Module:
Psychological Foundations of Mental Health

Week 4
Beyond basic cognition and emotion

Topic 3
Delving deeper into social cognition – Part 2 of 4

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Lecture transcript

Slide 3
So in this topic we're going to talk about mirror neurons and how they contribute to social interaction.

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Mirror neurons were first recorded in macaque monkeys in the premotor areas of monkey brains. Now, the first thing we need to note about mirror neurons is that these cells are motor neurons. So that means they fire when a human-- or in this case a monkey-- is performing an action-- is actually doing something.

Now, if we look at this first graph, what you can see here is the monkey-- is on the right of that image at the top-- is reaching out and grasping a small object-- something like a raisin or a peanut-- with a particular type of grip.

Now, below the picture of the monkey, the graph shows the responses of this particular cell in the monkey's premotor cortex on several different trials in which it repeats the performance of this particular grip. Each horizontal line is one trial. And you can see the cell firing on each of those trials.

Now, the final graph at the bottom is all of those responses added up. And what you can see from this is that this particular cell in the monkey's brain fires when this monkey makes that particular action-- so a very precise grip to pick up a small object. So this is a cell that's involved in moving, in performing a particular grip type. It's a motor cell.

Now, the exciting thing about mirror neurons, however, is they're not only motor cells. They also respond when simply observing someone else-- in this case, a human performing the same or a similar action. So in this picture on the left, you see the human reaching out and grasping a raisin with the same kind of grip.

Below that picture, you can see that the cell is also firing when the monkey merely observes the

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human doing the same thing. So these cells seem to fire both for the performance and for the observation of a given action. They appear to match observed actions onto the observer's motor programme for that very same action.

Now, why would these cells be important for social cognition? Well, they appear to bridge the gap between the self and others by mapping other people's actions onto your own motor programmes for those actions. More broadly, it's been suggested that mirror neurons are the neuroscientific basis for bridging the self-other divide.

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So what do mirror neurons do? We can describe what they do at the neuronal level. So we can describe their properties in terms of the conditions under which they fire. But what's their functional role? How, if at all, do they contribute to social cognition, to social interaction?

What mirror neurons do in terms of their responses at the neuronal level has been used to infer their functional role-- what mirror neurons are for. And that has led to a lot of speculation, both in terms of their role in social cognitive processes-- so it's been suggested that mirror neurons contribute to a wide variety of processes, including imitation, action understanding, empathy, speech processing, language, theory of mind or mind-reading, and morality. But there's also been speculation in terms of the links between mirror neuron function and a wide range of neurological and psychiatric disorders, including autism, motor disorders, including amyotrophic lateral sclerosis, stroke, and Parkinson's disease, schizophrenia, communication disorders, conditions such as obesity and stuttering.

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So amidst all this speculation, what's the actual evidence? In terms of causal evidence that mirror neurons contribute to social cognition, there are really only two areas where it's been shown for sure. And these are action perception-- so mirror neurons seem to help us process other people's actions-- and -- imitation copying observed actions.

Now, imitation is certainly an important social skill. For one thing, it helps us learn a huge variety of skills from other people. But the excitement around mirror neurons seems to extend to more than their role in imitation. So it's really important to try and distinguish between the speculation and the actual evidence when you hear about the involvement of mirror neurons in social processes and in disorders.

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So having said all that, is there any evidence at all for the involvement of mirror neurons in other areas of social cognition? Well, there might be, although there's little direct evidence as yet. However, they may well be involved in other aspects of social cognition where it's important to bridge the gap between the self and other people to represent other people in the self. And aspects of social cognition where this may be important include processes such as low-level empathy, mirroring other people's emotions.

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Empathic mirroring involves feeling the same as someone else-- for example, wincing when you see someone else in pain. Are mirror neurons involved when we feel with another person? There's currently no direct evidence from single cell recordings that show us for sure that there are cells which show these kind of empathic mirroring properties. What we would need to see would be a cell that fires when one's in pain oneself and also fires when seeing someone else in pain, for example. But what we do know is that the brain shows responses in the same areas when seeing someone else in pain as when feeling pain oneself.

