IŞIK SPECTRUM
Journal **2** (1): 1-6, 2022

Mirror Neurons: The Influence of Broken Mirrors on Social Learning with Autism

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ABSTRACT

Deficits of the autism spectrum disorder (ASD) affect social interaction, which is expected of a dysfunctional mirror neuron system (MNS). Therefore, this research will answer, “what role mirror neurons might play in the social learning of people with autism?”.
Mirror neurons fire when someone observes and/or performs an action. The direct-matching model is the most dominant MNS theory. It claims that the MNS is critical for the understanding and performance of action sequences. The broken-mirror theory can be divided into three sub- theories, all claim that the main cause of poor social cognition is in the MNS.
A few studies have been done using fMRI. Some conclusions were; differences in responses to observing emotional stimuli in ASD are driven by differences in the amygdala, MNS functions keep developing over the 18-55 years age range examined in their sample and that people with ASD can engage their MNS when a task demands it.
Interpreting these studies and answering the research question can be challenging, because emotional stimuli probably engage other brain systems besides the MNS so it cannot provide us with a pure index of the MNS function.

Keywords: *Autism, Mirror Neurons, Social Learning*

Introduction

It seems as if in the common media there is more and more attention for people with autism. This is not weird if you take into consideration that approximately 1 out of 59 children in the US have autism. That is an increase of 47% from 2012 to 2018 (Baio, 2018). The word autism comes from the Greek word “autos”which you can define as in itself. People with autism show symptoms such as withdrawal, you could say they are quite within themselves. Even though a lot of people are aware of what autism is and what possible symptoms are of people on the spectrum, a lot of the autism spectrum disorder (ASD) is still unknown and unsure. That is why this essay will answer the research question “What role might mirror neurons play in the social learning of people with autism?”

The mirror neurons system (MNS) consists of visuomotor neurons that discharge when observing and performing an action (Perkins et al., 2010). A mirror neuron “mirrors” the act or behaviour of another species as if it is their action. A set of different brain regions are shown to be active when we watch someone perform the same task as we are performing (Rizzolatti & Craighero, 2004). The mirror neuron system is also considered to play a big role in understanding another's persons feelings and actions. The broken mirror neurons theory argues that a dysfunctional mirror neurons system leads to poor social cognition in autism. However, the current data we have about mirror neurons vary quite a bit. The characterised deficits in ASD developmental conditions show in social interaction, certain obsessive patterns of behaviour as well as (non)verbal communication. These

dysfunctions might be because of a disturbance in the parietal-frontal mirror neuron system. It is what you would expect of a dysfunctional mirror neuron system. (Perkins et all, 2010)

To answer the research question, ”What role might mirror neurons play in the social learning of people with autism?” we will go further into detail about research such as the one of Hamilton (2013) who localized the mirror system function with FMRI measure. In this study, they used emotional stimuli and got different group reports. However, the ones not using emotional stimuli show no difference. Which again shows the mixed signals in the current literature (Hamilton, 2013).

This research question is important because it gives a clear understanding of what the role of MNS can be through all these mixed signals. Besides further investigation of the MNS could explain how ASD can arise and in the progress of finding out physicians might be able to find better ways to treat and diagnose ASD more successfully.

Autism Spectrum Disorder

People on the autism spectrum disorder (ASD) struggle with formal settings as well as in their daily lives with social interactions and communication. ASD is a neurodevelopmental disorder. It is characterised in the DSM-5 as difficulty in interaction and communication with other people, symptoms that hurts the person's ability to function properly at places like school and work, restricted interest, and repetitive behaviours. ASD is also considered a spectrum disorder because it covers a wide variation in severity and type of the symptoms people with ASD experience and show (Hodgens et al, 2020)

Mirror Neurons

The mirror neuron system (MNS) can be defined as a set of brain regions that are activated when the individuals are watching an action someone else does or when the individuals perform an action themselves (Rizzolatti & Craighero, 2004). Mirror neurons in monkeys also seem to respond to the sound of actions and code the intention associated with the observed action. This suggests that MNS is a dominant neural system for social cognition (Iacoboni & Dapretto, 2006). The key parts of our MNS are the inferior parietal lobule and the inferior frontal gyrus. In fMRI studies, explicit patterns of activation of mirror neurons have been found, which makes it almost certain that these brain areas have mirror neurons. Mirror neurons are causally related to imitation. Imitation is a crucial factor for social learning and interaction. Mirror neurons fire when someone observes and/ or perform an action. However, in humans, the MNS might play a more social function than in primates. The mirror neuron system also seems to be active in humans as young as 6 months (Saffin, J., & Tohid, H. 2016).

Research Results

The most dominant theory of the MNS function in us humans is established on the direct- matching model. This model maps observed actions on the observers' motor system. This theory emphasizes the idea that the mirror neuron system does not just encode the basic motor features but also the goal of an action. It also gives us a primary mechanism for imitating and understanding other

people. In this theory, the MNS is critical for the understanding and the performance of action sequences (Hamilton, 2013).

The broken mirror theory claims that a causal factor in poor social cognition of people on the spectrum is the dysfunction of the MNS. We can divide the broken mirror theory into three sub-theories (Hamilton, 2013).

