

Cognitive Neuroscience

Methods of Cognitive Neuroscience

Optogenetics

- Integration of optics and genetics that allows for experimental control of events within a specific cell

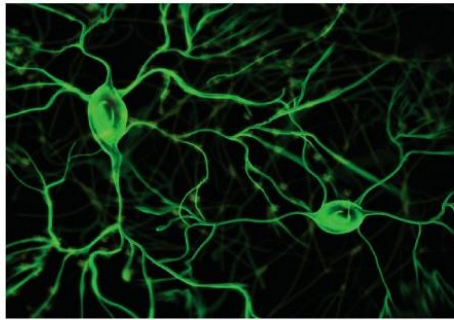


Optogenetics

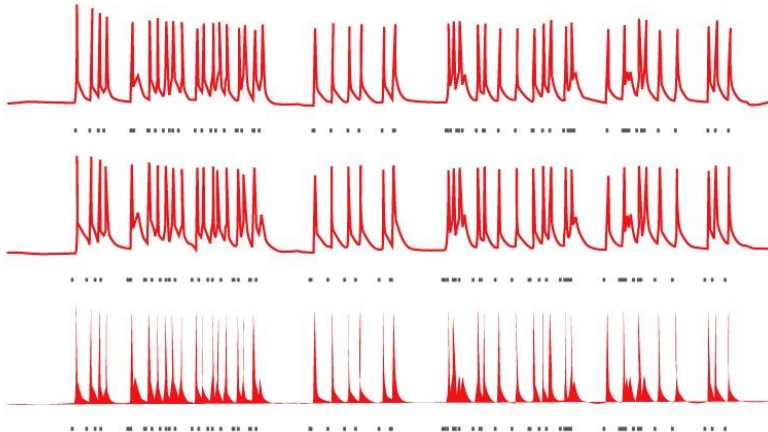
- Using Light to Manipulate Neuronal Activity

Optogenetic control of neural activity

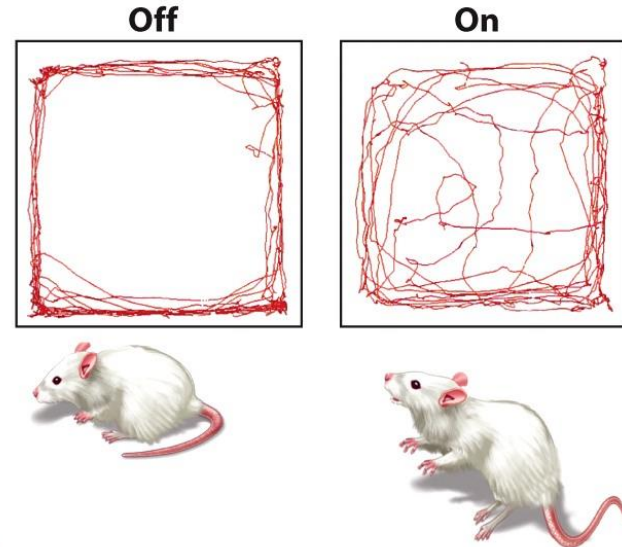
a



b



c



Cognitive Psychology: Mental Representations

- Information processing depends on internal representations.
- These mental representations undergo transformations.

**IT'S EASIER FOR PEOPLE
TO PROCESS IMAGES,
COMPARED TO TEXT.**



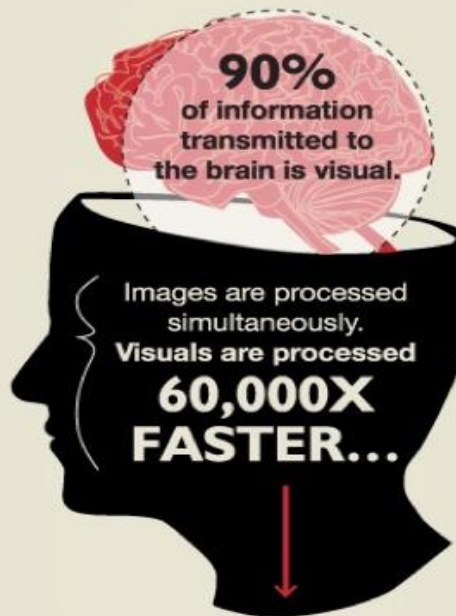
60% of the population
are **visual learners**



30% are **auditory**

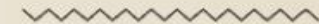


10% are **kinesthetic**



Text is processed sequentially.
Most people only
REMEMBER 20%
of what they read.

