Psychiatry an Overview
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Module-01
Brain and Behavior -Approaches
Lecture-02
Neurophysiology

So in the in the last lecture we ended it after covering the Neuroanatomy onto the very grossly telling you about how the brain functions we move on to looking taking a slightly deeper look at how the brain functions, as I said at the end of the last lecture is the electrochemical activity, in the brain which generates behavior by working in the various specialized areas of brain the firing between 10 to the power 11 neurons which are connected in columns and in the form of functional cell assembly.

So just look at we will try to look at how actually it happens in the brain but before that few names are important.

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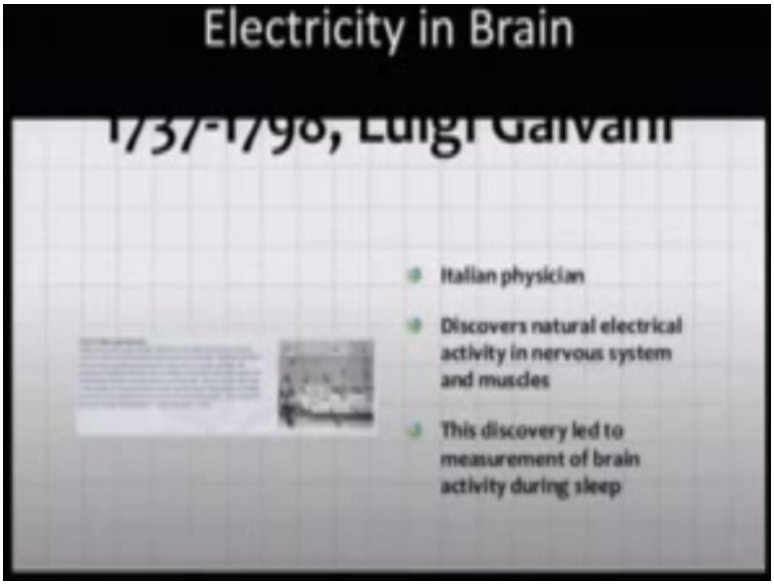

One people who discovered this function one is Galvani who discovered the natural electrical activity in the nervous system which led to the measurement of brain activity.

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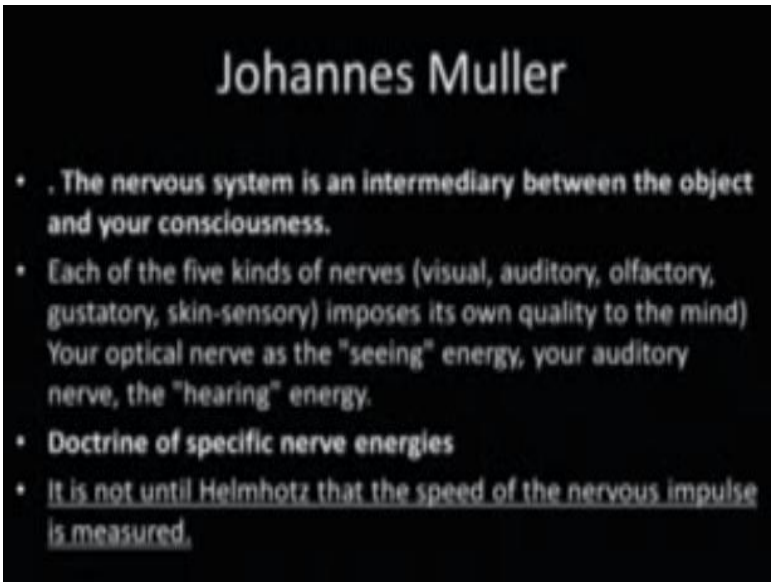

Muller who actually defined this five kinds of nerves visual auditory and but it was and the doctrine of specific never energies he was actually telling the nerves are specialized in passing information, but it was Helmholtz who actually give the speed.

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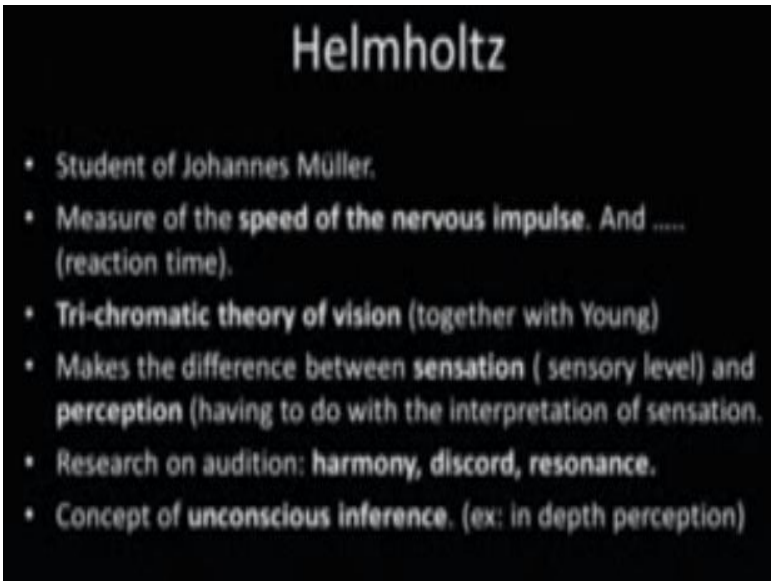

Of the nervous impulse, the electricity which passes through the axon, he also give the Trichromatic theory of vision the difference between sensation and perception audition have not he actually contributed a lot to understanding of the electrical activity in the brain and as I told you last time that it is the neurotransmitters which actually pass, the information from one neuron to the other and as he would remember it is not one neuron which is passing to one neuron.

It is an sample of neuron cell as some neuronal assemblies which pass information from one group to the other, irrespective of where they are situated so one of these is acetylcholine.

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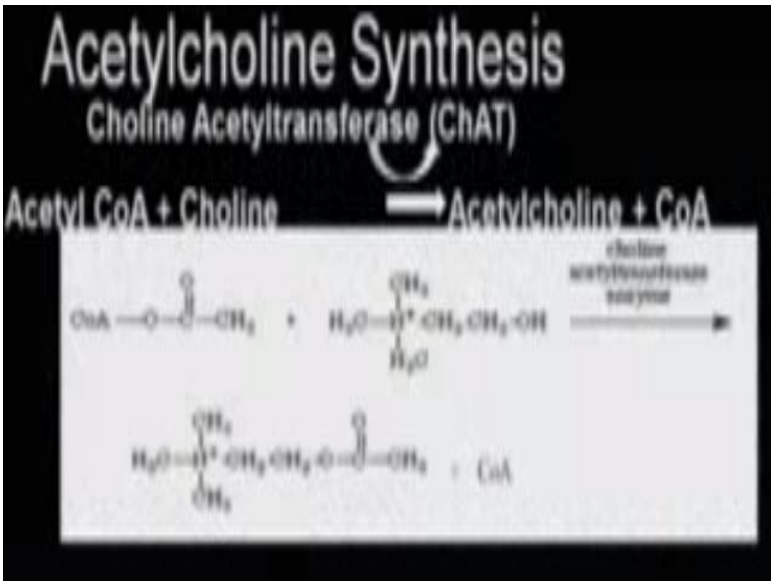

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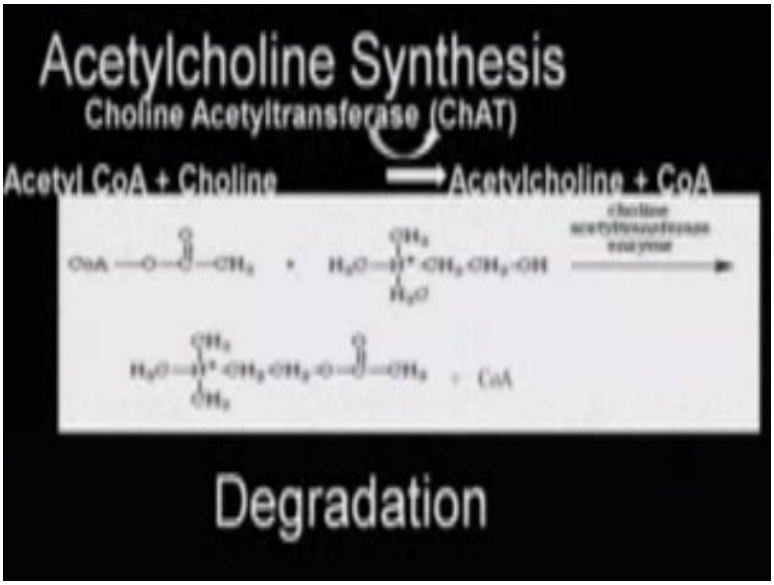

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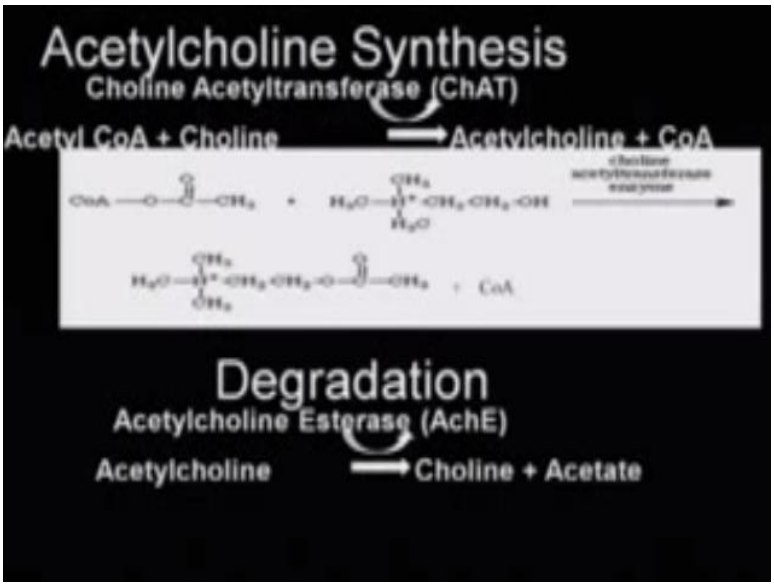

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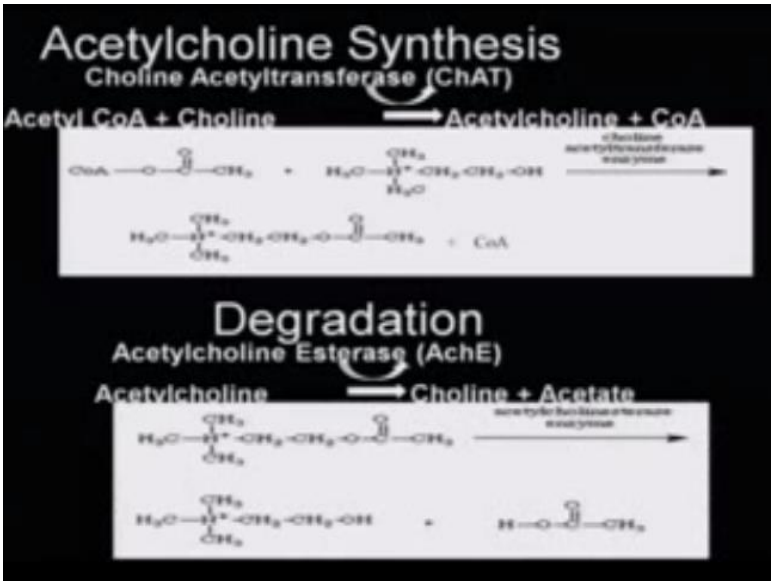

Acetylcholine is a this is just how it is formulated.

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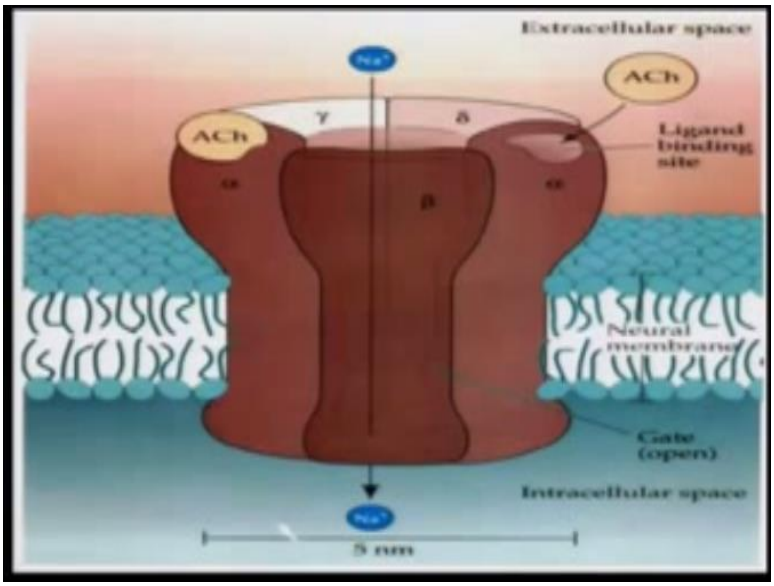

An Acetylcholine has its receptors on the cell body and then dendrite.

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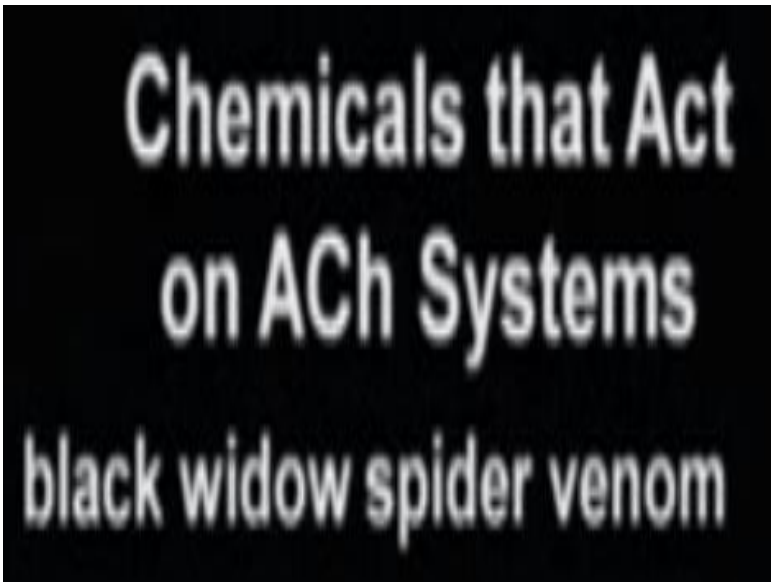

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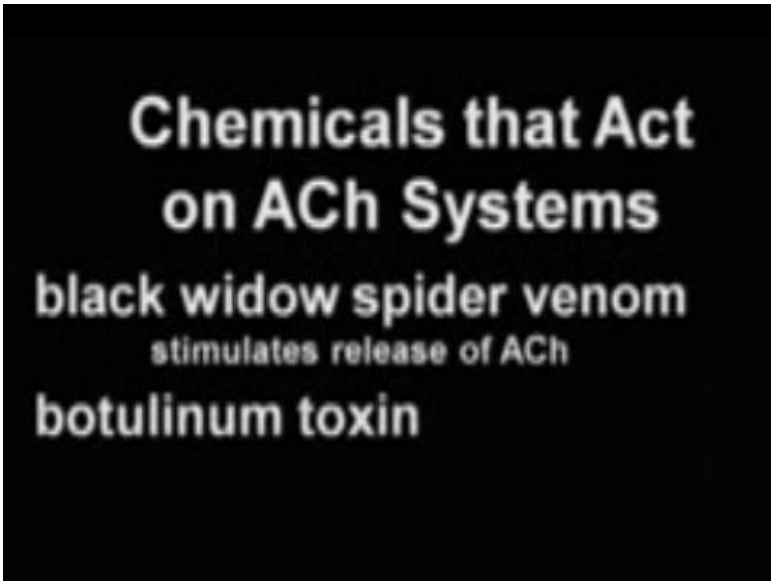

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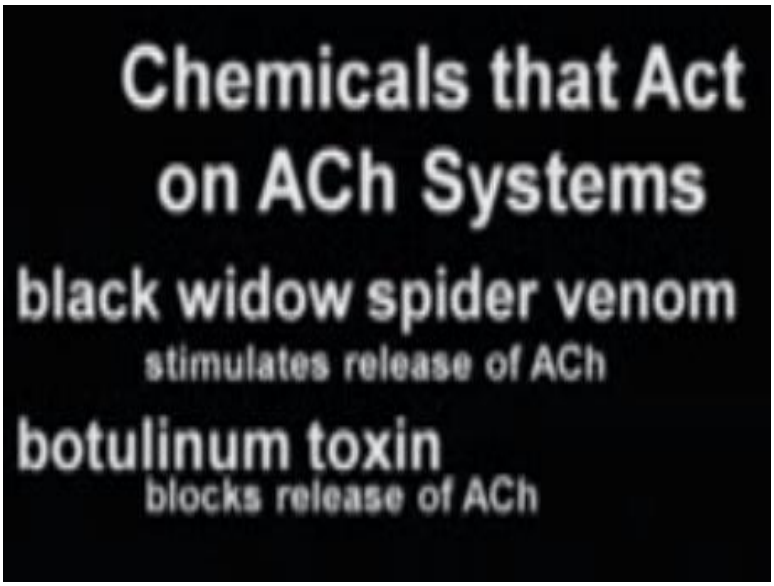

