

Empathy & Autism

Empathy is an important ability which allows us to tune into how someone else is feeling, or what they might be thinking. It allows us to understand the intentions of others, predict their behavior, and experience an emotion triggered by their emotion. In short, empathy allows us to interact effectively in the social world. There have been numerous research works exploring the lack of empathy in autistic individuals^{4,5,6,7}. It has been experimentally proved that empathy is implemented by a simulation of the mental states of other people and a large-scale network for empathy is composed of the mirror neuron system, the insula, and the limbic system⁸⁻¹³.

This paper intends to elaborate autism dysfunction in the light of mirror neuron mechanism and empathy mediated through mirror neurons.

The Concept of Mirror Neurons

Mirror neurons were first discovered in the early 1990's¹⁴. Italian researchers discovered a special class of cells in the brains of monkeys that fire when an action is observed and when it carries out the same action on its own¹⁵. Subsequently, these were discovered in humans. Research has demonstrated multiple specialized mirror neuron systems that perform and understand the actions, intentions, emotions and behavior of others through action understanding and direct imitation without the need for any cognitive reasoning¹⁶⁻²⁰.

There have been several research works corroborating the claim that dysfunction of the mirror neuron system in individuals with autism spectrum condition causes difficulties in social interaction and communication^{21,22}.

Individuals with ASD struggle with social interaction and communication, both in formal testing and in their everyday lives. Many different cognitive and brain-based theories have been proposed to account for these difficulties. Current proposals include difficulties in theory of mind²³, in social motivation and in mirror neuron function^{24, 25}. On this background, if we closely access the concept of MNS, we realize the association of all these disturbed social skills and a fractured MNS. The most important observation in this context is that an autistic child shows

deficiency in empathy for others. There is deficit in understanding about thinking perspective of other person.

Autism and Emotional understanding

Autism presents primarily with two distinct neuro-behavioural patterns: One being the abnormality in the social-cognitive domain e.g. mental aloofness, aberrant social interactions and lack of empathy. The second being behavioural abnormalities like temper tantrums, head banging, and some form of repetitive rituals. One interesting phenomena in autism is the inability to comprehend abstract reasoning and metaphors, which in normal humans is subserved by left supramarginalgyrus rich in mirror neurons²⁶. Mirror neuron abnormalities have also been blamed for a number of other autistic problems like language difficulties, self-identification, lack of imitation, and finally intention understanding^{27,28}.

Broken mirror neuron system – a different perspective of understanding Autism

Resonance Behaviour: Resonance behavior defined as neural activity spontaneously generated during movement, gestures or action and is also elicited when the individual observes another individual making similar movements, gestures or action has its underlying neural substrate in MNS²⁹. Also MNS has a role in understanding others intention and in prediction of other people's action and goal. Mirror neuron plays a vital role in mediating empathy and develop ability to recognize, share and understand emotions of others.

Correlating the functions of mirror neuron system and autism, if we imagine some one forced to look in a mirror broken in a pieces for life long, we can have a better understanding of the emotional storm an autistic child must be facing⁹. Also in a way the social norms laid by the society for behavior is a mirror for a normal individual which he sees to look into and match his ideal with his image. Hence mirror neuron facilitates learning by imitation. Also better self image is a foundation for empathy. A child with a fractured mirror neuron and in a way looking at his fractured self through this imaginary mirror has a poor self image. Also the compulsion from family and society to behave as per the usual societal norms makes the child more obsessive for ritualistic behavior and sameness. Facial reaction and expression are important tools to understand others perspective and in development of learned social behavior. This is also a function of mirror neuron system. Lack of eye contact, non cognizance of punishment and lack of

response to grief or happiness of others in autism is related to this fractured mirror neurons⁹.

Scientific Evidences for Mirror neuron dysfunction in autism

In 2001, in a review published by Williams and team on 'imitation, mirror neurons and autism, they highlighted the lack of imitation in early infancy as a part of autistic development and the potential MNS involvement³⁰. They explained various anatomical and functional studies done in the past that support their proposition.

It was proposed that there is an interlink between neuro-psychological models of imitation, empathy, and recent empirical findings from the neurosciences. Several neuroscientists have elaborated that there is an evidence to lack of a normally functioning mirror neuron system in autistic children with techniques such as EEG, Transcranial Magnetic Stimulation (TMS), and functional MRI (fMRI).

In a study by Obermann et al, they examined responsiveness of EEG oscillations, at the mu frequency (8-13 Hz), at actual and observed movements. The researchers found that when a person watched another person perform some action, the mu waves from motor cortex get suppressed on a EEG. This could be related to the MNS involvement. Interestingly, the mu wave suppression was found to be less in children with autism³¹.

