The role of the mirror neuron system in understanding actions and motor learning: Evidence from congenital amputation, developmental dyspraxia, and stroke.

Julie Werner, PhD(cand), OTR/L, Sook-Lei Liew, PhD, OTR/L, Lisa Aziz-Zadeh, PhD

MIRROR NEURON SYSTEM

Overview: We map other people’s actions onto our own body representations in the brain. First discovered in monkeys, mirror neurons fire both when doing and observing another make the same action. Functional MRI evidence posits that there is a human mirror neuron system in regions homologous to the regions mirror neurons were found in monkeys: the inferior frontal gyrus, ventral premotor area, and inferior parietal lobule. It is theorized that our ability to understand actions we see and learn by imitation is supported by the observation-execution matching function of the human mirror neuron system.

CONGENITAL AMPUTATION

Premise: We activate our own sensorimotor systems when viewing other people make actions, but it is unknown how we activate these regions when the observed actions are impossible for ourselves.
1. When we have a different body than someone else, we still activate our own sensorimotor systems. However, if the action observed is impossible for us, we additionally recruit other brain regions important for social understanding.
2. We engage our own sensorimotor regions more when observing those who are different from ourselves. However, visual experience with a person with physical differences from oneself can allow us to process them as we would for those who are similar to ourselves.
3. Real-life experience with a person with physical differences is associated with greater activity in neural regions associated with understanding the goal of others’ actions.
Summary: These studies provide neural evidence of how our everyday experiences with individuals with physical differences affect the neural processing that supports our ability to understand and empathize with others.

DEVELOPMENTAL DYSPRAXIA

Premise: Individuals with developmental dyspraxia have impairments in motor planning, motor learning, and imitation. The human mirror neuron system is thought to support these functions in typically developing individuals and may be differently functioning in dyspraxia.
1. Individuals with dyspraxia show less activity in regions of their mirror neuron systems during imitation and motor planning.
2. Imitation skill is supported by sensorimotor and working memory brain regions, and may be processed in a bottom-up fashion.
3. Motor skill is supported by brain regions thought to be involved in self-awareness and error monitoring.
Summary: Training individuals with developmental dyspraxia to better associate matching sensory and motor experiences may be one technique that occupational therapists could use to improve motor learning. Treatment techniques such as reciprocal imitation training may increase the observation-execution matching function of the mirror neuron system, but more research is needed.

STROKE

Premise: Can action observation be used to activate damaged motor regions in individuals with chronic stroke, particularly in individuals with moderate to severe hemiparesis who cannot activate these regions through volitional movement?
1. In chronic stroke patients, regardless of hemisphere affected, action observation of another person’s intact hand, on the same side as one’s own affected hand, is associated with neural activity in ipsilesional motor regions.
2. Individuals with greater motor impairment, regardless of which side is affected, demonstrate greater activity in the ipsilesional premotor cortex when observing others' intact hands.
3. Laterality of the lesion location (right versus left hemisphere) affects patterns of neural activation during action observation in a way that may reflect experience-dependent use.
Summary: Action observation may be one way to enhance traditional occupational therapy in order to stimulate the ipsilesional motor cortex, particularly in the absence of movement.
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SUGGESTED READING

REFERENCES

CORRESPONDENCE
Please address questions to Julie Werner: JMWERNER@USC.EDU