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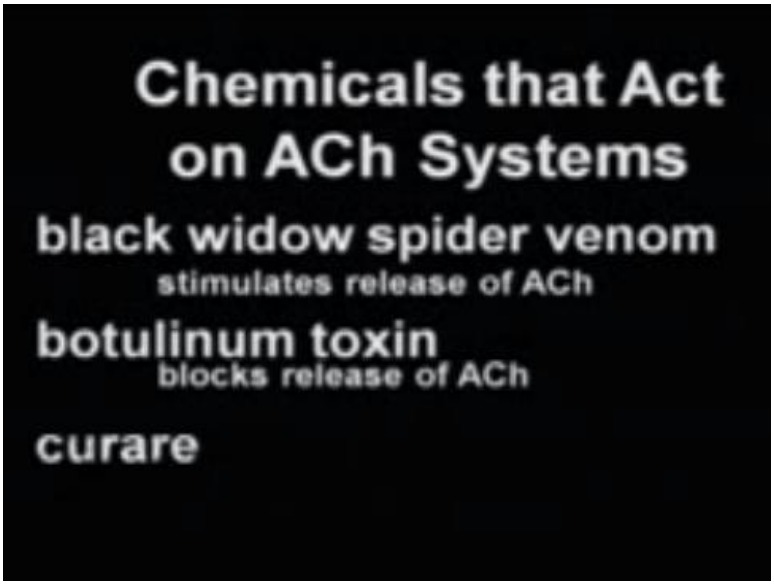

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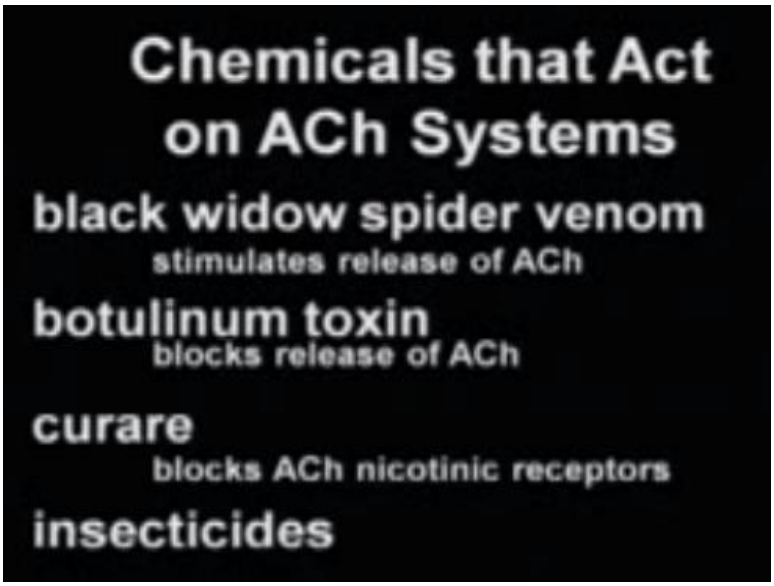

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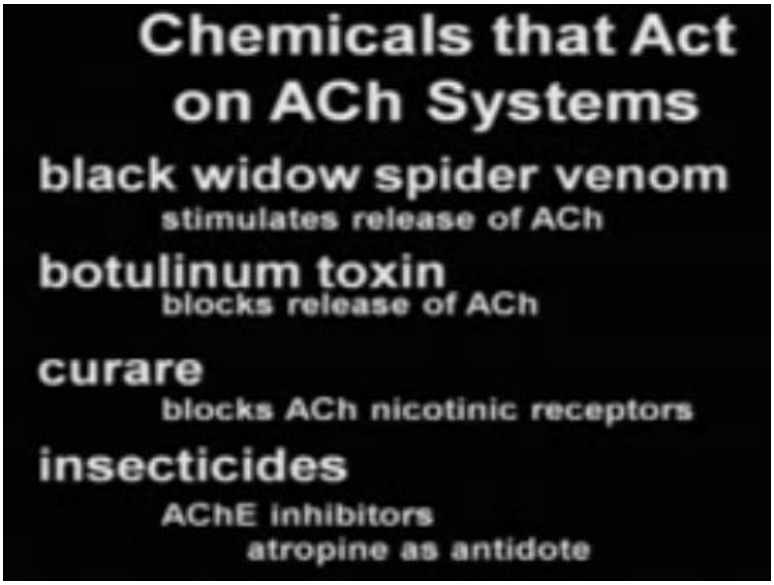

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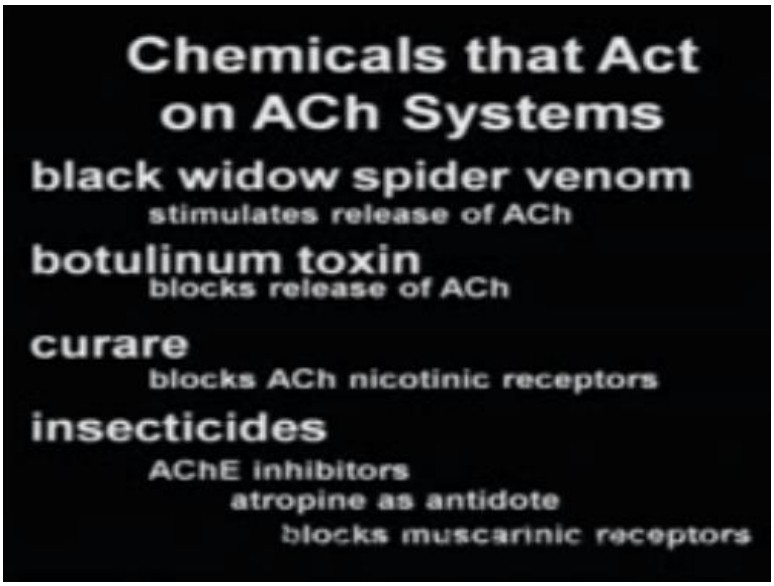

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Will bypass this how it is so these neurotransmitters are being made in the specialized cell body and the neurons and was the past from the axon to the dendrite of other neuron they either excited or innovative.

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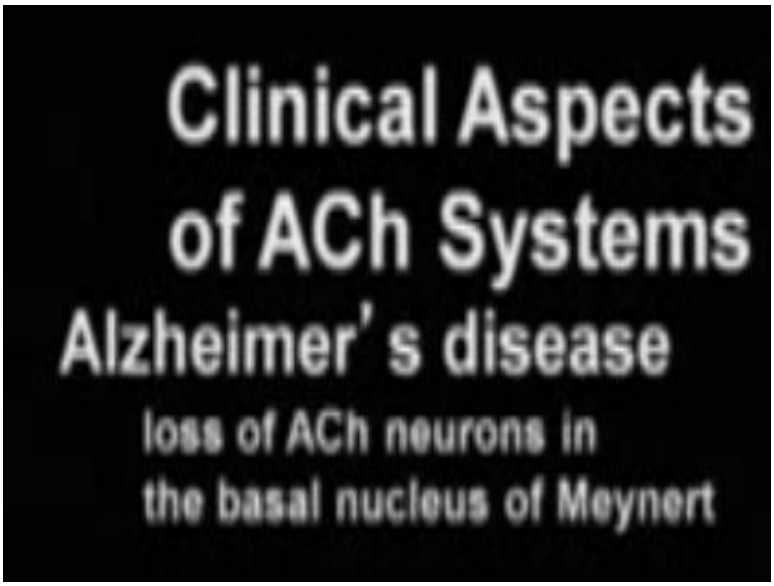

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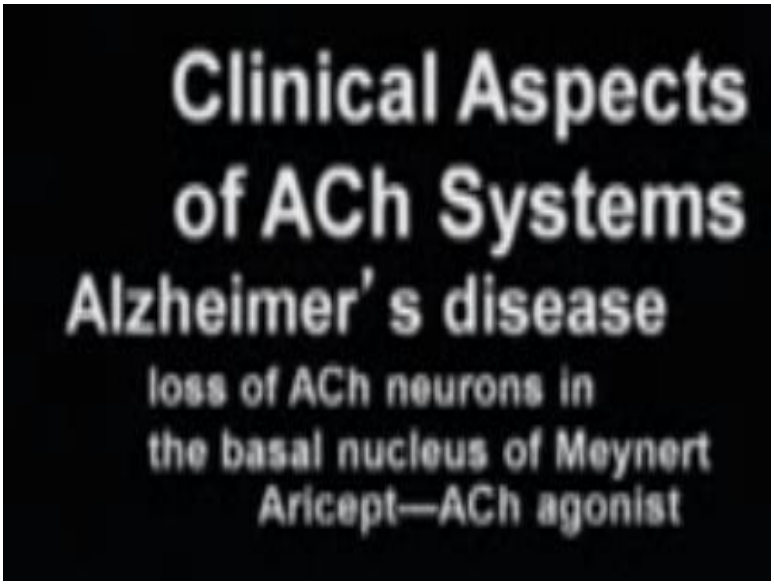

These are important because this is on the basis of this discovery of the neurotransmitter their levels and their receptors the drugs have been made which can alter their levels in the brain, in the form of tablets or injections and then in turn altering the behavior.

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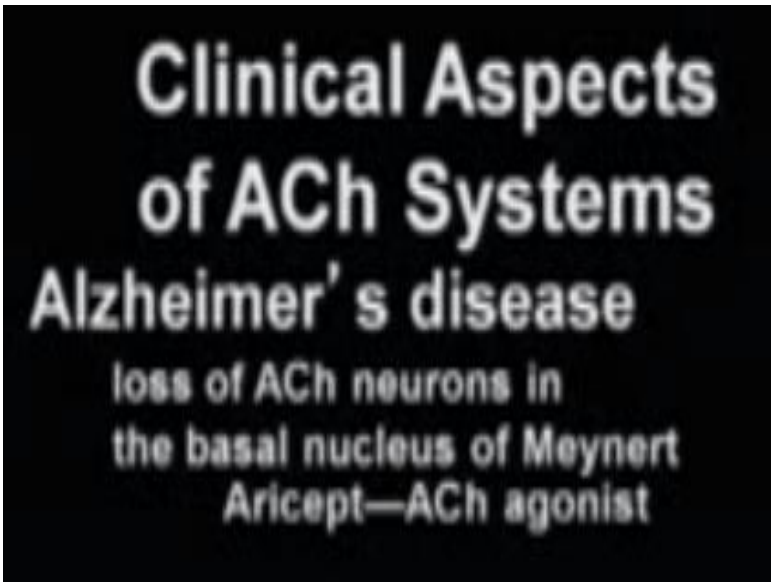

So these neurotransmitters actually regulate the electrical firing which in turns leads to normal behavior or abnormal behavior alteration of ways to external chemicals can impact illness.

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So one Acetylcholine the other is Monaminergic.

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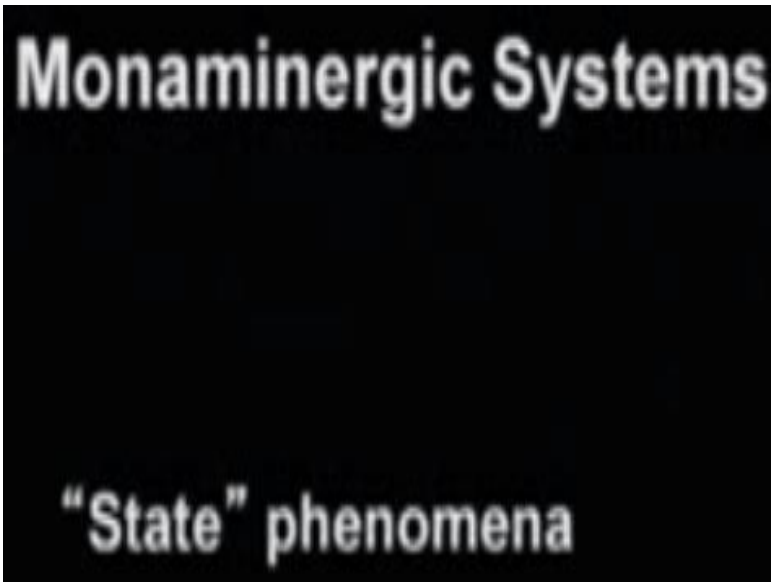

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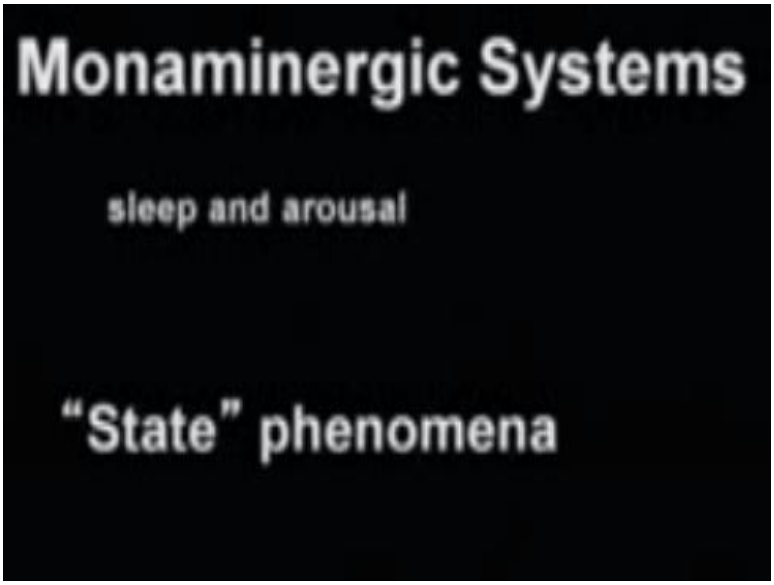

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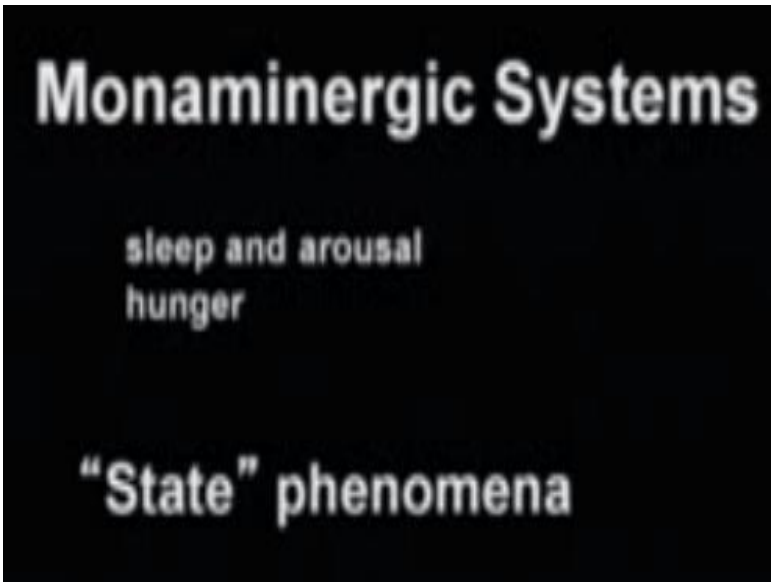

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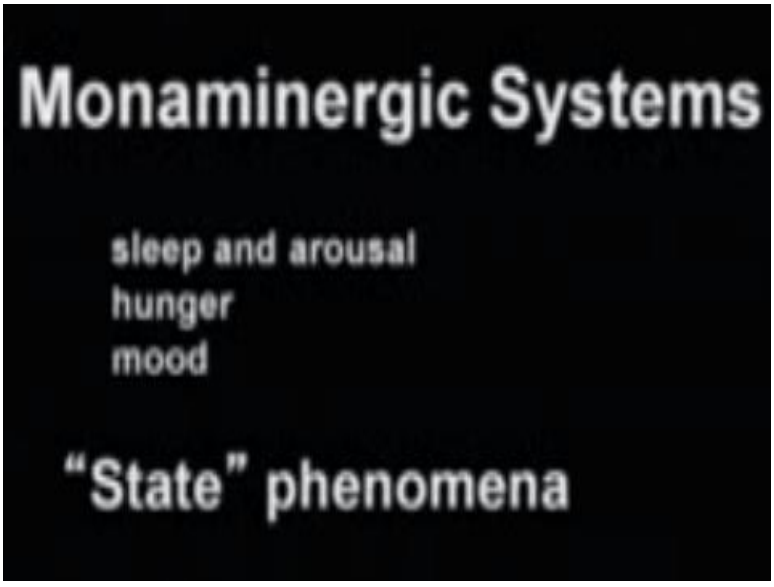

Which regulates sleep and arousal and hunger and mood.