**Publishers who use infographics
grow in traffic an average of 12% MORE.**

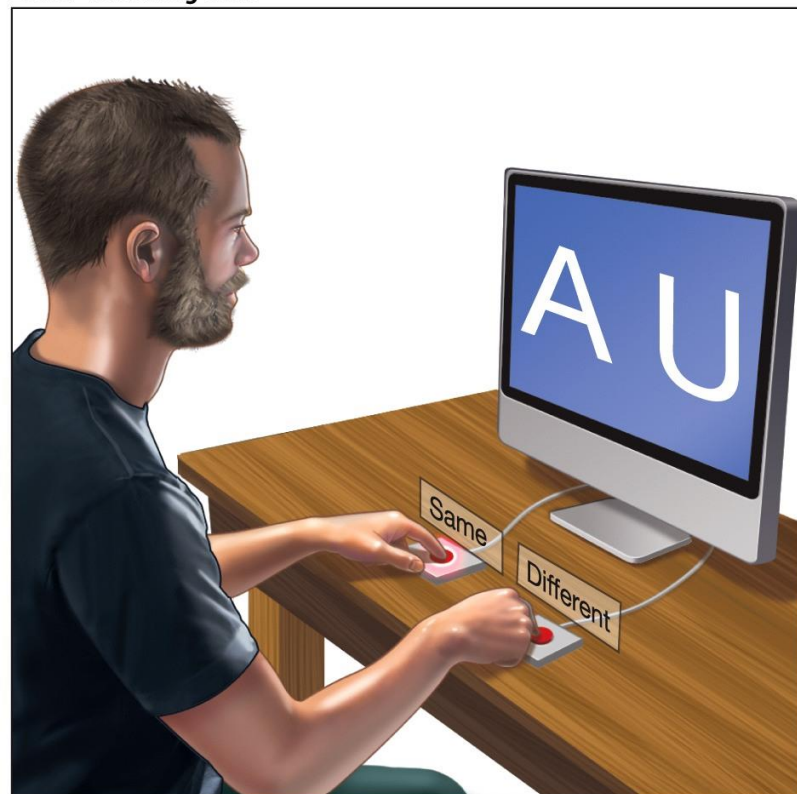


According to research at Cambridge University, it doesn't matter in what order the letters in a word are, the only important thing is that the first and last letter be at the right place. The rest can be a total mess and you can still read it without problem. This is because the human mind does not read every letter by itself, but the word as a whole.