Iacoboni, a Professor of Psychiatry and Biobehavioral Sciences, first established a scientific evidence for links between imitation, empathy and mirror neurons with the help of Transcranial Magnetic Stimulation (TMS) experimentation⁸. He based his experiments on earlier works that spiking neuronal activity recorded with in-depth electrodes correlates well with the blood-oxygenation level dependent (BOLD) signal measured by functional magnetic resonance imaging (fMRI)³². TMS uses rapidly changing magnetic fields to induce electric fields in the brain. With TMS, cortical excitability in chosen areas of the brain can be temporally modulated to test hypotheses relative to their involvement in task performance. These studies revealed an impairment in the system matching action observation and execution in autism, and concluded that a dysfunction of the MNS could underline the social deficits in

autism. An fMRI study of imitation and observation of facial emotional expressions⁴ tested the hypothesis that empathy is enabled by MNS, the limbic system, and the insula connecting these two neural systems. This model proposes activation of mirror neuron areas, insula, and limbic areas during both observation and imitation of facial emotional expressions⁴. Recent data also suggest that the activity in this network provides a biomarker of sociality and empathy. Another fMRI study of imitation and observation of facial expressions in children with autism and in typically developing children demonstrated not only a deficit in mirror neuron areas in the children with autism, but also a correlation between the severity of the disease and activity in these areas: The lower the activity in mirror neuron areas, the more severe the autism¹¹. Furthermore, a separate fMRI study on typically developing preadolescents—in which the activation task was again the observation and imitation of facial emotional expressions—has recently demonstrated that activity in mirror neuron areas was positively correlated with interpersonal competence and empathic concern³³.

Recently, the use of TMS as an investigative device to study cortical excitability and plasticity in ASD has been studied by Oberman et al. These studies show that a number of basic mechanisms and circuits are atypical while other measures appear to be normal, and this can give a direction to prognosis of autism³⁴.

Correlating MNS and autism for management

Echolalia i.e. unsolicited repetition of vocalizations made by another person may be a language acquisition strategy for children with autism and may have implications for management³⁵. A feature of echolalia that is repetition and imitation of other's words points to although underdeveloped but a preserved capabilities of autistic child for imitation. Also development of specific areas like arts, music, painting is sometimes observed³⁶.

Imitation Theory

If the autistic child himself is animated and made to watch his own video and if this is repeated, some areas of fractured mirror neuron system can be reunited to improve social functioning of autistic child. The animations can be shown to start with, targeting certain areas like speech, plays, reaction to others action. With repetitive exposure to a better self-image, the neuronal connections may take up in a

developing brain. Short target can be set and after achievement in certain areas, other developmental domain can be focused. This imitation technique, mediated through the MNS can be harnessed further for achieving behavioral milestones in children with autism.

A ray of hope in understanding autism

The primary goals for an autistic child are functional independence, quality of life, facilitate learning, promoting socialization and reducing maladaptive behavior. A unique feature coming as a ray of hope is the varying intellect. Although intellect vary from mental retardation to super intellectual functioning, many children show typical development in certain skills and specific areas. They can also show areas of development like puzzles, art or music. This therapy can be individualized to every child depending upon the areas of maldevelopment. This can be a foundation stone of integrated management of autism through the concept of mirror neuron system and contribute to give better life to individuals with autism.

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Understanding Autism: Through Mirror Neuron Dysfunction

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Abstract

Autism or Autism Spectrum disorder (ASD) has evoked interest of many neuro-behavioural researchers for its formidable challenge. According to available data, ASD affects as many as 1 in 250 children in India. Autism is a neuro-developmental disorder that involves abnormalities mainly in social behaviours and reciprocal interactions. The implications of lack of empathy in autistic individuals have been studied in detail by many workers in this field. The discovery of Mirror Neuron system (MNS) has shed a new light in exploring various neuro-behavioral disorders. The recent perspective of mirror neuron system and their involvement in action-imitation and emotions in humans appears to provide a rational explanation in understanding autism. The Mirror Neuron dysfunction affects the mechanism of action representation which regulates empathy and is critical in individuals with autism. This paper is a review account in understanding autism, role of empathy in autism and the involvement of MNS in autism, through scientific evidences e.g. fMRI, transcranial stimulation and EEG experiments. The authors also propose use of 'Imitation Theory' in management of autism through harnessing the MNS. The understanding of this newer Mirror Neuron Dysfunction perspective in autism will help the workers in this field to appreciate autism in the light of neuroscientific evidence and accept it as more than a mere behavioral disorder.

Keywords: Autism, Autism Spectrum Disorder, Mirror Neurons, Mirror Neuron System, Empathy, fMRI, Transcranial Magnetic Stimulation

Introduction

Defining Autism: "The more you know, the more you understand how much has remained unknown."

This aphorism rightly depicts the mystery of autism. Autism spectrum disorder (ASD) and autism are both general terms for a group of complex neurobehavioral disorders characterized, in varying degrees, by difficulties in social interaction, verbal and nonverbal communication and repetitive behaviours¹. The term "spectrum" refers to the wide range of symptoms, skills, and levels of impairment or disability that children with ASD can have. The symptoms of autism mainly include impairments in social interaction and developmental language and communication skills combined with rigid, repetitive behaviours. ASD affects as many as 1 in 250 children in India².

Autism is first visibly noted in early infancy with lack of attention to faces by the baby. This is because the autistic individuals are impaired at using information from faces and find difficulty. Autism usually presents as syndrome of ASD having impairment mainly in 3 areas: social interaction, communication and developmentally appropriate activities. Aberrant development of social skills and impaired abilities to engage in reciprocal social interactions are hallmark symptoms of autism³. Attainment of social mile stones is a serious apprehension for parents of autistic children.

In early childhood, abnormal eye contact, failure to orient to name, failure to use gestures to point or show, lack of interactive play, failure to smile, lack of sharing, and lack of interest in other children raises an alarm of possibility of autism in the child. With growing age, children with autism have trouble in communicating and having social interactions. They have trouble understanding what other people think and feel. This makes it very hard for them to express themselves either with words, through gestures or facial expressions.