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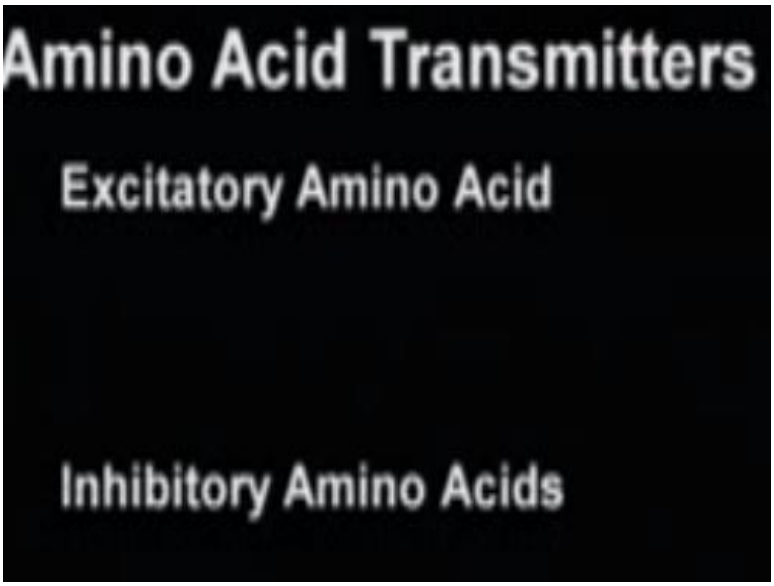

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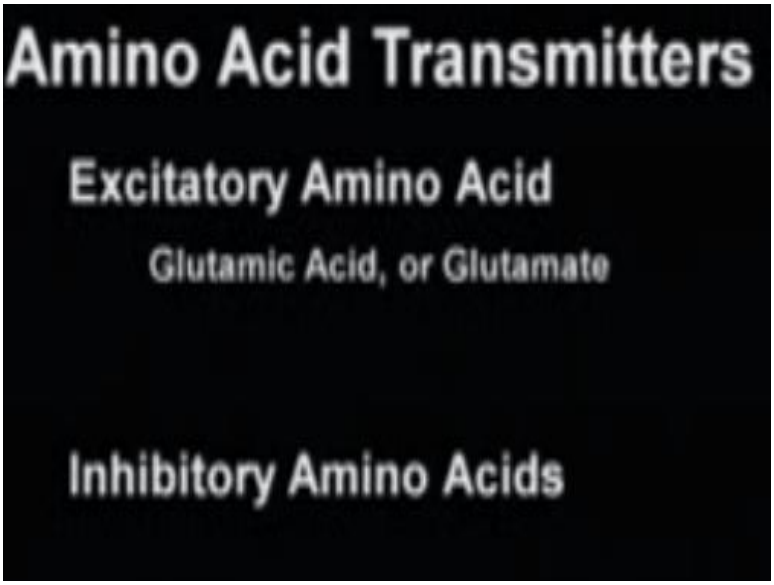

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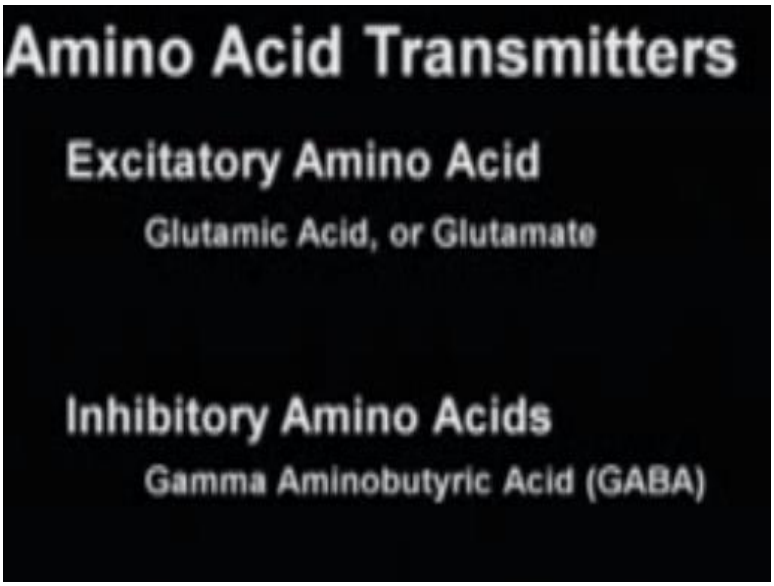

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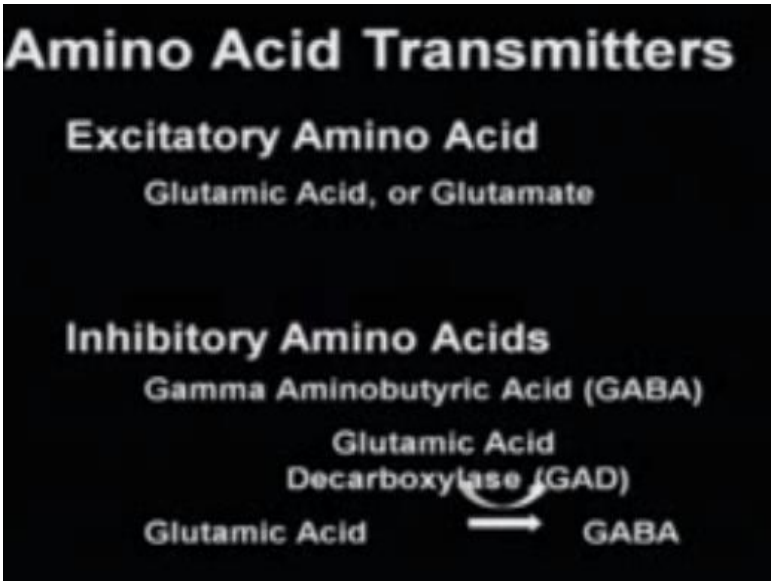

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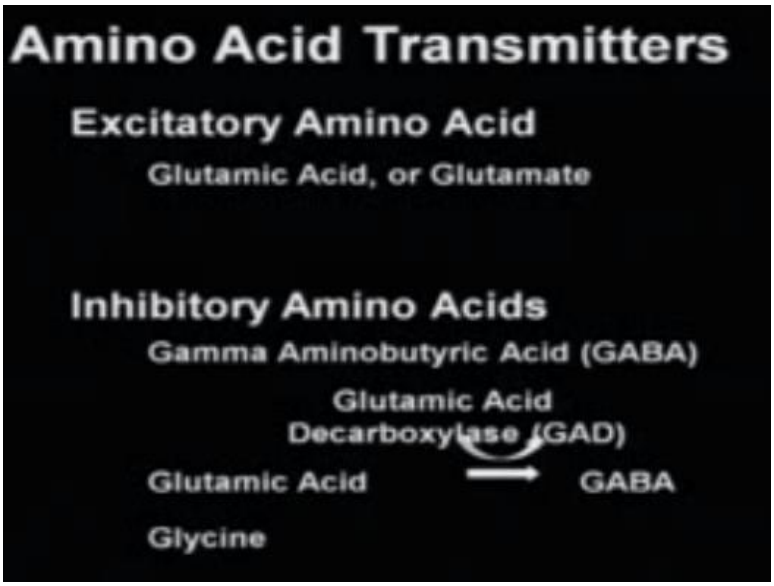

Amino acids like Excitatory Amino Acids like glutamate inhibitory like GABA Gamma Aminobutyric Acid.

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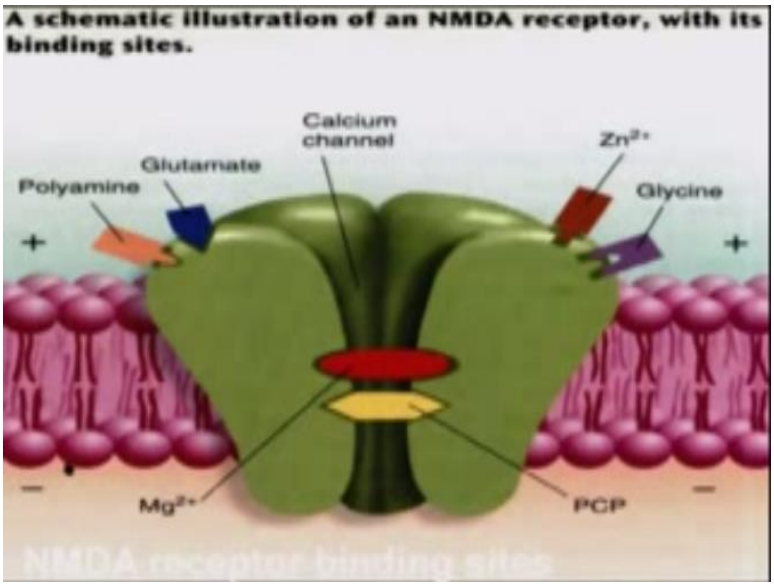

So NMDA receptor this is just to show you how it functions this is one of the glutamate receptors and these are the sites where glutamate combined, depending on the binding of glutamate this may open and as I said it can allow sodium to flow in or, to depolarize or to polarize it can increase the positivity outside but excitatory, so they will always lead to a reversal of polarization, on setting a current.

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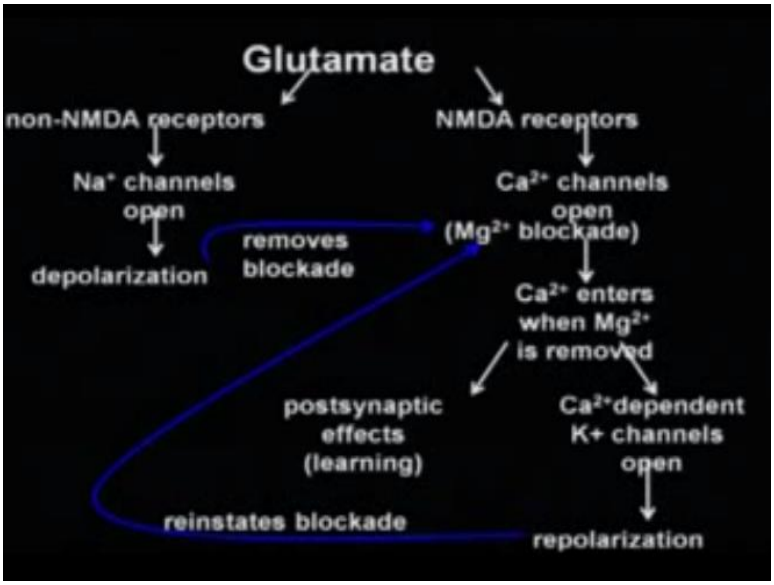

This is one of the slide which shows you that sodium channels open it leads to depolarization here calcium channel opens this calcium enters when magnesium removed and leads repolarization, so these are the process depolarization and repolarization.

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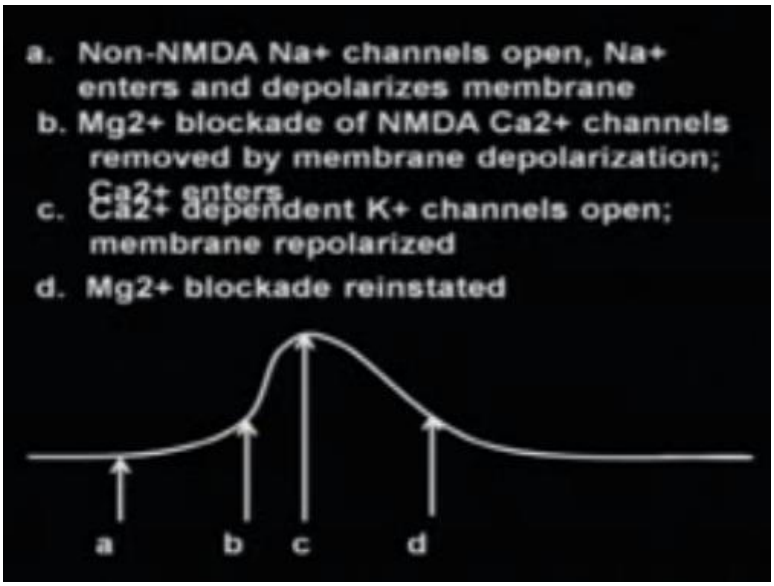

Through which the firing is control.

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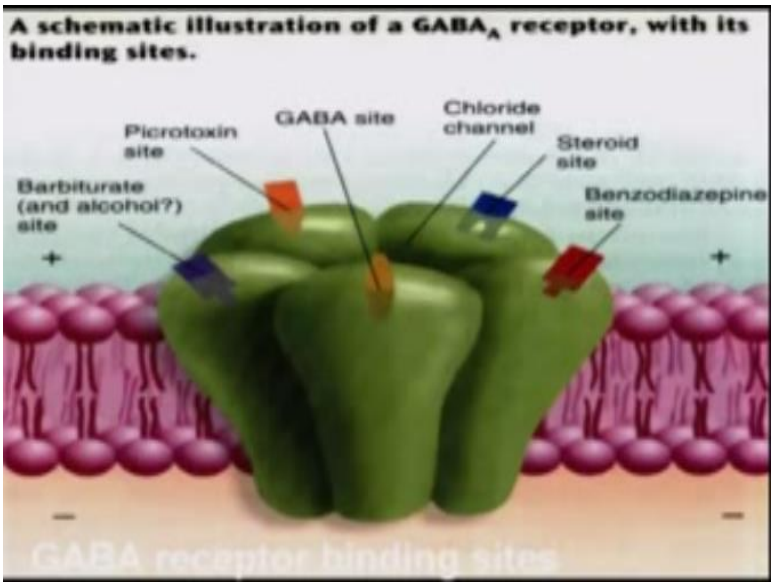

These are the GABA receptor.

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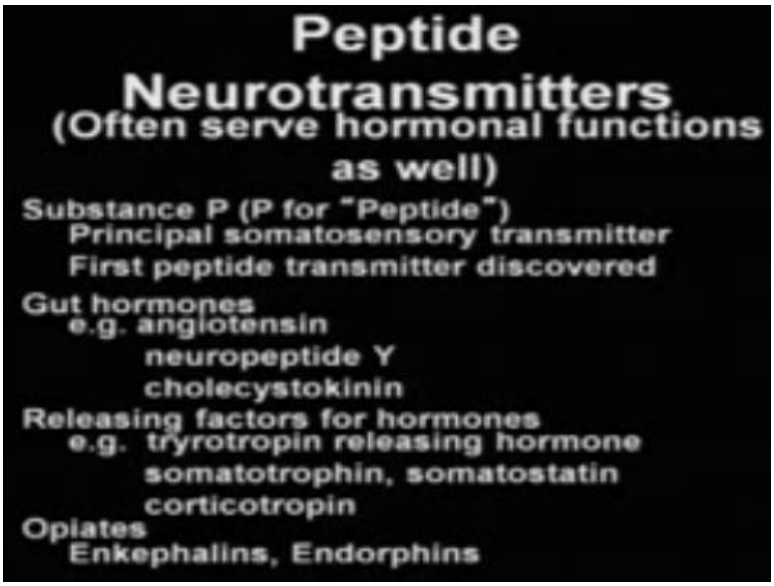

The other receptors which serve this hormone substance be Gut hormones like angiotensin neuropeptide Y releasing factor for hormones.

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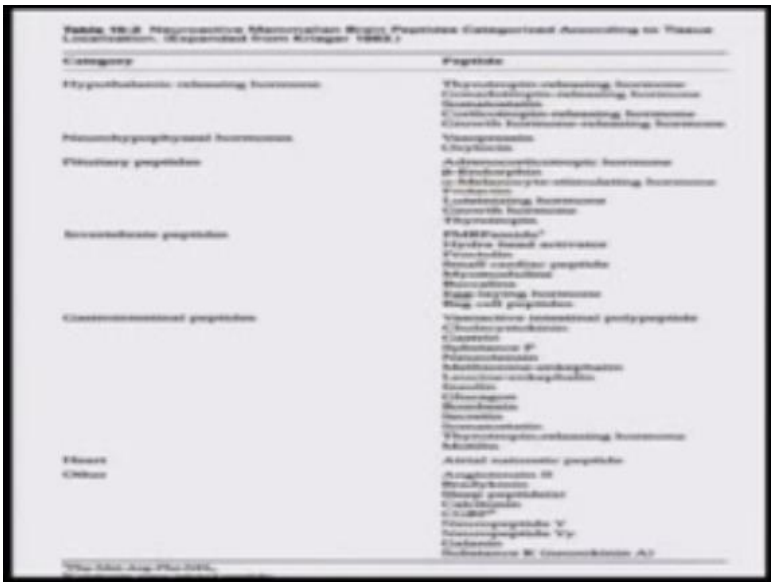

So this is just a list of all the type of chemical they are many more which are being in the process of being discovered, this chemicals are spread all through the body.

