Mirror Neurons

At the University of Parma, in 1996 and group of neuroscientist were busily mapping the neural pathways associated with hand movement in Macaque monkeys. The team of Rizzolatta, Gallese and Fogassi uncovered what is potentially the most significant neurological component in human behaviour and may be as powerful for our understanding of learning as the discovery of DNA is for understanding genetics. The discovery was completely made by accident. The break-through came when Fogassi returned into the laboratory and casually picked up a raisin from an experimental bowl. A Macaque monkey was still wired to electrodes used in the planned experiment and as Fogassi lifted his hand the neural activity being tracked in the monkey's brain displayed the same neural activity as if the monkey was reaching for the raisin. Yet the monkey had not moved.

After replicating the experiment several times it was obvious that something new and significant had accidentally been uncovered. In a series of papers following this discovery the active neurons became known as mirror neurons. Subsequent research is progressively validating the significance of motor neurons and they are shown to be present in most primates. In humans they are particularly more abundant and complicated.

In 2005 Iacoboni described two types of motor neurons. One that responds to observed actions and another type those fires in response to the perceived purpose of that action. Iacoboni had volunteers watch films of people reaching for various objects in a dinner setting (teapot, cup, jug plate of pastries, napkins) in different contexts. In every instance a basic set of reaching neurons fired. But different additional sets of mirror neurons would also fire depending on what expected action was suggested by the setting. For example neatly set tables prepared for tea compared to a setting looking as tea had been finished had disparate results. In the first instance the viewer expected the hand to pick up a teacup to drink, one set fired. However if the viewer expected the hand to pick up a cup to clean it another set fired. The interpreted purpose came from the arrangement of the objects so consequent responses were different.

Taking this example further, think of the importance of being able to tell by the way someone handles a rock whether they are going to throw it or just study it. Decisions made at this point have real safety implications and in evolutionary terms, mirror neurons provide a decided advantage. The importance is in the perception of the intention of the action thus allowing advantageous responses.

The associated firing, of mirror neurons, to a perceived direction of behaviour provides a powerful clue to how children learn the social and cultural information, which allows them to successfully integrate into their community.

Children are born with the necessary bodybuilding and survival mechanisms in their brain. Things like blood pressure, breathing, sleeping, etc. are automatic. However the social behaviours must be learned. In a basic form people need to be able to move to maximise their physical satisfaction. They plan what they want, understand how to get it and what to expect when their actions are complete. That is by watching others they 'practise' the action and anticipate the outcome. This is the domain of mirror neurons.

Theory of Mind

Philosophers have long been concerned with the mind. That is the dichotomy between the mind and the brain. Where does consciousness reside? How do we understand others and understand they have a mind like ours? The discovery of mirror neurons has provided a vital clue that helps cognitions more clearly understand how a mind develops.

Initially it was believed that children collected evidence in the form of gestures and expressions. With this they developed an understanding of another's mental state and therefore predict outcomes of behaviour. This is the 'Theory –Theory' model which Gallese refers to as the Vulcan Approach, with reference to Dr Spock of Star Trek. Spock is portrayed as non-emotional type of being who relies completely on logical decision-making.

The other popular supposition is referred to as the 'Stimulation Theory'. This suggests that humans are natural mind readers. We can place ourselves into 'another's shoes'; we can create an internal representation of their actions, sensations, emotions, etc. It becomes 'as if' we are experiencing the same feelings as the person we observe. Mirror neurons provide the explanation for this theory of learning. It is the mirror neurons that allow the brain to 'replicate' the observed sequence of movement, the emotional content of the action and most importantly predict the purpose of that action. Mirror neurons allow for a perfect learning system.

Learning and Language

As pointed out humans, like all social animals require a system that allows a group to understand the intentions of another's actions, signals, etc. Through this recognition they can perform their own actions that match that initial action. It is the ability to understand, not only the action but also the intention of that action that is the building block for all social behaviour. Mirror neurons allow this to happen.

Arbib claims that language has developed from simple gestures, a type of protolanguage. From this scaffold of rudimentary pantomime a verbal protolanguage evolved which was progressively refined until a fully functional language emerged. This theory, although not without some critics, strengthens the case for the presence of mirror neurons.

More supporting evidence of the significance of mirror neurons emerged when Gallese and Rizzolatte found that when people listen to sentences describing actions, the same motor neurons fire as would have had the subject performed the action they or witnessed them being performed. The cells responded to an abstract representation that described a visual or visceral state.

When teaching it is through language and demonstration that information is transferred from the teacher to the student. The various styles of learning, visual, kinetic, auditory, etc., presented by the teacher not only cognitively engage the student but the presence of mirror neurons allow the student to gain access to the intention of the lesson. This combination of empathetic understanding and behavioural intention combine in a way that it is almost as if the students performed the action themselves.

As student's understanding improves they can recognise more subtle, complex ingredients of the teacher's message. If, for instance a person is proficient in a certain area, say dance, they will pull together more information about another's dance. These accounts for the pleasure knowledgeable people get when watching a virtuoso's performance compared to someone who has no base education in the field of speciality. If you observe a 'master class' given to already proficient students, the teacher's ability to make subtle but significant changes is inspiring. This is because both have mature models of the actions and are aware of things the rest of us don't see.