And what you're seeing in this image is our participant lying down in an fMRI scanner. You can just see their legs and shoes because their body and head is in the scanner. On the left, you can see their friend, who's sitting outside the scanner.

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Now, the participant and the friend are both wired up to a machine that delivers mild electric shocks to their hands. And what the participant can see on the screen in front of them is telling them whether they or their friend will get the next electric shock.

So we scan the participant's brain while they're experiencing pain or while their friend is experiencing pain. The fMRI data are analysed, and, sure enough, there are areas of the brain that show the same response when the participant is in pain themselves as when their friend is in pain.

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And similar effects have been found for other emotions, including disgust. Here, the participant sees someone else sniffing a disgusting smell or the participant themselves-- again, in the fMRI scanner-- has to sniff a disgusting smell themselves. And certain areas of the brain show the same response-- which is in white in these pictures of the brain-- when the participant experiences that disgusting smell themselves and when they see someone else experiencing disgust. So it does seem likely that we have some kind of mirror mechanism for low-level empathy.

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Now I've given you an overview of what we know at present about mirror neurons. What are the main issues to consider when thinking about mirror neuron research?

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The first issue is that mirroring actions and mirroring emotions may not necessarily involve the same mechanisms. Action mirroring, i.e. the type of mirroring that's involved in action perception and in imitation, involves mirror neurons in motor areas of the brain. In contrast, mirroring other people's emotions involves emotional areas of the brain.

So if we do have mirror mechanisms for empathy, these are highly unlikely to involve the same mirror neurons or the same areas of the brain as those that are involved in motor mirroring or in imitation. That's important from a clinical perspective because it's possible that they may be patients with particular conditions who could have intact motor mirroring but impaired emotional mirroring, or vice versa.

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The second issue is that the tendency to mirror actions or emotions may be learned through experience. In research in my lab, we've shown that motor mirror responses in adult humans can be retrained with a few hours of sensory motor experience. And specifically, this kind of experience changes mirror neuron responses, it changes imitation, and it changes action perception. All of this suggests that mirror responses are very flexible, which casts doubt on the idea that matching mirror neuron responses are a characteristic that evolved specially for social cognition, because if that were the case, you wouldn't expect them to be easily altered through experience.

It also suggests that experience may be sufficient and, indeed, necessary to produce mirror neurons in the first place-- at least for actions. And so it's going to be important for future research to find out whether this may also apply to emotional mirroring. Finally, this suggests that if mirror neurons are important for social cognition, we should bear in mind that therapeutic approaches which aim to train mirroring may be fruitful.

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The final issue in current mirror neuron research is the problem of self-other distinction. If we mirror other people's actions and/or emotions in our own brains, then we need some kind of mechanism to distinguish representations of the other person from representations of the self. Because otherwise when your mirror neuron for a particular action is firing, you can't know solely from the firing of that neuron whether it's firing because you yourself are performing that action or because you're watching someone else perform that action.

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And the same goes for emotions. You need to know whether you yourself are in pain or whether your emotional mirroring system is active because of someone else's pain. So the important point to consider here is that mirror neurons alone can't explain social cognition. They work as part of a network of brain areas involved in dealing with social information.

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In summary then, here are the key points you need to know about mirror neurons. Action mirror neurons are motor neurons that fire when producing an action and when seeing someone else perform the same action. A similar mechanism may underlie basic empathic emotional mirroring, but there's no direct single cell evidence yet, although there's reasonable evidence from techniques such as fMRI.

A few key things to note about empathic mirroring is that, firstly, it's unlikely to involve the same brain areas as action mirroring. It may arise as a result of experience. And it can't explain empathy on its own. It may require an additional process known as self-other distinction.