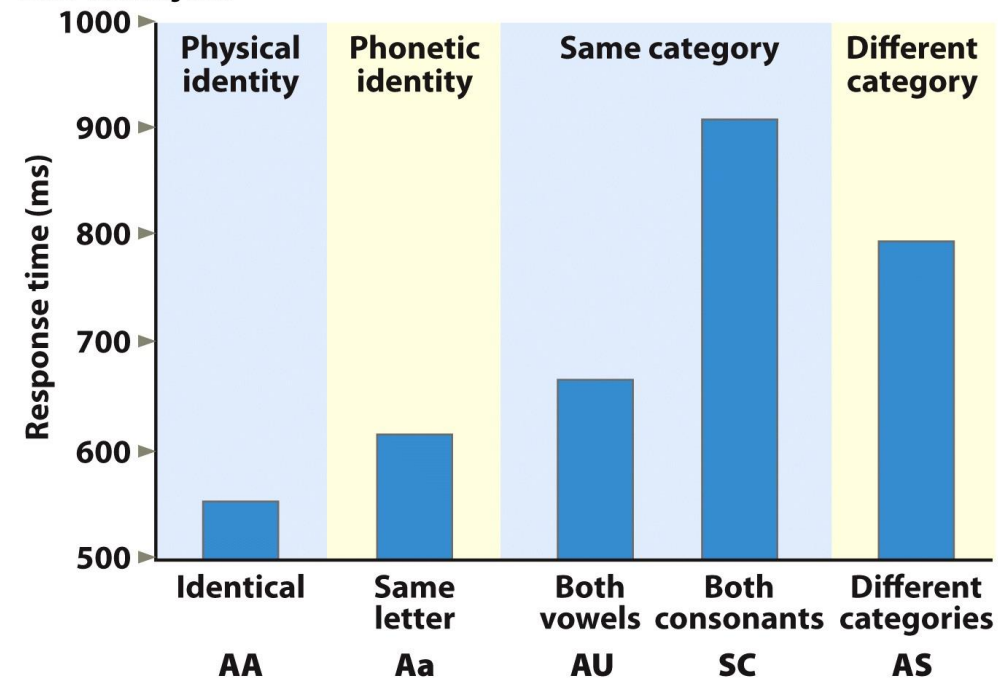
Common Cognitive Tasks: Letter Matching

- What processes underlie decision making?
- Using Reaction Time

Letter-matching task



Letter-matching task

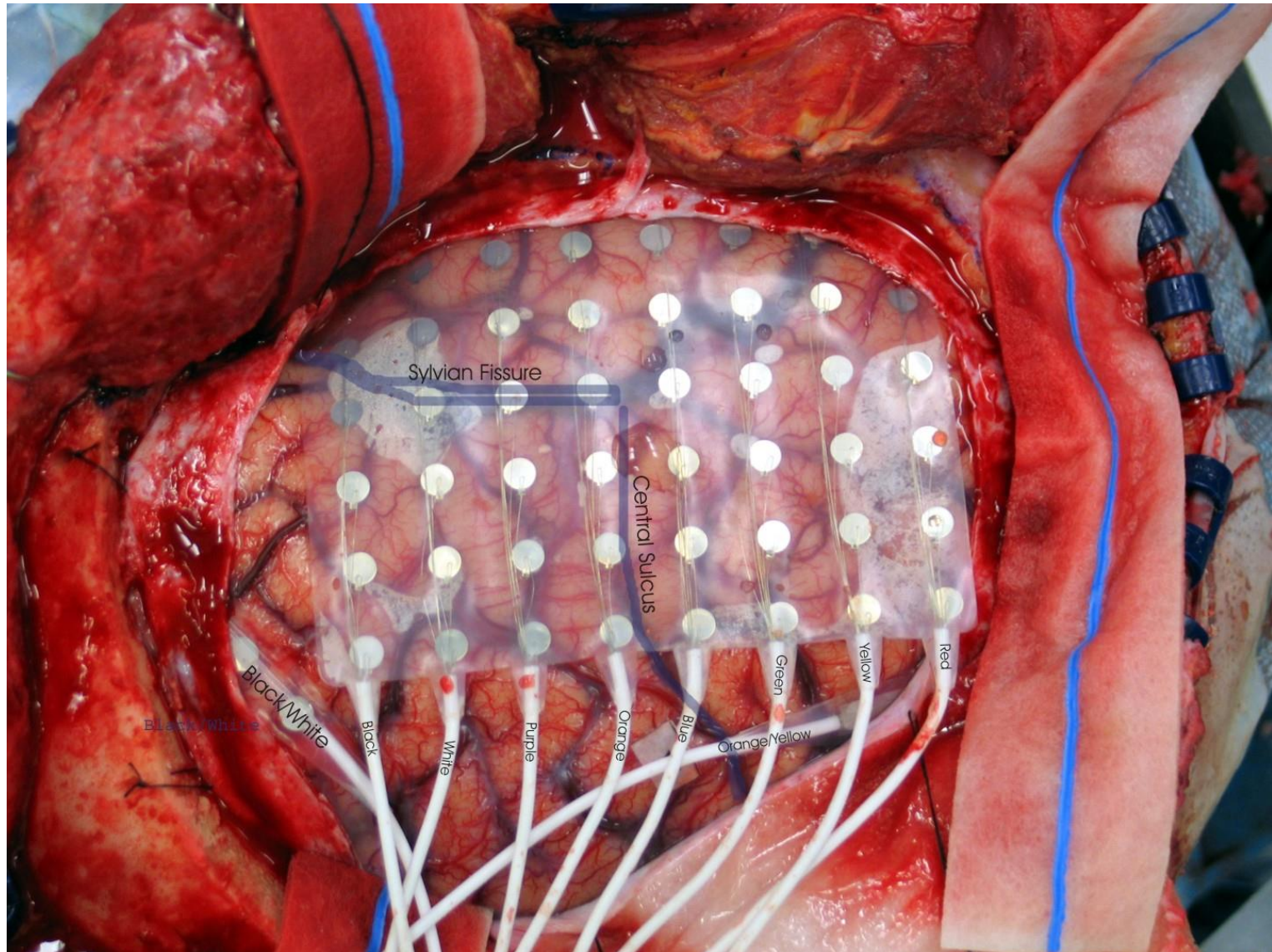


Common Cognitive Task: Stroop

Stroop task

| <u>Color matches word</u> | <u>Color without word</u> | <u>Color doesn't match word</u> |
|---------------------------|---------------------------|---------------------------------|
| RED | XXXXX | GREEN |
| GREEN | XXXXX | BLUE |
| RED | XXXXX | RED |
| BLUE | XXXXX | BLUE |
| BLUE | XXXXX | GREEN |
| GREEN | XXXXX | RED |
| BLUE | XXXXX | GREEN |
| RED | XXXXX | BLUE |

Invasive EEG



From Actions to Empathy -Mirror Neuron



Joan M. Mas 2/2007

Important Questions

- Why is it that we get so deeply involved in such things as sports, videogames, movies, dances?
- Why is it that we have such strong emotional responses?
- How is it that we can read other people's body language and faces so well?
- What is it that allows us to connect so deeply when we watch other humans?

Monkey Evidence

- In monkeys
 - Originally found in premotor cortex
 - Same neurons fire when
 1. When monkey performs a goal-directed action
 2. When monkey observes a similar action



Not just a monkey thing... it is a people thing too!

- Growing up as children, first you see, then you do



- through this process we develop a rich basis of knowledge that we can use to apply to how we see other people
- when we see → we experience

The answer?...Mirror Neurons!

- a special circuitry found on both sides of the brain that helps us whenever we look at each other
- give us the ability to connect with one another
- the brain's way of translating what we see so we can relate to the world and understand it

Mirror neurons and autism

- Mirror neurons appear to exist in monkeys in the sense that particular cells in the motor cortex fire when the monkey sees an action performed as well as when they perform the action.
- Babies are born with the ability to imitate. It is suggested that this is due to the presence of mirror neurons.
