurons in establishing shared neural circuits between two individuals is one of the central functions of mirror neurons. Also, there is a possibility that the only barrier that creates the illusion of one individual being separate from the other is epistemic, and upon the removal of this physical barrier of the skin that we recognise our identity as being shared with everyone else around us.

Mirror neurons are innate in their presence and functioning

Researchers suggest that mirror neurons are present in human beings since birth and a part of their functioning is automatic. In their article on intentional attunement, Gallese & Goldman (1998) talk about the automaticity of intention ascription. They provide evidence that the premotor mirror areas get activated to help determine the cause of an action regardless of whether the participant was asked to determine the intention of the observed action or not. It occurred implicitly, without conscious involvement on the part of the observer.

Runehov (2012) discusses how the development of mirror neurons in human beings could be a result of the formation of a high number of experiences, i.e., a sufficient amount of learning has taken place to enable the neurons to ascribe intentions and recognise emotions upon observing them in the environment. However, as she states in the paper, since the consensus for the same is far from majority, this function of mirror neurons in human beings still needs to be explored and researched upon more in order to be considered a central function or role of the mirror neuron system in human beings.

Mirror neurons display flexibility of function

Mirror neuron system in the human brain is far more flexible more in its functioning and excitability as compared to the mirror neuron system in monkeys. It is involved in action understanding, intention ascription as well as in aiding the understanding of social cues and emotions (Blakeslee, 2006).

The high level of flexibility of mirror neurons has been discussed as a major property of mirror neurons. Ramachandran and Brang (2009) discuss the ability of mirror neurons to fire in cases of motor actions being observed as well as being activated upon receiving tactile stimuli. By following the case study format and observing the ability of the subjects to experience touch and cold referrals, it was observed that the mirror neuron system, does, in fact consist of tactile receptors.

Shapiro (2009), in his article about the possibility of mirror neurons being a kind of sixth sense, talks about the ability of these neurons to be activated upon observing stimuli with varying physical properties e.g. a monkey hand or a human hand, varying sizes of these hands, variations in appearances and proximities or kind of gestures made, in order to explain the flexibility of mirror neurons. He also talks about the presence of various kinds of mirror neurons; some that fire upon observing grasping behaviour while others that fire on observing communicative or mouth gestures.

From this discussion, it can be concluded that mirror neurons in human beings display a relatively high range of flexibility in their functioning. They consist of different kinds of receptors such as tactile receptors, communicative receptors, receptors that get activated upon observing motor acts etc. Also, these receptors are flexible in the physical properties of the stimuli that activate them i.e. the proximity, the size, the appearance of the stimuli do not affect their activation.

Mirror neurons lead to occurrence of shared body states between individuals

Mirror neurons lead to the development of shared body states between two individuals. Shared body states, in this context, refer to the occurrence of same or similar bodily processes between two individuals which assists in understanding the actor's behaviour by the observer.

In their case study with amputees, Ramachandran & Brang (2009) talk about the interconnectivity of the shared neural circuits of the human brains, the dynamic nature of the equilibrium that has been established between these neural circuits, and the occurrence of an interaction between these even at the earliest stages of sensory inputs. They draw this conclusion after observing the fact that upon amputation of their limbs, the participants were capable of experiencing touch referrals in their own phantom limbs when the corresponding, intact limb of the experimenter was stroked. Thus, there occurs a reorganisation/disturbance in the sensory apparatus of the amputated limb of the subject which skews the dynamic equilibrium that would otherwise have existed between the neural structures of this limb with the corresponding, still attached limb of another individual. This provides evidence that in fact, there do exist dynamic states of equilibrium between different individuals and these states undergo a state of disequilibrium upon interruption of the normal sensory circuits of the body.

Gallese, Eagle, & Migone (2007) proposed that shared body states exist between two individuals when they experience similar emotions or phenomena. It is due to the presence of these shared body states that the observer is able to understand and empathise with the actor. They deny the argument that an individual's ability to empathise with another person arises out of their ability to formulate an analogy between the actor's situation and their situation and thus understand the observee's situation. They mention the experience of these body states as being the reason behind humans' ability to exhibit experiential understanding.

Gallese and Goldman (1998) mentioned the ability of mirror neurons in assisting and thereby enabling the experience of shared mental states in two or more individuals. Thus, it can be said that mirror neurons not only cause a virtual reality simulation in the observer but also leads to the occurrence of an actual qualitatively similar state in the observer as is present in the individual being observed.

Gallese (2001), in his article about the 'shared manifold hypothesis', states that it is due to the presence of the shared manifold that we can share the mental states of other individuals. This shared manifold is the reason that we view other human beings as similar to us and it enables mind-reading and shared body states. He states that these shared states can exist in human beings at three main levels - the phenomenological, where we empathise with individuals due to shared experiences and action states; the functional, where we experience mental states of others in the form of virtual reality stimulation as if we were experiencing these; and the subjective where the mirror matching circuits are highly coupled with mirror matching states within our own body (Gallese, 2007).