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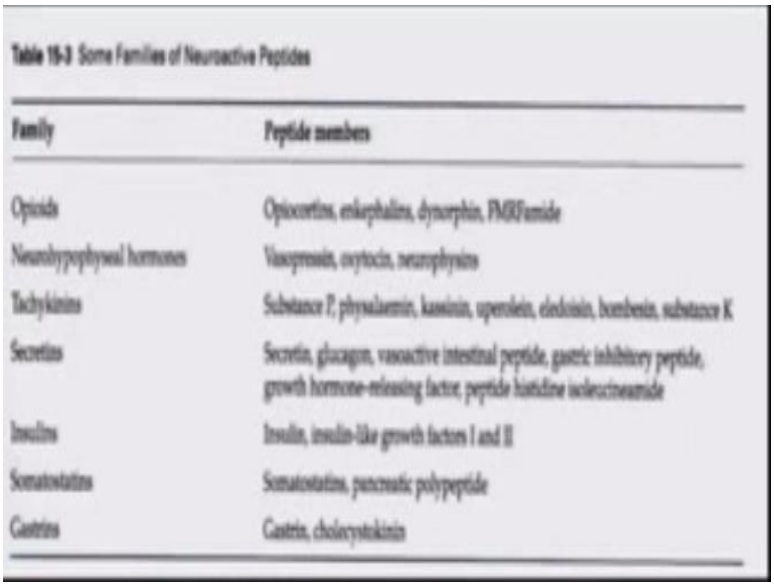

Table 19-3 Some Families of Neuroactive Peptides

Family	Peptide members
Opioids	Opiocortins, enkephalins, dynorphin, FMRFamide
Neurohypophyseal hormones	Vasopressin, oxytocin, neurophysins
Tachykinins	Substance P, physalaemin, kassinin, uperolein, eledoisin, bombesin, substance K
Secretins	Secretin, glucagon, vasoactive intestinal peptide, gastric inhibitory peptide, growth hormone-releasing factor, peptide histidine isoleucineamide
Insulins	Insulin, insulin-like growth factors I and II
Somatostatins	Somatostatins, pancreatic polypeptide
Gastrins	Gastrin, cholecystokinin

But we are focusing here are so these are neuroactive opioids if you if you look at opioids which also form some drugs of abuse like morphine and heroin they are naturally present in the human brain controlling what we call reward systems, like and opioins also do it. The reward system is area for a brain where if you do a certain activity that brain area feels pleasure in that and you feel a sensation of sensation of being of feeling good and that is why the brain has this tendency of repeating that action which makes you feel good.

That is the whole perceived of happiness, sometimes some people if you, you all must be knowing of the term call addiction this is one of the basis of addiction that somebody uses some chemicals has a good feeling and tends to use it again tell he keeps using it till a point, where that same amount of chemical stops giving that pleasurable feeling and that is the basis of what he called tolerance when people increase the amount of the drug which they are using drugs or alcohol.

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Table 16-1 Small-Molecule Transmitter Substances and Their Key Biosynthetic Enzymes

Transmitter	Enzymes	Activity
Acetylcholine	Choline acetyltransferase	Specific
Biogenic amines		
Dopamine	Tyrosine hydroxylase	Specific
Norepinephrine	Tyrosine hydroxylase and dopamine β-hydroxylase	Specific
Epinephrine	Tyrosine hydroxylase and dopamine β-hydroxylase	Specific
Serotonin	Tryptophan hydroxylase	Specific
Histamine	Histidine decarboxylase	Specificity uncertain
Amino acids		
γ-Aminobutyric acid	Glutamic acid decarboxylase	Probably specific
Glycine	Enzymes operating in general metabolism	Specific pathway undetermined
Glutamate	Enzymes operating in general metabolism	Specific pathway undetermined

It is also basis of habit formation whatever you feel go to tend to keep doing again the basis of it is feeling good inside in this reward system, so these what I have already mention acetylcholine dopamine, norepinephrine and serotonin and histamine GABA.

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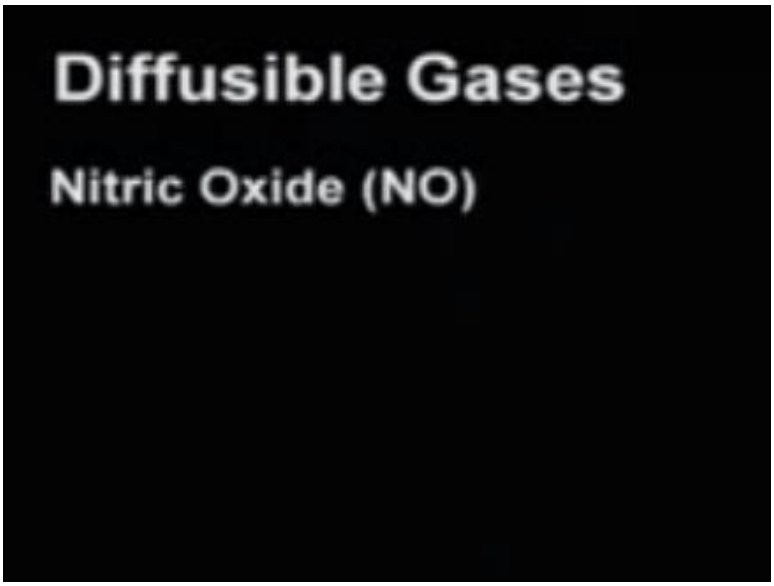

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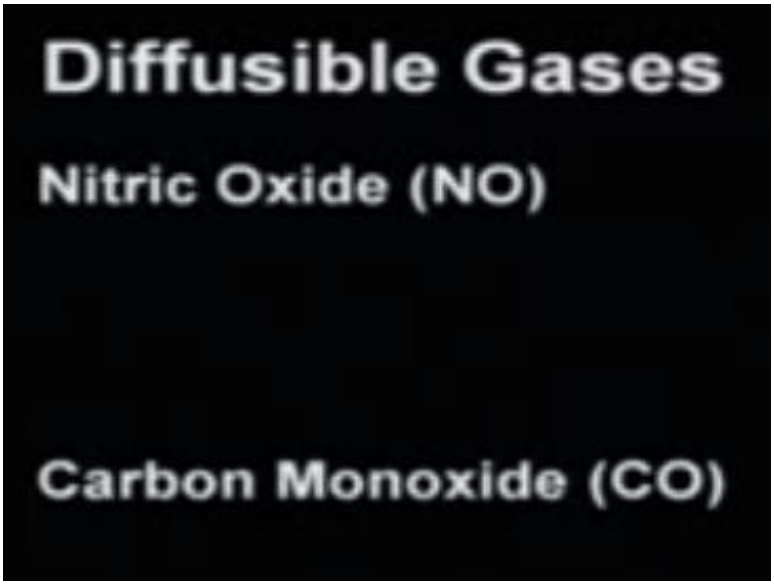

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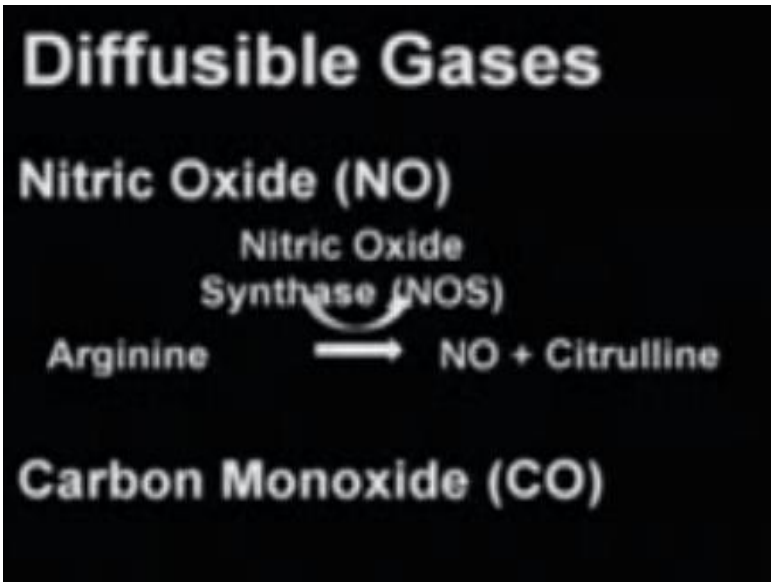

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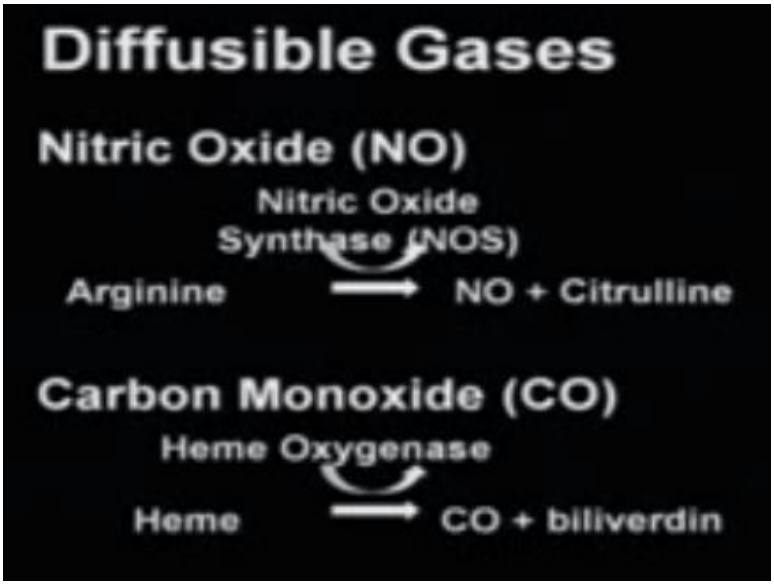

Nitric oxide is a divisible gases.

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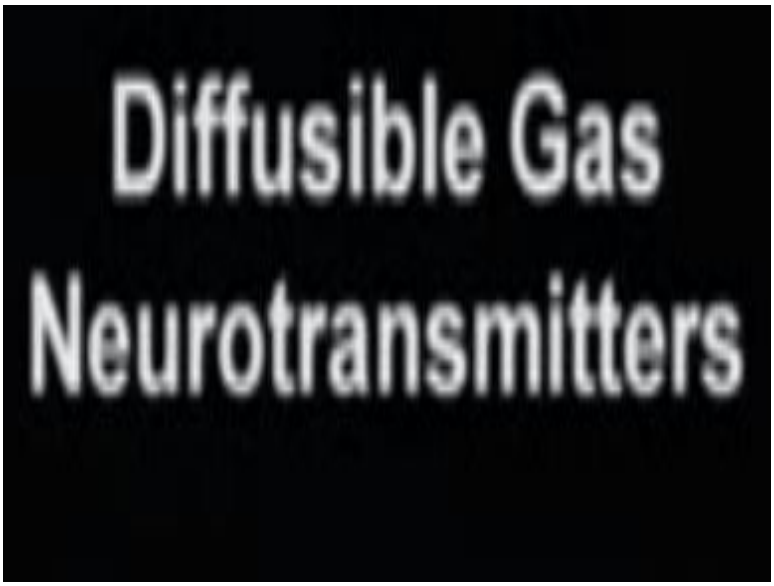

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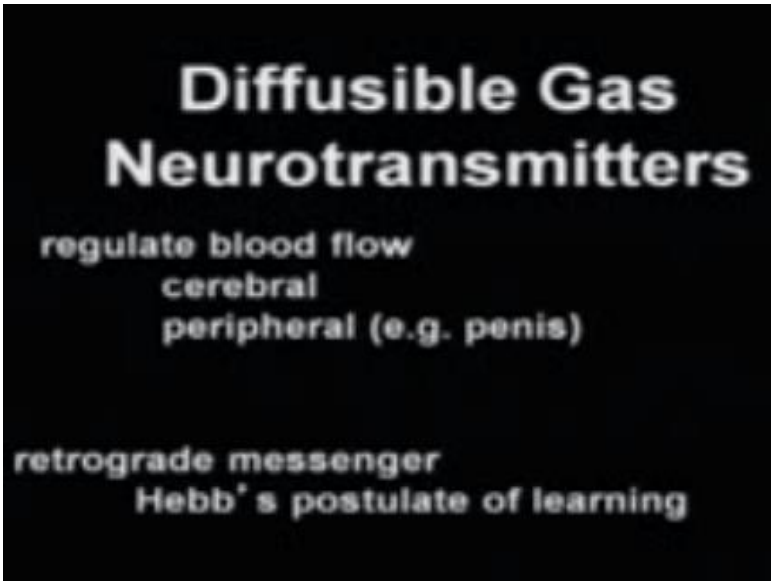

Will skip this details they actually regulate the blood flow in the brain and periphery especially the nitric oxide is the basis of this common drug called Viagra where it controls the blood flow to the penis.

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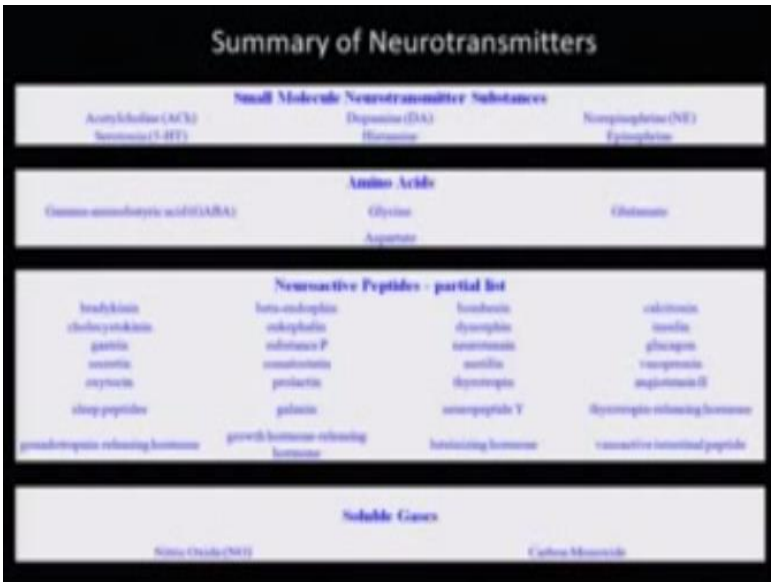

So this is a small summary.

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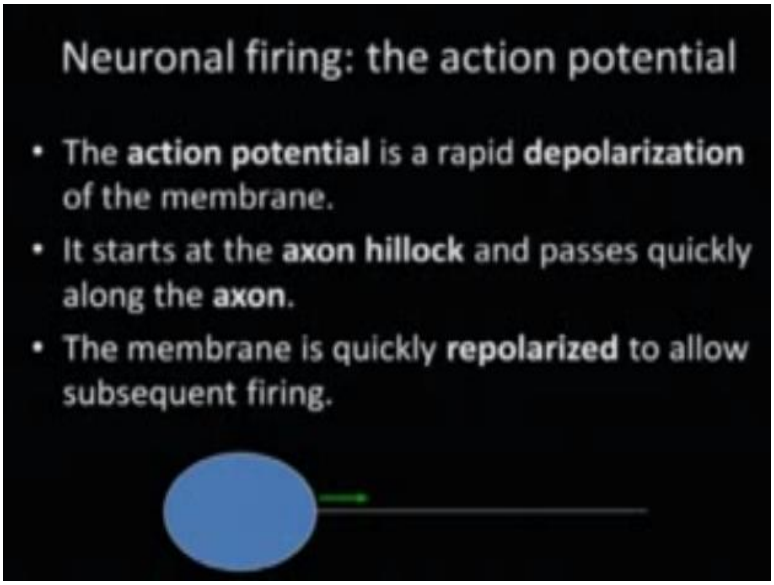

So now once this these chemical secreted the according to the neural receptors depending on the specialization and their function they either excited or inhibit but then what starts

at the cell body is the basis of all electricity in the brain and that is called the action potential.