- Autistic spectrum disorder is characterised by the kinds of problems we might expect to see if the mirror neuron system were not functioning correctly.
- This is the 'broken mirror' theory of autism.

Experiments

WORK IN PAIRS THROUGHOUT

1. Both grasp a small object, such as a pen
2. Now one of you grasp whilst the other watches only
3. Now just look at the object without grasping it

Around 20% of the neurons that fired when you grasped the object also fired when you watched your partner grasp that object. These are *mirror neurons*.

Some “logically related” mirror neurons, the same ones, will also have fired when you saw the object which may have been about to be grasped.

Not just actions... but FEELINGS too!

- Marco Iacoboni of UCLA did fMRI studies of emotional faces
- Results: the same neurons fired when you imitated a face seen on a picture (actually moving the facial muscles), as well as when you just looked at the picture
- suggests that mirror neurons send signals to the limbic and emotional systems in the brain
- this in turn allows us to *empathize*!



What does all this mean?

Deep in our architecture and biological makeup,
we are meant to be together, and *socially
interact.*



Mirror Neuron Dysfunction

- Many researchers have concluded that Autism is the result of Mirror Neuron Dysfunction



Characteristics of Autism



- Infants:
 - Avoid contact & fail to anticipate being picked up
- First Few Years of Development:
 - Might develop some skills such as walking or talking quicker than normal but other developments are considerably delayed

Impairments in social communication

Individuals with an ASD have impairments in social communication.
The way in which the person is affected varies.
These impairments can include difficulties in using and understanding:

speech

gestures

eye contact

tone of voice

language

Impairments in social interaction

Individuals with an ASD have impairments in social interaction. The way in which the person is affected varies.