From the above stated discussion, it can be safely stated that the existence of shared body states in human beings might be a legitimate result of the existence and functioning of the mirror neuron system in human beings. These shared body states exist as they enable us in identifying other human beings as similar to us and help in empathising with them by experiencing the same inner emotional states as them within our own bodies.

Mind reading capabilities of human beings is assisted by mirror neurons

Mind reading, in the context of mirror neurons refers to the ability of human beings to place themselves in the mental-shoes of others such that we are able to understand another's mind by using our mind as a model for theirs (Than, 2005).

Runehov (2012) believes in the ability of human beings to utilise their own brains as models for an actor's brain in order to understand, and predict the actor's behaviour. She talks about two kinds of mind-reading that exists in human beings. One is first person mind reading which is also prone to mind writing, forming beliefs about one's own mental states. This kind of mind reading is prone to manipulation and faking by the self. The second kind of mind reading,

according to Runehov, is third person mind reading, the Machiavellian mind-reading, which refers to the tendency of human beings to try to understand other's mind by modelling their own minds after others in order to outsmart others or gain an advantage over them. This kind of mind reading is not prone to mind-writing as it is not open to first person interpretations.

In his article about 'The Shared Manifold Hypothesis', Gallese (2001) talks about the evolutionary processes that lead to the development of the capacity for mind reading in human beings. He also talks about development of intersubjectivity and mind-reading as a form of communication in human beings arising as a result of the development of the Shared Manifold Hypothesis (Gallese, 2001).

It can be seen from the above discussion that though it is a controversial topic and requires further research to enable complete understanding of the phenomenon of mind-reading, it can be seen as a legitimate role played by the mirror neuron system in human beings.

Residual Category

Various sub-themes extracted out of the reviewed articles did not fit into the synthesised themes that were formulated after the translation of these sub-themes in order to understand the complete picture. These sub-themes have been discussed here.

The first, sub theme that emerged out of the review of the case study by Ramachandran & Brang (2009) talks about the *Mirror neuron system leakage*. The authors discuss the incidents when a participant, who had not undergone amputation of any part of their body experience a tingling sensation at the times when they observed the experimenter's limb being stroke. They posit that this occurs due to the hyper connectivity of the mirror neuron system which leads to the leakage of neural signals and leads to the dysfunction of the mechanism that is responsible for blocking of this sensation.

The second, sub-theme related to this mentions the *establishment of a direct experiential line between two individuals*. This sub-theme emerged out of the review of the article by Gallese, Migone, & Eagle (2007). The authors suggest that even though individuals employ explicit hermeneutic strategies consciously in order to make sense of others around them and their behaviour, at the unconscious level, there gets established a link between the actor and observer enabling the observer to embody the actor's mental states and understand their actions, emotions, etc.

Shapiro (2009), in his article titled 'Making Sense of Mirror Neurons', mentions various *properties of mirror neurons* which did not appear in any of the other reviewed articles. These included the ability of mirror neurons towards dis-habituation. By dis-habituation, the author refers to the fact that a particular set of mirror neurons fire only upon observing a particular function towards which they are programmed. Even after repeated gestures performing the given act, if in one trial the gesture is half performed, these dis-habituate and do not fire.

The third, sub-theme that emerged out of the analysis of the study titled 'Before and Below the Theory of Mind', Gallese (2007), mentions the *neural correlates of social cognition*. The author believes that social cognition and many of its aspects can be traced back to a neural level in order to better understand and examine these.

The fourth sub theme was in the article by Runehov (2012) where she talks about the increase in similarity in the characteristics, mannerisms and synchronicity of individuals who live together or spend a large amount of time together for an elongated period.

It can be seen from the above discussion that mirror neurons are not only involved in action imitation, forming shared neural circuits, establishing shared body states with others, and in mind-reading. They could also be responsible for establishing an experiential line between the actor and observer, exhibit leakage and bi-modality, have neural correlates in social cognition and display dishabituation. The tendency of mirror neurons towards forming shared neural correlates and the existence of shared body states enables individuals to form models of the other person within themselves. It can be said that this system enables human beings in transcending the barrier between themselves and another individual, thus helping them identify themselves as being 'one' with the other person. However, evidence for their role in these is limited and requires further research.

Limitations and recommendations for future research

Although careful systematic research was undertaken to complete the present study, it has a few limitations. Since the researcher lacks a high level of expertise in the field of neuroscience, the conclusions drawn from the study are merely tentative and need to be explored further. Since the study had to be completed within a given time-frame, only a limited number of articles were reviewed. Another major

limitation of the study was the lack of resources to access all the available literature. This might have, without the conscious knowledge of the researcher limited the scope of the study. However, due to the extensive amount of literature that had already been read up on the topic before the selection of a research question and start of the study, this limitation has hopefully been overcome.

In future, a higher number of articles may be reviewed and a more extensive study can be undertaken by individuals with a higher level of expertise in the concerned field. This could lead to new, radical findings in this field as it has a high level of potential for research. From the above stated themes and discussion, it can be seen that the mirror neuron system in human beings is a mixed bag full of surprises. It has immense research potential for the field of science as well as philosophy. It has been called the point of amalgamation for the two fields that have existed in isolation, independent from one other.

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CASE REPORT