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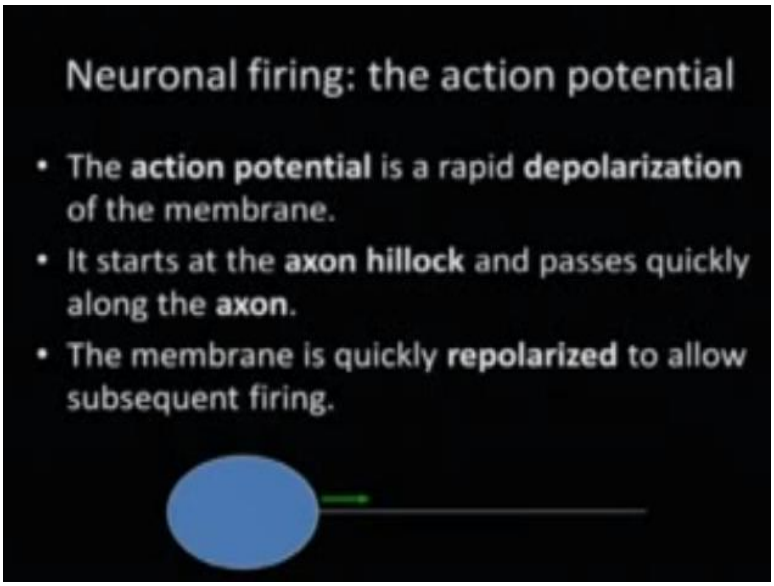

It is a rapid, depolarization of the membrane. Depolarization as you know is the reversal of the positivity which normally in a polarized state is positive outside the cell membrane and negative inside, the rapid depolarization it starts at the axon hillock and passes quickly along the axon, at the end of the cell body it starts, it is quickly repolarized to allow subsequent firing.

So once this wave of depolarization passes from one small area to the adjoining area the previous areas are repolarized to allow, the further signal processing.

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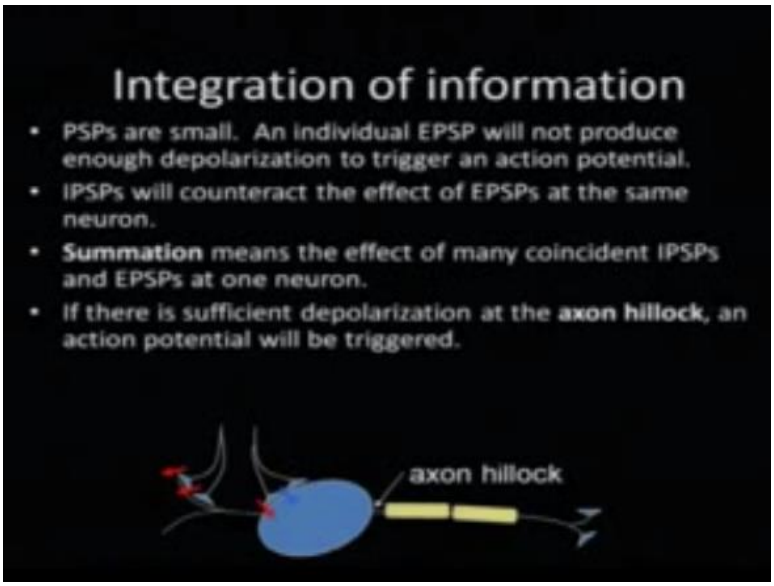

So this postsynaptic potential small an individual neuron as I said will not produce enough depolarization, similarly the inhibitory postsynaptic will counter the effect of excitatory. So as I told you there multiple if you look at this the multiple neurons descend on a deride or a body of the neuron called axon hillock where the axon is starting, and all this inputs whether they are excitatory postsynaptic potentials.

Postsynaptic is this Presynaptic is before the gap if they are excitatory or inhibitory some of them may be excitatory some of them may be inhibitory so this summation which goes on summation can be special or temporarily, special means that if you take a small area and the number of neurons which are descending on it, so the EPSP and IPSP counter each other and whatever the net result is will decide whether it is going to fire or not.

Or they may be temporal maybe they are few neurons and in a sequence the signal is coming from the top and depending on the speed and the is the inhibition or excitation which they cause that can also be submitted so but if there is sufficient depolarization which starts here action potentially will be triggered which will be passing on to the.

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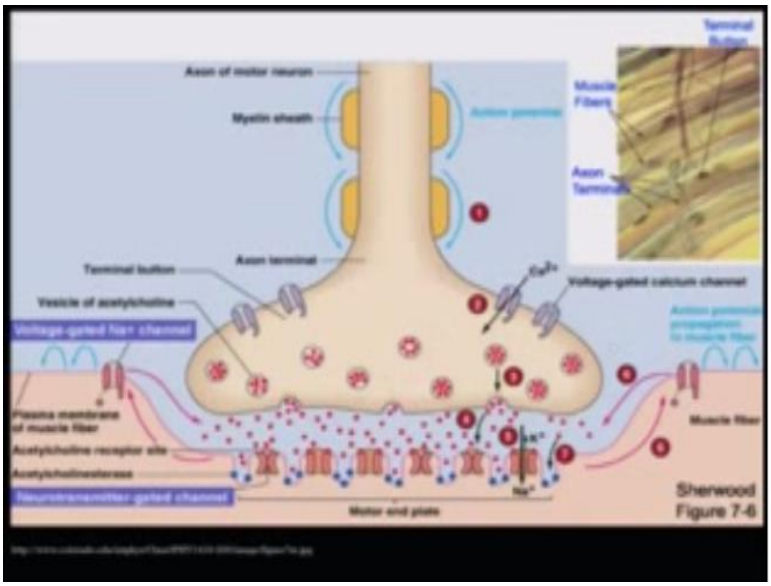

Other neurons it is like here, you can see it eventually this is a muscle fiber so even when you have to move your muscle actually the nervous which exit the spinal cord and go and end on the muscles they will secrete chemicals which will decide whether the muscle fiber is going to contract or not.

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So that is broadly how the neurons function but if this is where we talk of one or two neurons but when we look at the sample of neurons and when they get together and as I said they form functional assemblies and they also from the specialized areas, all this range of human behavior comes. This is just a broad thing to show you whether how the left brain and the right brain function.

It is not exact division but largely some functions have been associated with the left brain logic and analytical strategy practical controlling this functions, of our behavior are largely controlled by the left brain where is the right brain is more freedom passion creative, right as a tendency to look over the overall picture where the left is more sequential and linear.

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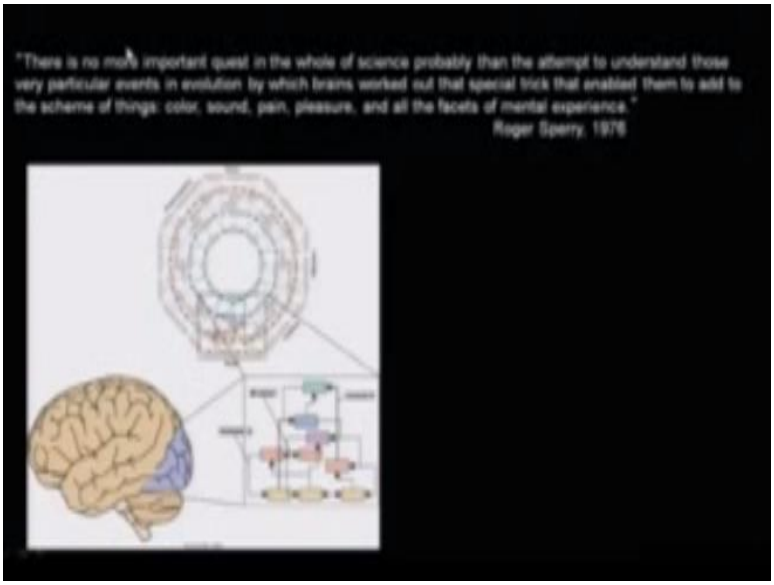

That this is very important sentence is no more important quest in the whole of science when they attempt to understand very events in evolution by which brain worked out that special trick, that enable them to add to the scheme of things color sound pain pleasure and all the facets they are essentially seeing that in the evolution the brain gained these functions, and to make us fit with all the possible sensations and mental experiences,

Sperry was the person who studied the split brain and the corpus callosum is damaged and the two brains function separately and you will be surprised to know they it seemed to have their own existence what the left brain may see the right brain may not see especially in this brain-damaged patients, where the left and brain function the corpus callosum is gone.

So the left brain may say if you ask a question what do you want to be the left brain may give another answer right brain may have another idea about your life.
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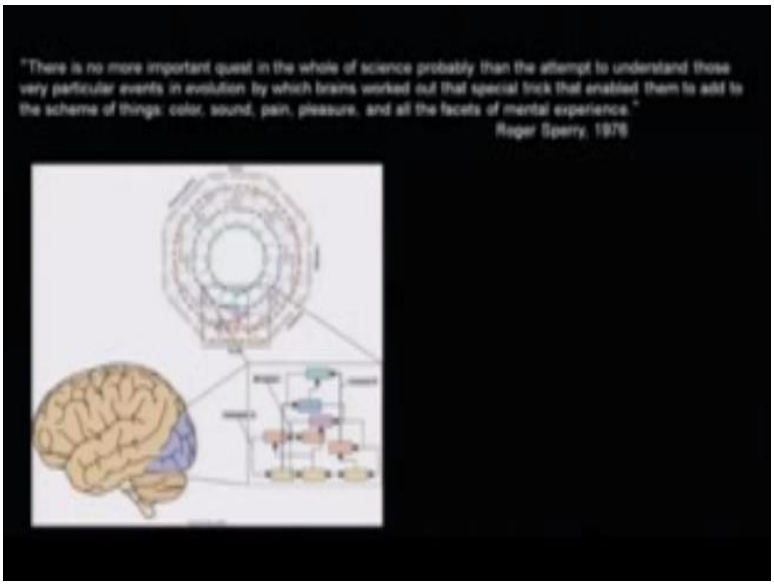

At the end of the day it is they have to combine and integrate to make a composite whole.

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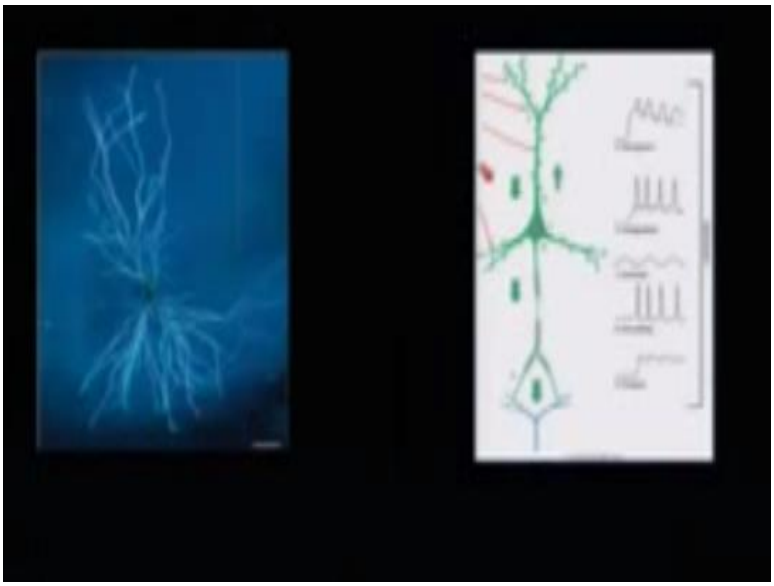

Again just to reiterate what I was telling you, so you receive the signal here is the reception its integration that is a summation which goes and then it passes on signal is encoded the output and which fires the other neurons.

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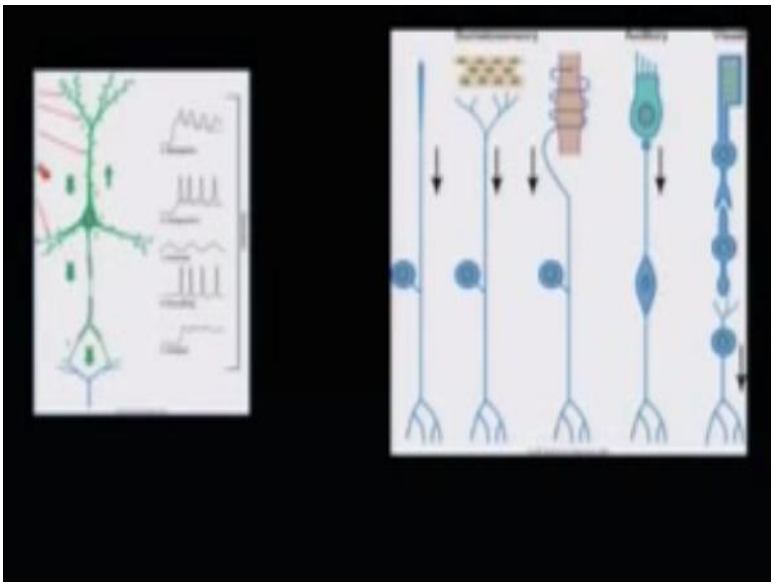

Again the same somatosensory visual and this is how neurons are arranged in different layers.

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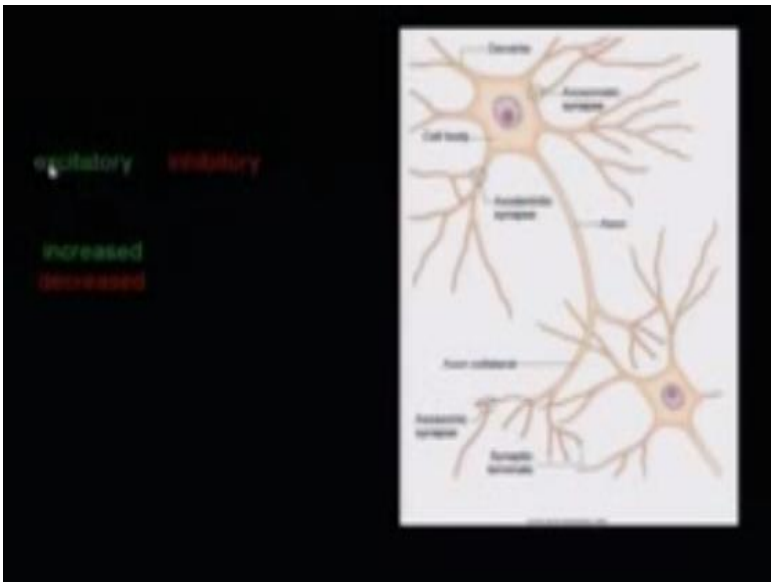

So excited three is this inhibitory is increase and decrease so if it goes on like this like axon comes puts a chemical here it is maybe excitedly the other one comes which may be inhibitory these to be summates and net productively passed down.

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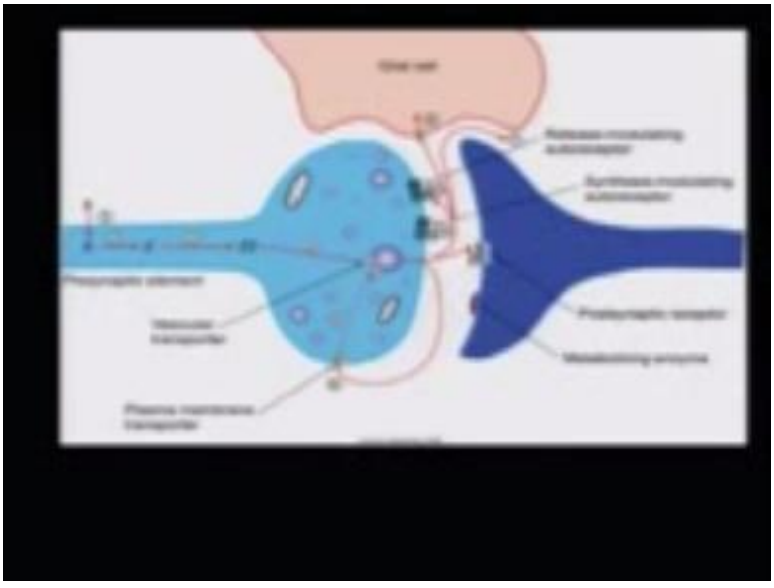

It is important to understand this electrochemical range of behavior, because this is where the drug treatment of the pharmacology works.