Empathy

The peculiarity of mirror neurons that allow us to equate the processes of our mind with another's goes beyond motor action. As Iacobani asserts, "we do not have to pretend, we are the other person's mind". We experience not only their motives; we experience their emotions. This underpins empathy that is the ability to internalise the emotional state of others by simply observing their facial expressions and body language.

In fact emotions can be readily absorbed from a third party source such as television, film, books, etc. This characteristic has implications for youth observing violence and pornography. In both cases it may be more than just the visual sense that is experienced. If this is true, voyeurs will have a similar reaction as would occur if the person actually participated in the scene. This has significant social implications regarding the access to these experiences being so readily available and especially available to young people.

A student disability faced by many teachers is Autism, and it's less profound form, Ashberger's Syndrome. Such children suffer in the social sense. Their inability to infer either thoughts or behaviours of others and the loss of their ability to predict, accounts for their own appropriate action. Autistic children appear to be trapped in their own world, unable to make personal connections with others. They are more interested and comfortable with 'things' rather than people. In other words they lack empathy.

For years the cause of autism has been poorly understood. However, since mirror neurons have been identified a real, observable cause of this disability is at hand. Children with autism have very few mirror neurons hence they have little or no ability to learn social skills and language as effortlessly as the majority of others. Since Ashberger's syndrome is on a continuum down from autism, it seems logical that children are born with different allocations of mirror neurons, hence different potential to learn. It may well be that some students may have an excessive number of these neurons and may become inappropriately overwhelmed with emotions they observe in others. So much is still not understood but the relationship between mirror neurons and Autism provides a powerful clue in understanding this disability.

Teaching implications

Environment

The predictive characteristic of mirror neurons provides even more valid reason about the importance of the classroom's physical environment. The lesson from the experiment involving the serving of tea is that the arrangement of the physical

environment predicted the intended use of the room. The intention to clean up or to consume the tea was inferred from the scene presented. Teachers should understand that a classroom is either set up for learning or, if it untidy, dirty and non-appealing, it is set up with no serious purpose. Students will make that predictions unconsciously and that judgment will affect the whole tone of the lesson.

Relationships

As seen, students cannot only read the intentions of others but their emotions as well. At school they are able to do this by observing facial expressions, tone of voice and other body language particularly of the teacher. This is because their mirror neurons fire up when we see the expression in others.

This has real implications for teachers. All teachers have experienced that class which challenged us beyond what could be reasonably expected. When confronting that class, the first visual contact between teacher and students is vital. As professionals, it is our duty to send a message that indicates the ensuing time will be positive and rewarding. Allow them to 'predict' this through your body language and tone of voice as well as the actual words you use. If you sigh, frown and appear despondent you have already lost their cooperation for that lesson. You have mirror neurons; they have mirror neurons, use them in a professional way. Smile and the world smiles with you!

Modelling

The effectiveness of teaching that depends on modelling/mimicking is explained by mirror neurons. The mastery of complex motor skills involves a process of preliminary motor neuron simulation, priming, programming and rehearsing. It's the stimulation of mirror neurons that facilitates this process. The students perform the task in their head before they attempt it in real space. The better the demonstration observed the more successful the reproduction. Teachers should take care to get this right.

"Professional athletes and coaches, who often use mental practice and imagery, have long exploited the brain's mirror neurons perhaps without knowing their biological basis" Dr Iacoboni. Observation directly improves muscle performance. Mirror neurons make this connection much more than a cognitive observation; it is more real.

Mirror neurons explain the enjoyment people experience when observing elite athletes, dancers etc. We mentally represent actions we watch we are unable to physically mimic in real space.

On the other hand, children who lack the opportunity to observe a model of a motor driven skill, in the preferred developmental period, have difficulty recovering from this depravation. It seems that like any neural development, the formation and strengthening of mirror neurons not only depends on an appropriate stimulus but also as often happens, there is a defined time when the presence of myelin facilitates that neural formation. Further a lack of stimulus over time results in the materials required for neural connections to be pruned that is discarded from the appropriate site to allow for more efficient neural development in other areas.

Conclusion

An investigation around the existence and function of mirror neurons is in its infancy yet the potential impact of educators is enormous. The theory proposed gives a biological explanation for practices successful teachers instinctively understood.

Successful teachers understand the importance of strong, positive relationships with their students. The transfer of this is through mirror neurons. Pre-service teacher training, and on-going teacher training has scientific confirmation and can counter hard line protagonists who support the belief that any soft approach ruins students. That 'spare the rod and spoil the child' belief that gains currency when teaching is difficult.

Understanding the deficit of mirror neurons in Autistic children, and the variable distribution, through Ashberger's Syndrome on to 'normal' should reduce frustrations face when confronted with these children. It is easy to forgive mistakes of a child with visual deficits. The teacher should be just as forgiving for mistakes they make in interpretation of intensions as they are of others. Because the 'mistakes' of autistic kids are often un-likeable a more a 'professional' response required from the teacher.

Teachers have long realised the benefit of demonstration of new skills. The properties attached to mirror neurons confirm why demonstrations work and why the quality of the demonstration is significant. Coupled with mental rehearsal this is an area that has the potential for productive research.