These impairments can include difficulties in:

building and sustaining
relationships

sharing

giving and receiving
compliments

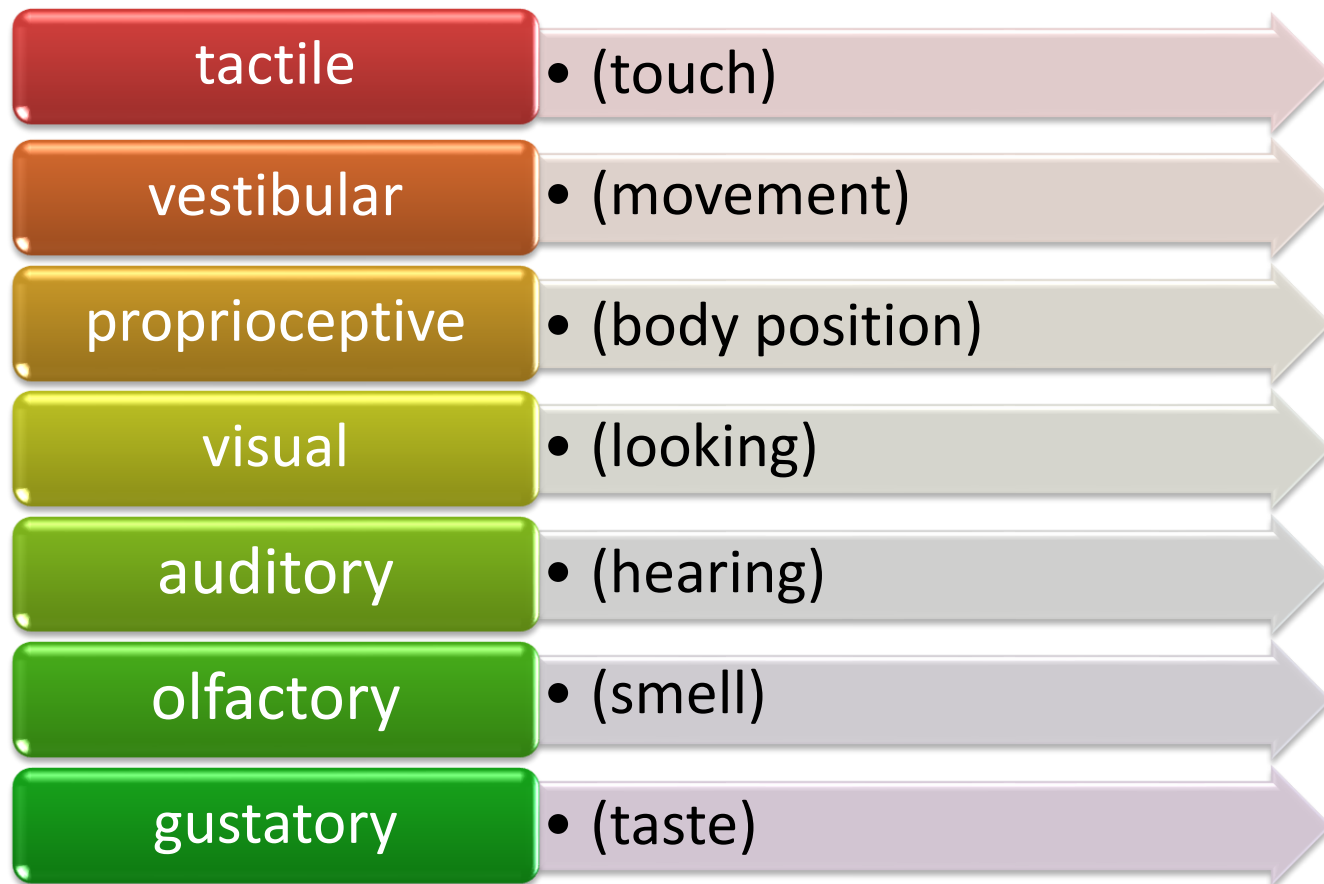
enjoying conversation

showing concern for others

understanding humour

Sensory issues

Many people with an autism can have sensory issues. The individual with ASD's perception of the senses can be heightened or decreased. All the senses can be affected.