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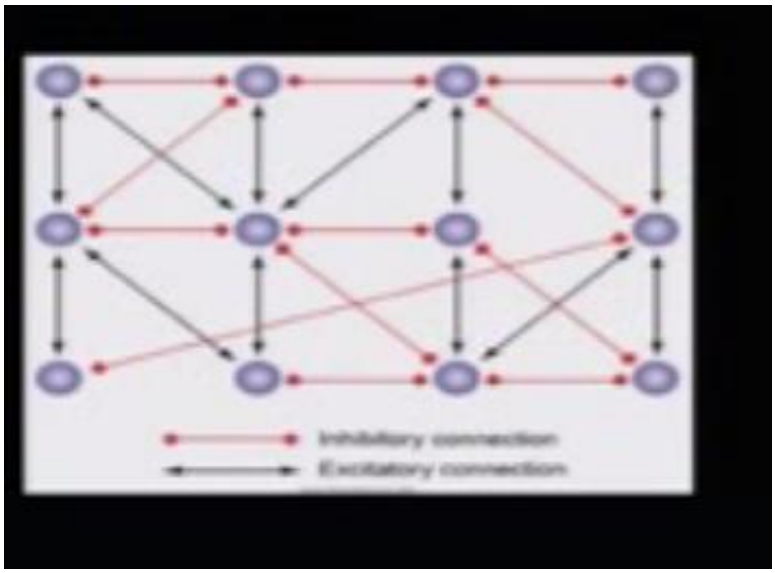

If you put it on network form and you can just have patience to just look at this these maybe these are the neurons and this may be innovatory connection this will be excitedly this is how neurons are connected. They are just few of them take it to a scale of 10 to the power 11 not all neurons are connected to each other but each neuron is connected to the other by maximum of two to three synapses.

So between one neuron to another it may be a different distances and different geographical location, is still there be two or three intervening neurons which will actually connect them.

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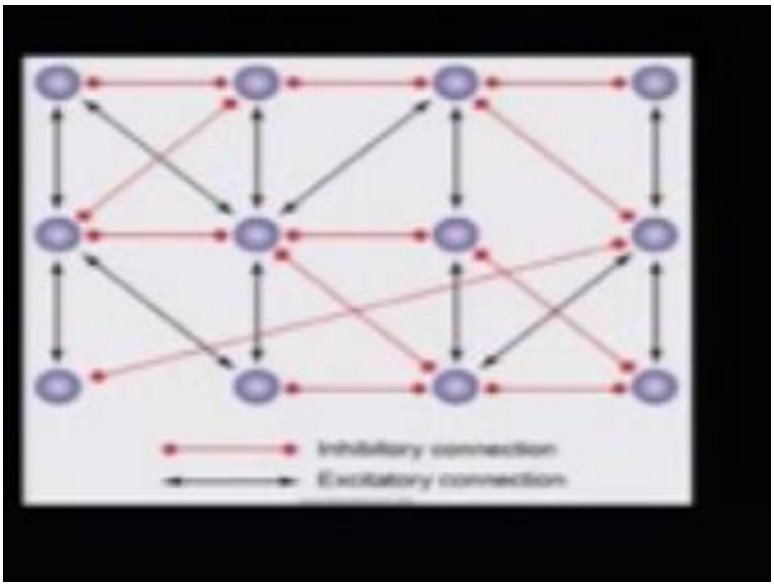

Through excitatory and inhibitory connections.

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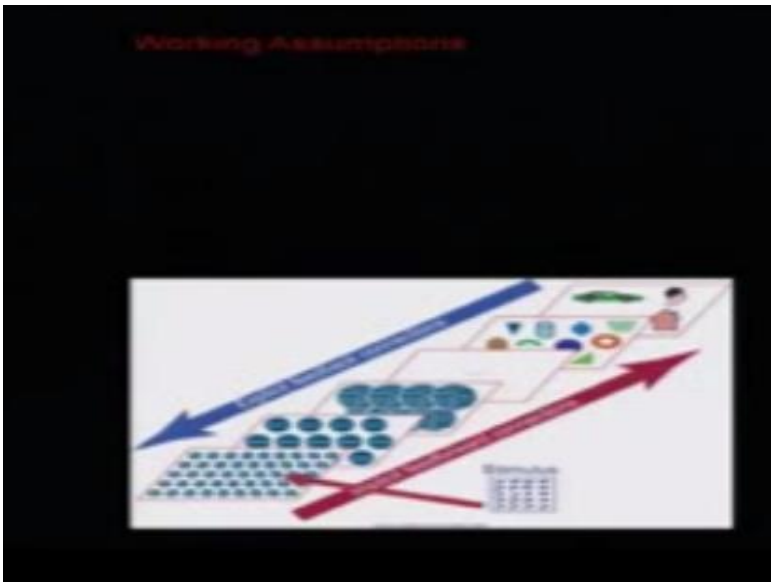

And so it is not a linear thing in the sense liner think suppose there is a signal and it goes on achieves it is effects to say for a muscle movement but there has to be a feedback

connection, the feedback connection unless it is brought back to the brain you can see it this is the basis. This is a stimulus, it goes to the brain and we act on this but there has to be a feedback connection to the brain, otherwise the brain will not know what to do the next moment and one of the important functions.

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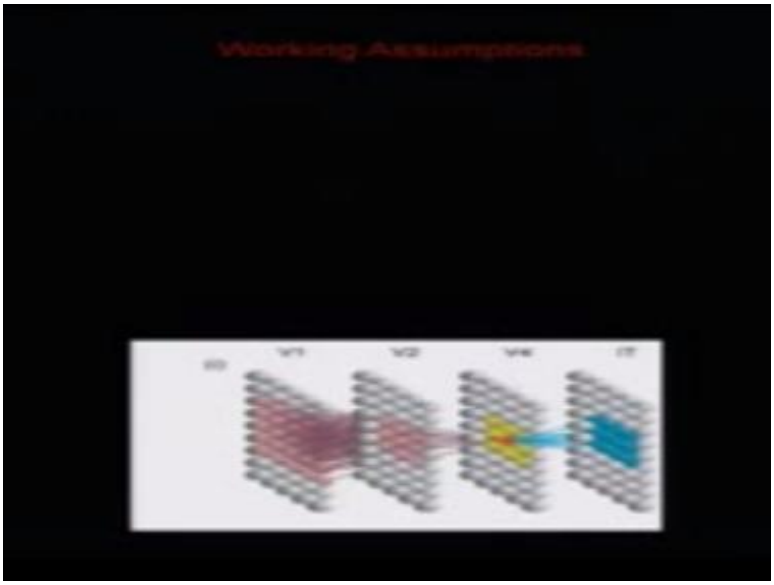

Of the way human brain has evolved is anticipation and prediction because if you do not anticipate and predict what is going to happen, we may not be able to really survive in this world.

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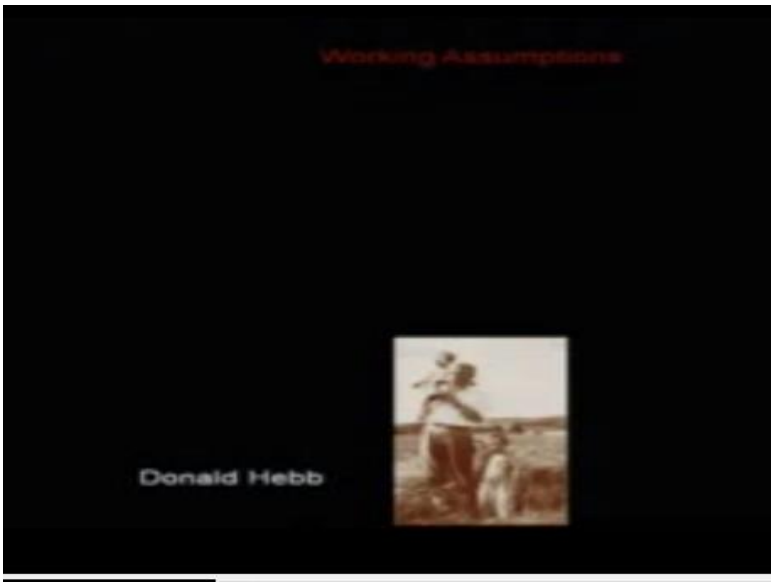

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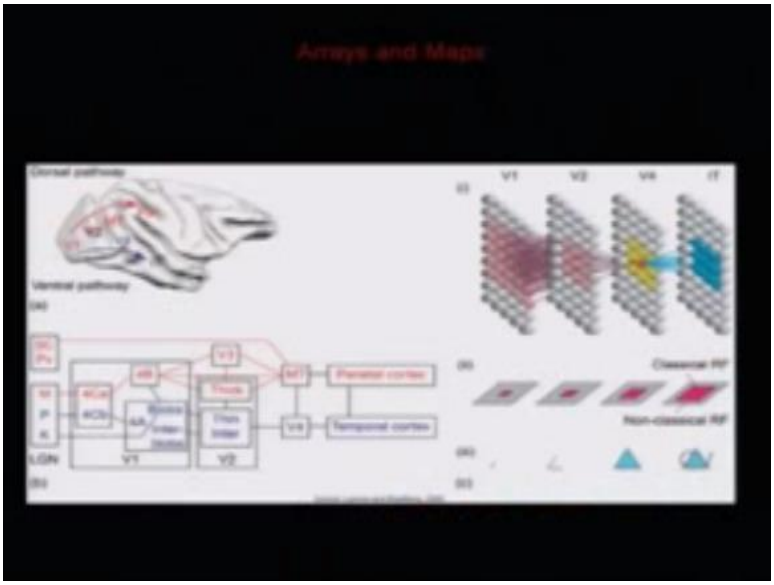

So this is again the weight moves to the cortex.

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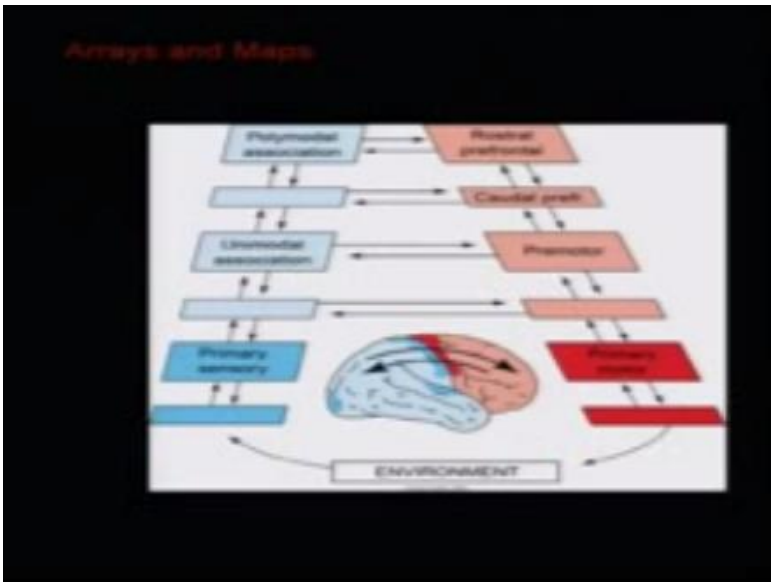

So how do we live we live like this, this is the environment the sensation goes as we have discussed primary sensory there is an association here there is a the poly model from various modalities, like this maybe a primary sensation of touch but while it reaches here this touch may be integrated with vision, with the sound with smell then it goes to the prefrontal cortex which decides decide on what to do it comes down it goes to the motor area through the spinal cord to the primary motor and it comes down to act on it.

So this is called a stimulus response cycle, now if there is a threat or if there is a stimuli which can harm you damage or your brain actually bypasses the whole thing reaching your consciousness. If as I said in the last lecture if you suddenly there is a pinprick you remove your hand even before your conscious of it, so this whole process of.

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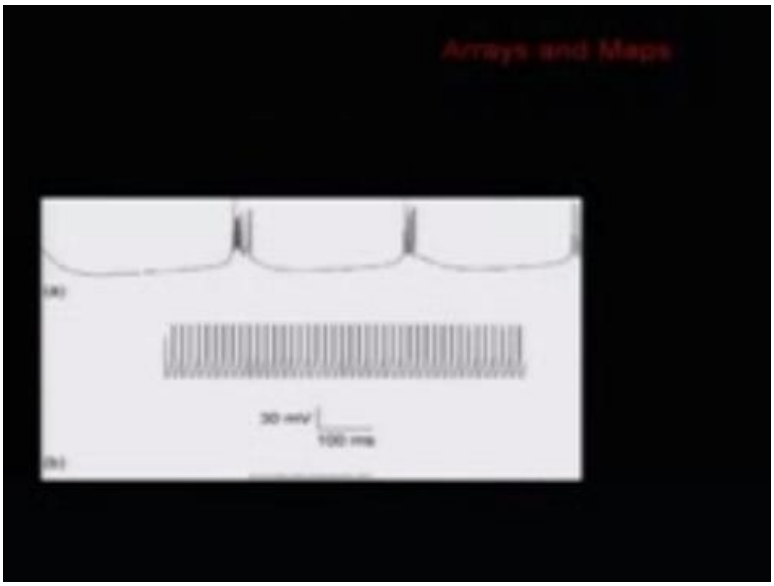

From the unconscious to conscious take some time from a stimulus which comes to your eye or body it takes about 200 to 500 millisecond, for it to reach your conscious level.

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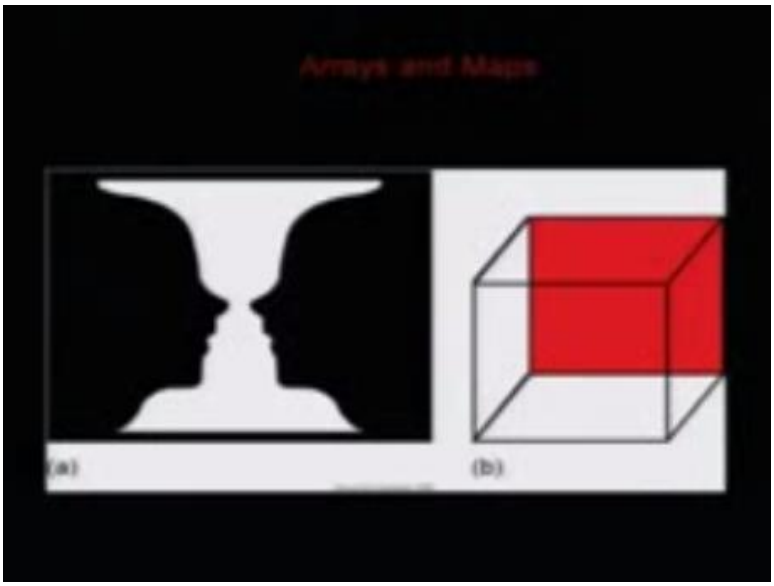

It will not reach before that. So lot of reflex actions are done within that hundred milliseconds period because if suppose you wait for you to decide whether you want to

remove your hand from the pinprick, it may actually heard you so the brain evolution in an attempt to save itself from the Predators and all the dangers of animals and nature it actually devised this reflects action, which just happens within a hundred millisecond, and you are saved.

So for one to survive with reflex action and your brain must be functioning fine now what you have decide reaches your brain saying 200 to 500 milliseconds on which the brain can consciously take a decision of acting or not acting. That means simply that lot of your processes in the brain are happening in the unconscious way, in fact almost ninety percent. So when we study psychology fraud was the one who are saying a lot of it is unconscious you may be proven right with coming research it is only 10 to 15 percent what reaches your conscious brain and that too is decided by how is your, your unconscious mind has decided to make a composite image.

So you are unconscious brain through integration of all the various sensations which are going in the body, in the mind comparing it with the existing memory and map also taking an emotional decision on it the limbic system decides in the hierarchy of thread fully stimuli the limbic system decide whether it is pleasurable whether it is good or it is thread full depending on that it takes a composite set of information given to the and also on the salience of the stimulus which is presented to you.

It is given to your frontal cortex or the cingulate gyrus which are the areas of central executive networking cellular network to decide on what action to take. Whether you are going to act on it or whether you are going to emote on it or think about it, so unconscious still is powerful now, at a given point of time there so many stimuli going on so the brain unites all that, to give you a singular sense of unity which gives you a sense of what are you what is me.

So when I am saying that what is me or when you are saying what is you it is taking in all the information in the environment putting it into a singular unity and that create and creating a sensation of I it so when you look at I it is not one thing and if you go down there you will actually boil down to thousands of sensations and thousands of a different type of electrical firing. These are the type of electrical firing which create different type of electrical activity in the brain which will talk when we talk of investigating in into the

brain and, and, and this goes on this goes on through your lifetime. So imagine the complexity.

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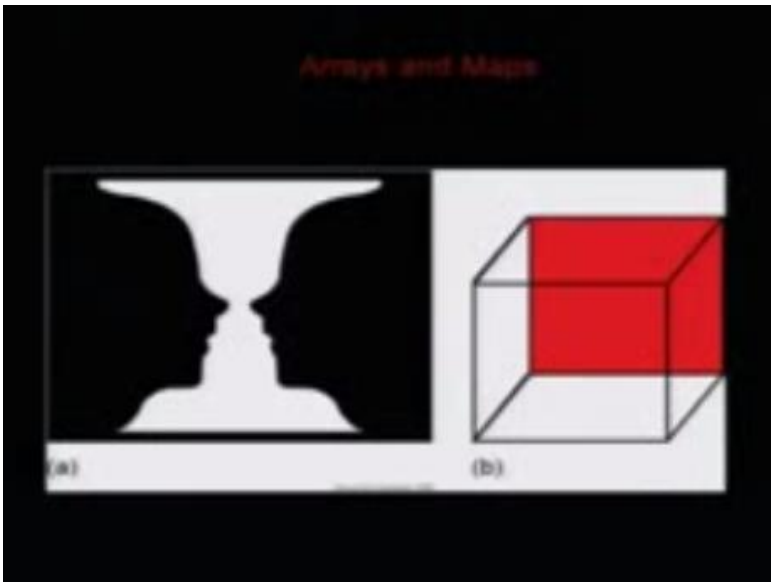

Of the task which brain is managing that if every given instance this is just one of the pictures if you look at it, so what do you see, you look at the cube when you look at the black-and-white picture different people see different things that this is happening unconsciously.