• Action sequences get represented by mirror neurons. The neurons that chains act together are only active in monkeys when the monkey performs or sees action in a specific sequence. The activation of the chaining mirror neurons at the beginning could be the neurons allowing the monkey to predict how the rest of the sequence could go. This also lets the monkeys understand the intention of the performer of the action. This suggests that only the actions of chaining mirror neurons could be abnormal in people on the spectrum. Dysfunction of the chaining mirror neurons could potentially lead to difficulty in other areas of social cognition (Hamilton, 2013).

• Extensive behavioural evidence of weak imitation skills in people with ASD, combined with the supposed role of the mirror neuron system in imitation leads to the theory that MNS dysfunction could be the cause of poor imitation in people with ASD. It links the mirror neuron system to the self-other mapping function and suggests that failure of a basic self-other mapping in ASD could potentially be the cause of the struggling in imitation and all the other social cognitions like the theory of mind that people with ASD struggle with (Hamilton, 2013).

• The mirror neuron system brings forth a basis for simulating the mental states of other people, actions, and emotions. Non-successful basic simulation system in the mirror neurons system in ASD could cause general difficulties in empathy, language, and theory of mind. It suggests that understanding of emotions and actions in the mirror neuron system should all be irregular in people with ASD (Hamilton, 2013).

All claim that this is the main cause of poor social cognition can be found in the mirror neuron system.

FMRI is the best way to measure the MNS because it gives us localized activation within and outside the MNS regions of humans. Especially the responses the IFG and IPL gives us are important. So far there have been eight studies done that investigated the MNS in individuals with ASD. The results of these studies are;

• One showed the differences in the MNS in people with ASD. They used fMRI to observe children that were asked to imitate emotional expressions or to observe the expressions. Right IFG showed a more powerful engagement in the non-ASD children than in the ASD children during the imitation of emotional expressions. However, the left anterior intraparietal sulcus showed the exact opposite. Three other studies have been done. These observed the whole-body actions showing neutral or fearful behaviour in adults with ASD and non-ASD adults who were watching a movie. Both engaged their MNS in response to a neutral stimulus. However, the non-ASD adults showed more activation of the inferior frontal gyrus and amygdala in response to fearful stimuli than the adults with ASD. They concluded that the difference in responses to observing emotional stimuli in ASD is driven by differences in the amygdala rather than by the core of the MNS (Williams, 2008).

• Another study of mirroring emotions observed the brain responses when the participants observed a disgusting taste or expression. The anterior insulate responded in the non-ASD adults, the adults with ASD showed similar responses. But when the researchers used a region of interest analysis, they found age-related changes in the engagement of the right IFG across the groups with lower activation in the youngest participants with ASD. But did not find any differences in the older participants. They concluded MNS functions keep developing over the 18-55 years age range

examine in their sample. It seems to be possible to improve the MNS functions in adulthood (Williams, 2008).

• Schulte-Rüther et all. (2011) investigated how non-ASD and ASD participants responded to sad and happy facial expressions when asked to say how this person feels or to say how the participant feels when you look at the facial expression. They found group differences within brain regions that are associated with the theory of mind but are not associated with the inferior frontal cortex. Both groups of participants engaged the left hemisphere when instructed to attend to their own emotions. They concluded that people with ASD can engage their MNS when a task demands it.

Interpreting these studies is hard because emotional stimuli probably engage other brain systems besides MNS so it cannot provide us with a pure index of the MNS function.

Discussion

The role that mirror neurons might play in the social learning of people with autism is that dysfunction might cause difficulties in the development of social cognition. However, the research results are quite mixed, and we cannot truly account for all the results of the MNS. Because emotional stimuli probably engage other brain systems besides the MNS, it cannot provide us with a pure index of the MNS function. Other issues might be that different features of action could be inscribed by different groups of mirror neurons and different functions of social cognition could be differentially served by different groups (Williams. 2008). Therefore, there is not enough significant and clear evidence that we can claim that mirror neurons play a role in the social learning of people with autism. For this study, it might have been better to look at a more specific function of the MNS in social cognitive functions rather than keeping it broad.

It might be better to ask ourselves what contribution a specific neurobiological process might make to the development of those cognitive functions that are damaged in ASD. Also, do not see MNS as a cause on its own but rather as a possible factor for the damaged social cognitive functions in ASD. For this, we would need to combine an interaction of top-down and bottom-up approaches. With top-down, we can try to understand the cognitive functions that are affected. With bottom-up, we can try to understand how specific neurobiological processes like MNS contributed to those cognitive functions (Leekman, 2016).

Further, it might be interesting to see the relationships between the mirror neuron system and other circuits in the body that are similar to get a better idea of what we can truly account for to the mirror neuron system. So, we can be sure we are not falsely accounting anything to the MNS. Right now, we cannot be positive that we are not accounting something falsely to the MNS.

More research into how we can develop our mirror neuron system at an older age could be interesting too. Also, to see if that lessens the symptoms of ASD and if there is a difference in the later development of the MNS between people diagnosed with ASD and people who are not diagnosed with ASD.

The importance of conducting this study is that it could be useful in the educational practice of children with ASD. As well as in the coaching profession to improve the way the coaches can help the people with ASD to function better in daily life and formal settings.

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