Characteristics of Autism (cont'd.)

- Toddlers:
 - Abnormal behaviors
 - Start to see social dysfunctions
 - “Insistence of sameness”
 - Lack of imaginary play
 - Avoidance of eye contact



Cerebral cortex - a thin layer of gray matter on the surface of the cerebral hemispheres. Two-thirds of its area is deep in the fissures or folds. Responsible for the higher mental functions, general movement, perception, and behavioral reactions.

Amygdala - responsible for emotional responses, including aggressive behavior.

Hippocampus - makes it possible to remember new information and recent events.

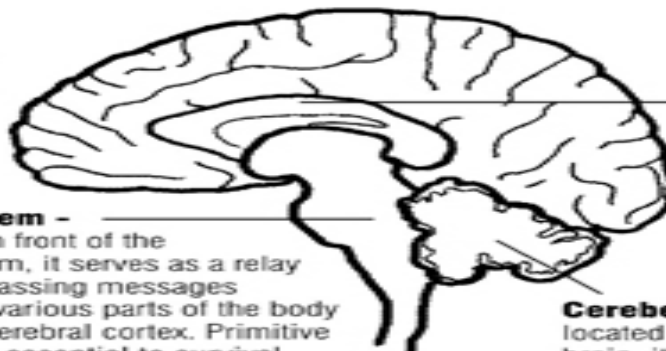
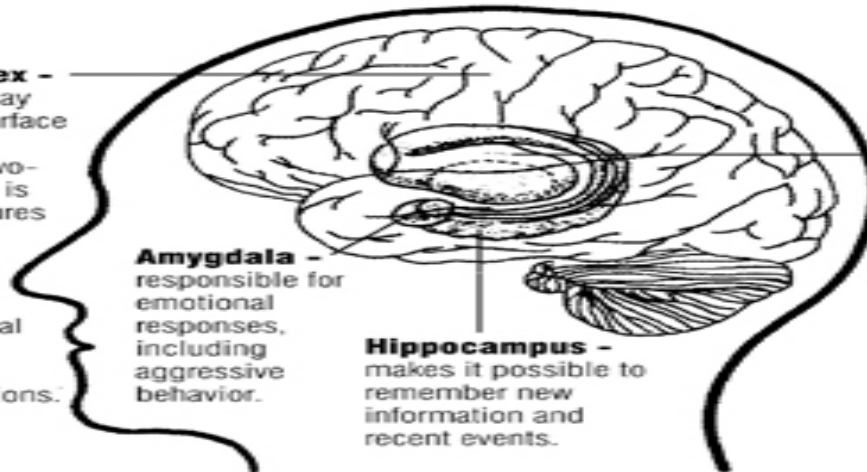
Basal ganglia - gray masses deep in the cerebral hemisphere that serves as a connection between the cerebrum and cerebellum. Helps to regulate automatic movement.

Major Brain Structures Implicated in Autism

Brain stem - located in front of the cerebellum, it serves as a relay station, passing messages between various parts of the body and the cerebral cortex. Primitive functions essential to survival (breathing and heart rate control) are located here.

Corpus callosum - consists primarily of closely packed bundles of fibers that connect the right and left hemisphere and allows for communication between the hemispheres.