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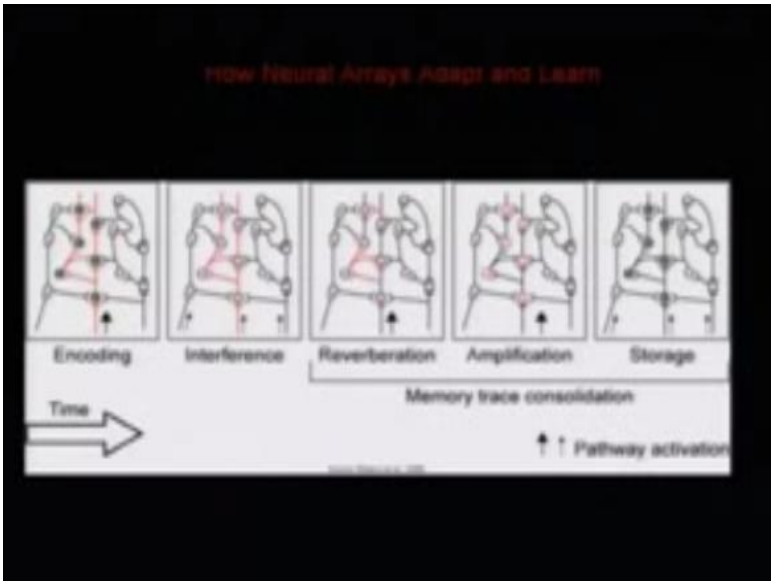

Your brain is really creating there is also in the process become very smart even if you give half information to it and if it really has a previous information about it or some memory map it tries to fill in, that is later on we talked about gestalt it tries to fill in those gaps and again tries to give you a composite image. This is what is happening is the encoding in the brain there is an interference with various other sensation.

This is how memories from the reverberation, reverberation means the seam circuits keep firing again and again and as they keep firing the whole signal is amplified and stored this is stored by changing the sinuses the sinuses are strengthened, so when you tend to forget like you talk to somebody and you forget what did you talk it is possibly that your attention span in the brain was not enough to keep those set of neurons firing which were remembering that.

So attention that actually the bottleneck the bottleneck attention has so many inputs right from outside from your internal body from your internal memory from your emotional state from your priority lot of things are going and attention has to filter some of them pay attention to some of them these things at a given point of time and depending on that, which obviously has some amount of intent and will your brain will process that.

So if a brain if your attention is not on something and that it tends to forget that later on the mechanism is that because the brain had decided not to pay attention to it. So the inner circuit where things.

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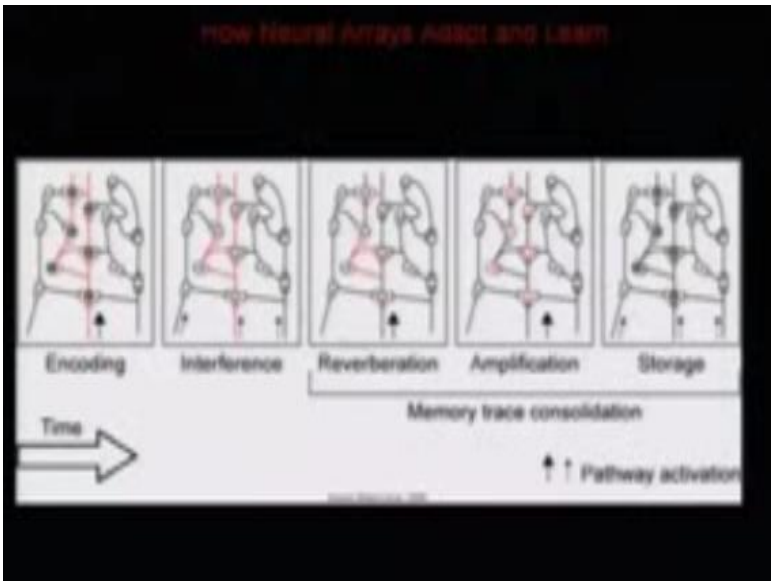

Would have been remembered when not firing reportedly on, on that issue so me and because it did not change the signups that is why you do not tend to remember and that is how memories, so lot of memories divided on procedural memory which is how you move your body and always into the cerebellum and basal ganglia there is a lot of declarative memory which is episodic, which is maybe concerning your life or are and their semantic which has their meaning in some event or some act which is stored in the form of a meaning.

So memories form depending on the emotional weight age given to a certain event now people may say that you will be rational and thinking but the emotional mind actually gives weight age to the hierarchy and the relevance, and that is why we tend to forget things which we do not like.

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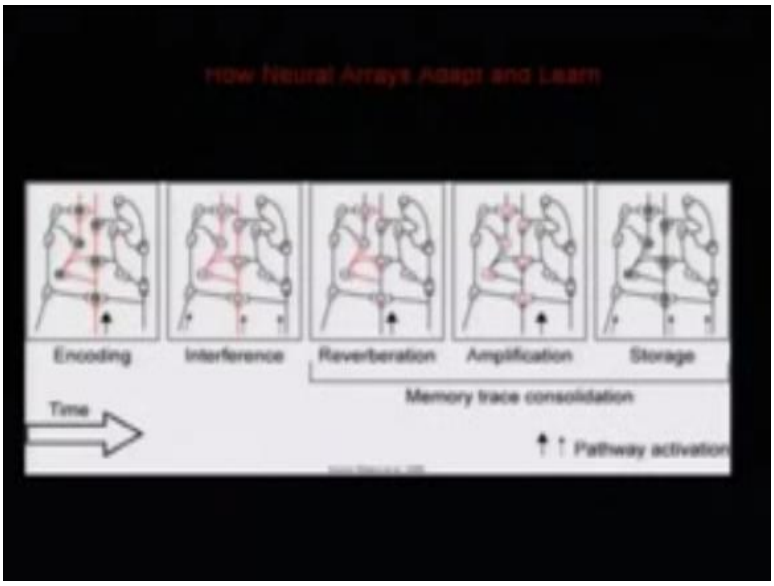

Remembering a lot of things which you do not like often becomes a source of other problems.

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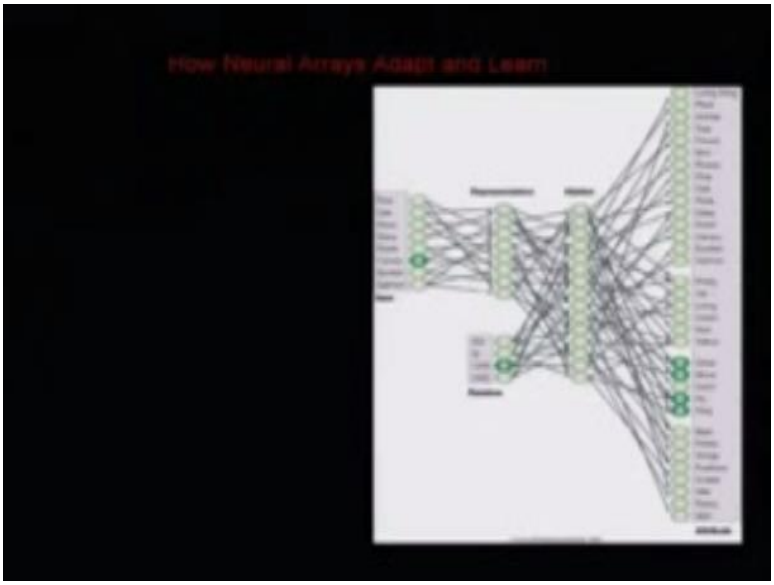

So again like there are items here represented in the brain the hidden process going on and these are all the categories of things of action and things which you know, right so connection between these and these is formed in the unconscious brain.

So brain may not explicitly tell you how it is forming the connection but the neural arrays will always form a connection, so that if you say sing you can really come back to this one of these, living things with which you can connect, like in your personal memory in your personal memory bank if you look at you may recognize your grandmother but is it the same set of neurons which are recognizing grandmother.

And are recognizing some film celebrity or are they different what, is the emotional content to each of it, all that is determining on what you realize that you know.

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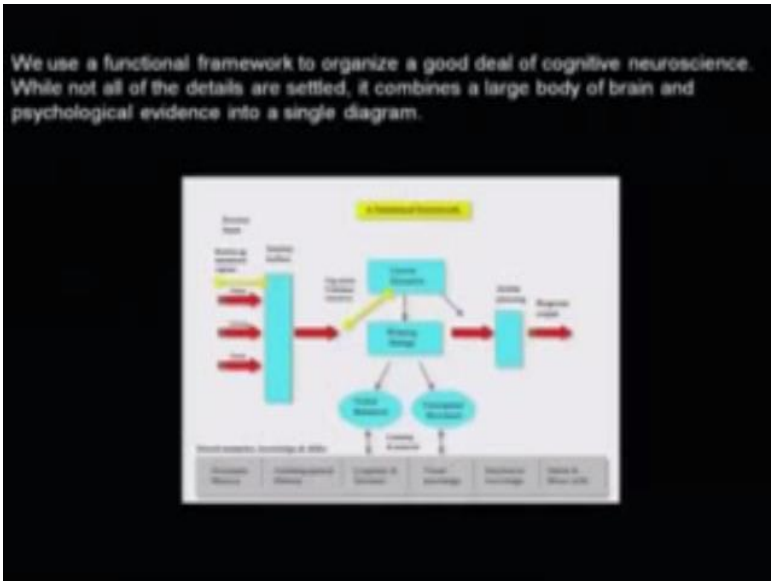

So we use a functional framework to organize a good deal of cognitive neuroscience but we do not know everything we really do not know a lot of stuff in fact but we know a lot of it preferably also which are being used to at least create some brain-computer interfaces and, a lot of it comes from psychology, so once again to grossly look at it is a sensory input, is an attentional capture vision hearing.

Their sensory buffers right our eyes ad our ears and so there is a top down voluntary attention with the mind actually decides on which one to pay attention to so it goes to the central from Central Executive goes to working storage verbal rehearsals so we know memories immediate short-term and long-term immediate is immediate in seconds, short term is like we are rehears the mind is rehearsing and once it going to long-term.

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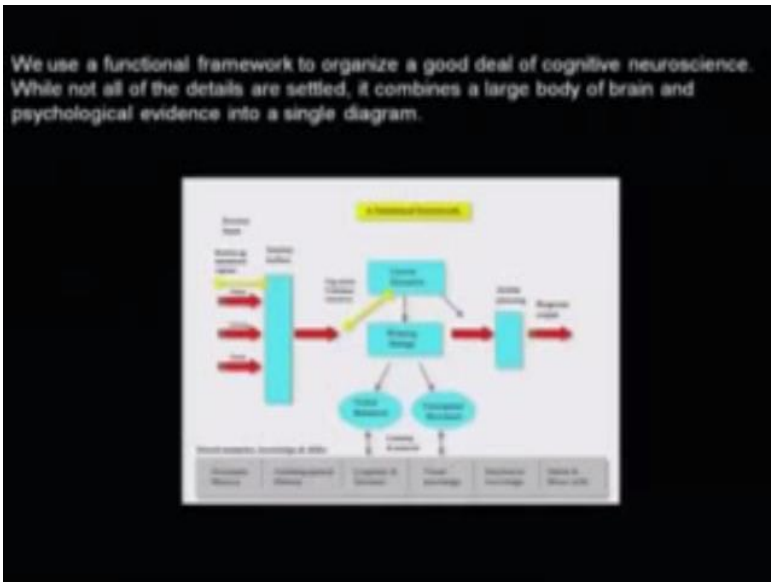

Storage it is stored in the form of water were from memory linguistics symmetric have it muter skill but Central Executive once it receives all this data it will decide o own action planning or response output or it may sent to verbal rehearsal and visuospatial sketchpad.

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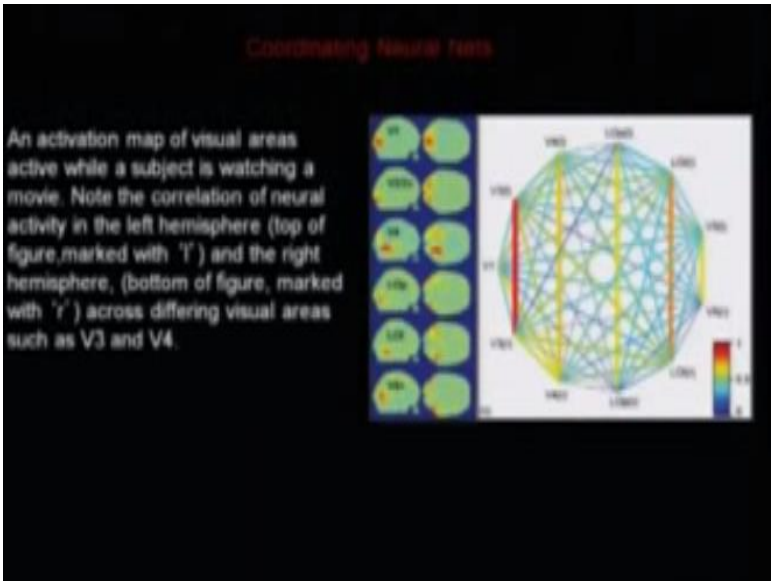

So visual areas this is just a while watching a movie, see the activities in the left hemisphere all this.

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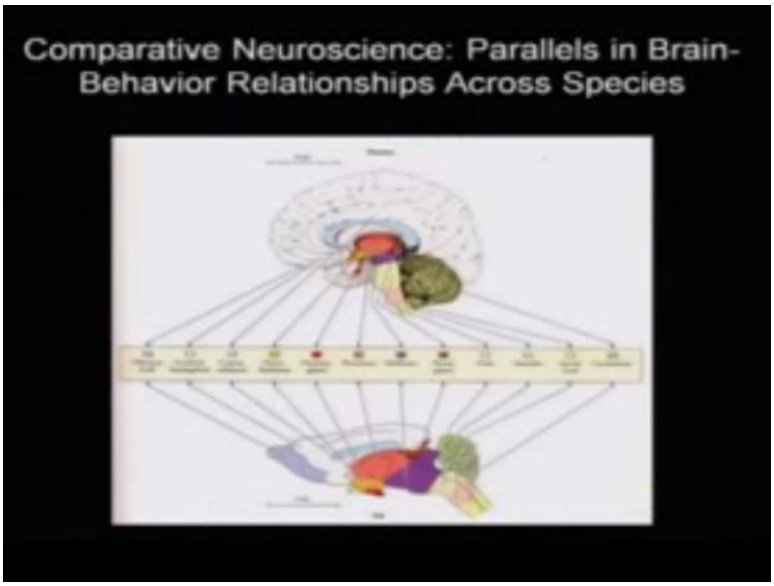

This is another network across species you can compare with the areas of the brain of the same been heaven developed I mean a new area in the brain over evolution.

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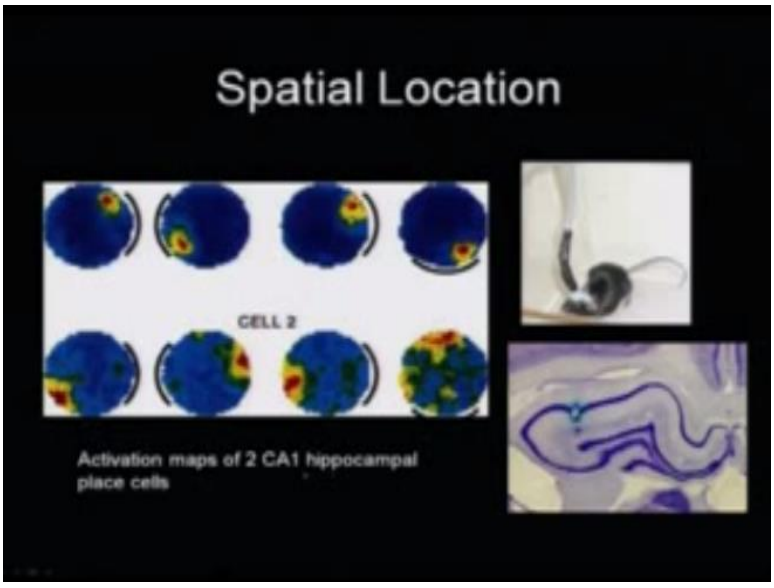

This is a activation map hippocampal places depending on what task which we give we will talk about this in the while we are talking about imaging. These are the areas we get activated depending on the task which will give.