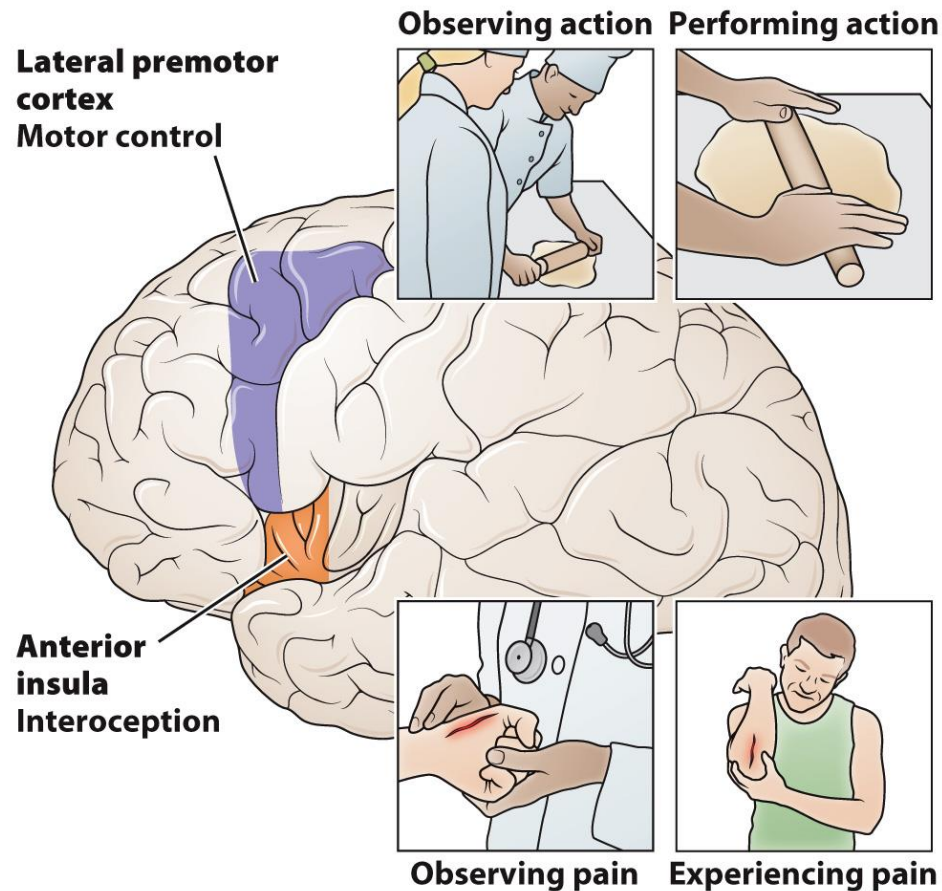
Cerebellum - located at the back of the brain, it fine tunes our motor activity, regulates balance, body movements, coordination, and the muscles used in speaking.



The Mirror Neuron System (MNS)

- Discovery published in 1992 when found macaque monkeys
- Subset of Neurons activates both while observing and while performing:
 - Actions such as grasping
 - Emotions such as sadness
 - Watching someone receive painful events such as shocks
- “Thus, our capacity for **empathy – the ability to share another’s emotions and feelings** – is based in a simple ‘mirroring’ mechanism implemented by the human MNS that allows us to use the same neural resources to represent states of the self and others in an overlapping way.”
- <http://video.pbs.org/video/1615173073/>

Neural Mechanisms of Emotional Mimicry and Contagion



Modern Social Neuroscience: How do we Understand the Other ?

- **Theory of Mind (TOM) & Mentalizing**
refers to our ability to understand **mental states** such as intentions, desires and beliefs of others.
- **Empathy**
refers to our ability to share the **feelings** of others, be it a particular **emotion** or **sensory** state of the other.



Perception of Socially Salient Features

Emotional Facial Expressions



Familiar and Famous Faces



Morris et al. (1986). *Nature*; Phillips et al., (1997).

Modulation of Empathic Responses

- Theories of social preferences predict that empathy should be **modulated** by the perceived fairness of other individuals, and that individual agents punish violations of social norms.
- Thus, empathy should be reduced or abolished towards agents whose behaviour deemed socially unfair and thus whom we dislike.
- Instead we might expect to observe evidence of '**Schadenfreude**' – the feeling of satisfaction experienced when social violators experience punishment –as predicted by studies of altruistic punishment



Understanding Empathy

“This finding showed that the representation of intentions and actions is automatic and pre-cognitive – the MNS is activated without conscious effort (Iacoboni et al., 2005). This implies that ‘mirror neurons are a kind of ‘neural wi-fi’ that monitors what is happening in the other people. This system tracks their emotions, what movements they’re making, what they intend and it activates, in our brains, precisely the same brain areas as are active in the other person. This puts us on the same wavelength and it does it automatically, instantaneously and unconsciously’ (Goleman, 2006).”