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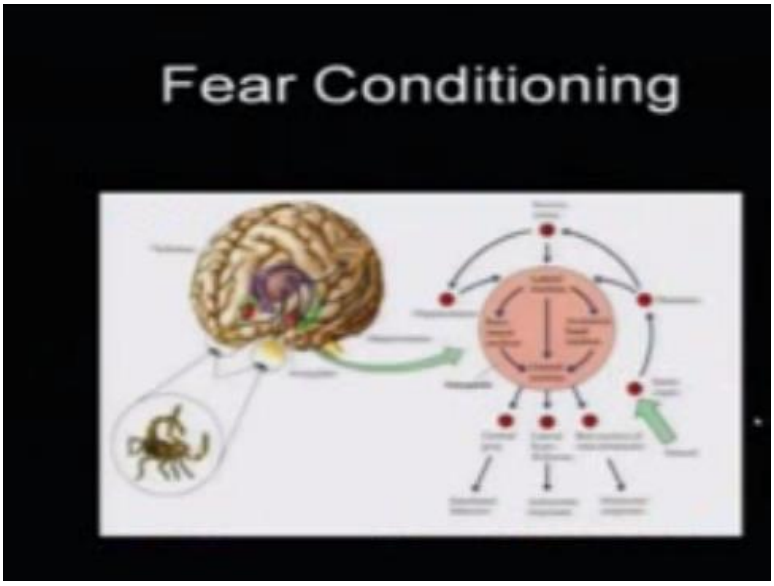

And this is a source of unless also because once there is a fear which goes into the brain is a sensory cortex receives it hippocampus the area where all this short-term memory and collaborative firing is going on once this area receives and remember it as a as a fearfully stimulus and passing on the telus helmets also and answers it this will be stored so every time you see this animal you mind will trigger the same fear response which it has come to.

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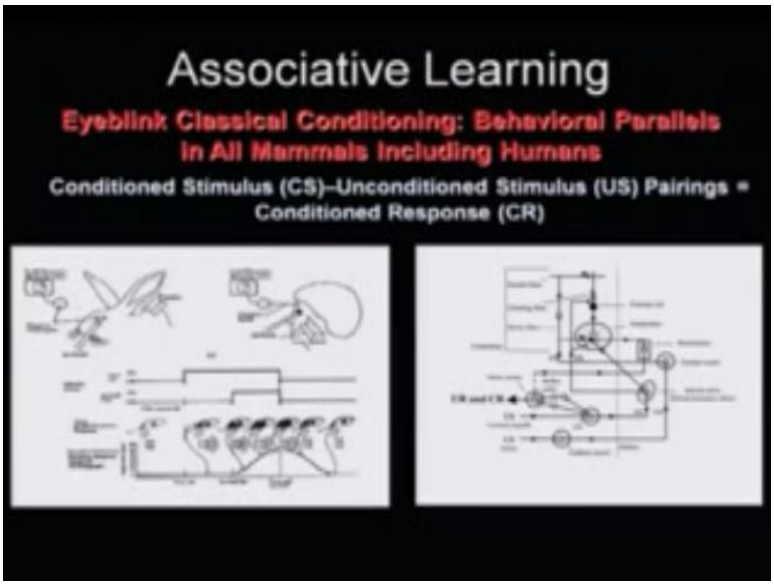

Classical conditioning remember power of that he used this is not the biology but he knew the psychology of it if remember the famous dog experiment.

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So emotions.

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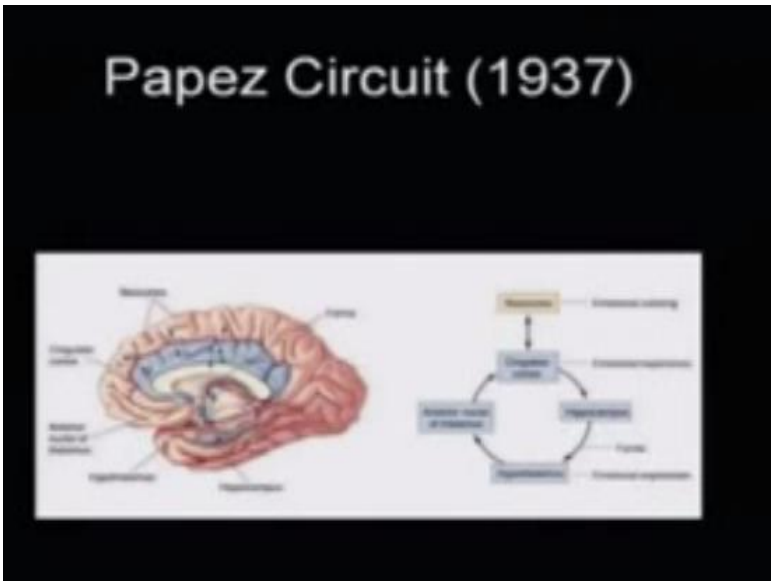

Are also normal Pepez circuit the circuit in the limbic system which actually is the emotional circuit and lot of activity on this decides on what is stimulus what memory what action we are going to pay attention and what is important for us these are the stretch neo cortex singular guidance and to the nucleus hypothalamus.

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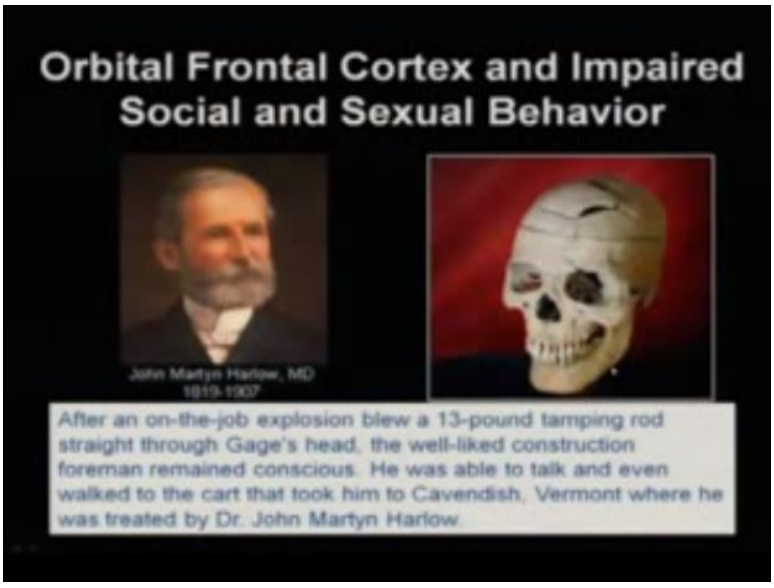

Remember famous gage this is the so there was a damage to his orbital frontal cortex and later on we found impaired social and sexual behavior name. That was the first sign that

the there are areas of brain which control behavior we still know that the damage to context and various areas can lead to different type of behavior.

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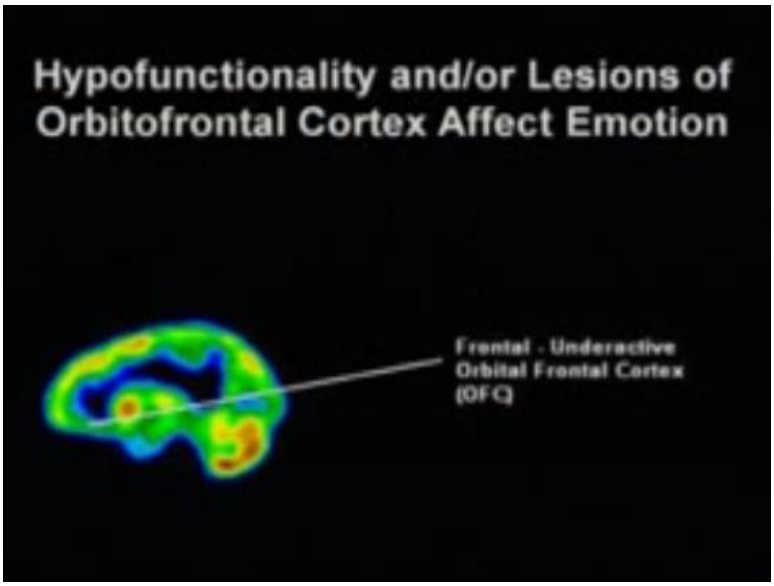

Imagine this now we have a founder, that in psychiatric illnesses different areas of brand of although we are not totally sure but lot of information indicates that in frontal area or deep in the brain in limbic system can really affect emotions.

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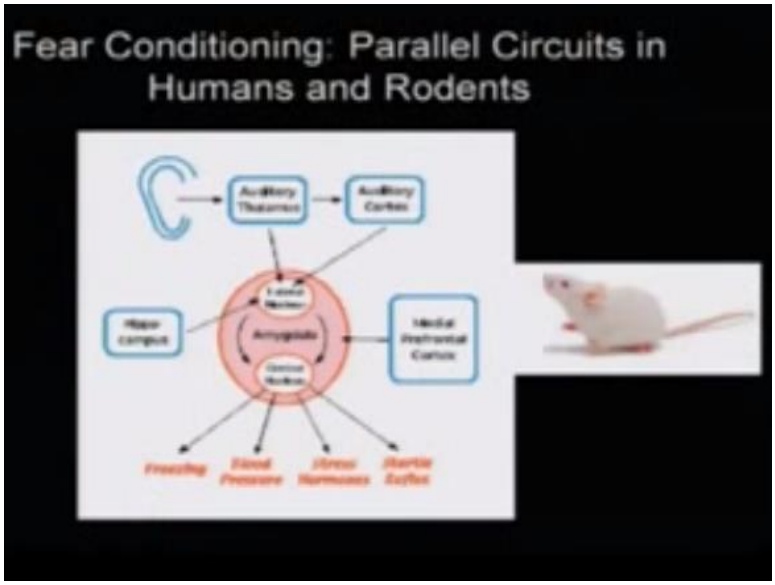

Again about the parallel circuit.

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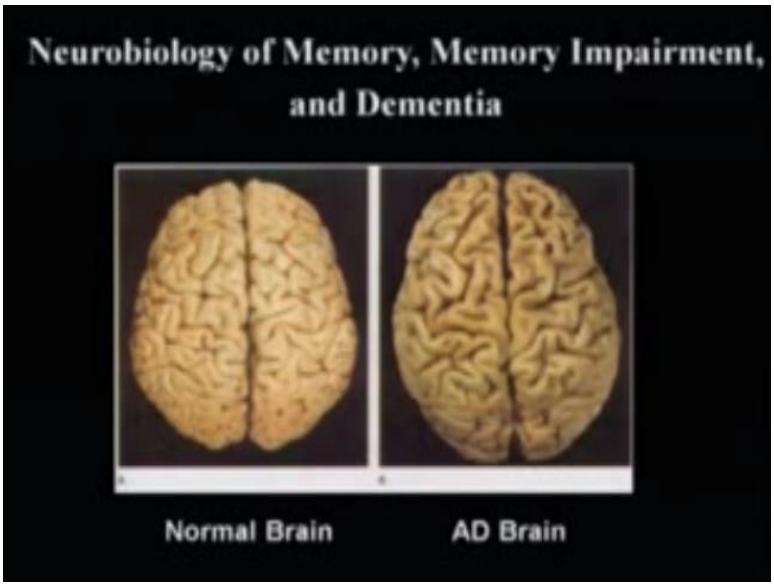

In dementia they illustrate the progressive decline in memory intelligence and personality you can see the difference in the brain there is a is almost like shrinking of the brain, mostly in hippocampal area where there is a damaged memory.

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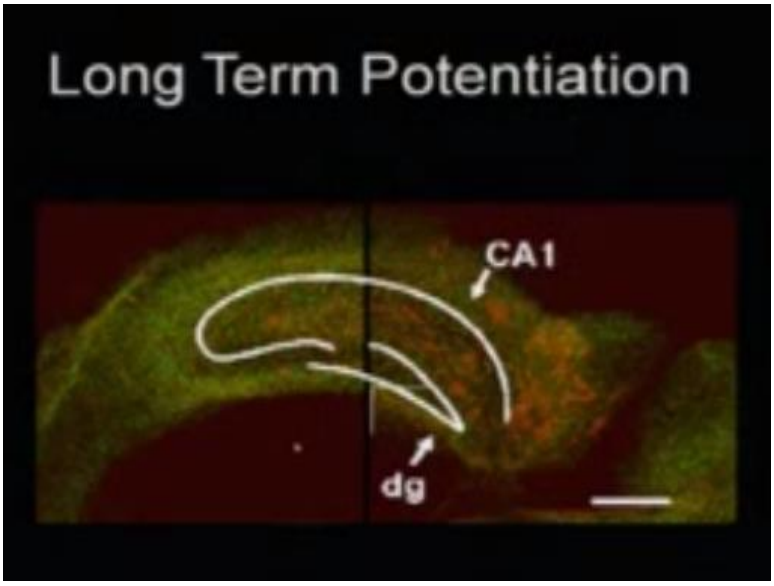

And this is what I was telling you about the long-term potential once there is a long-term potentiation and the brain firing is gone beyond a certain time frame is an synaptic alteration and that you do not to forget that is why in dimensions the recent memory, where the memories being formed in hippocampus and the limbic system in Pepez circuit.

The damage to those neurons really leads to the physician short-term memory first, and long-term memories are last to go.

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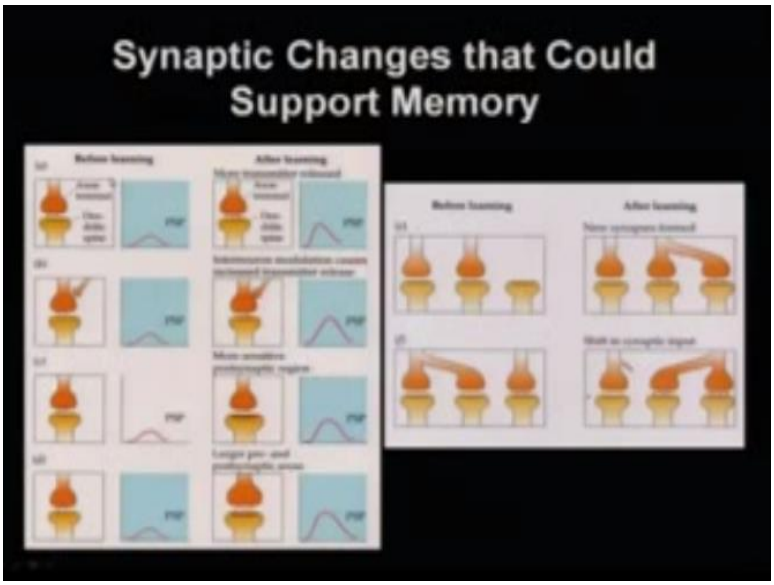

So these are the type of before learning and after learning more transmitter release excitedly postsynaptic potential larger pre in postsynaptic areas and this is the new synapses formation this is memory formation really.

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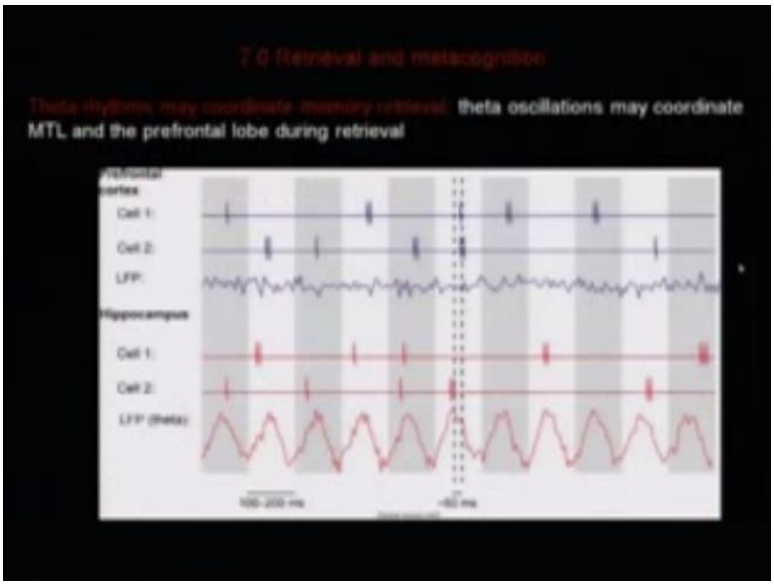

We come to the EG waves and all that later on.

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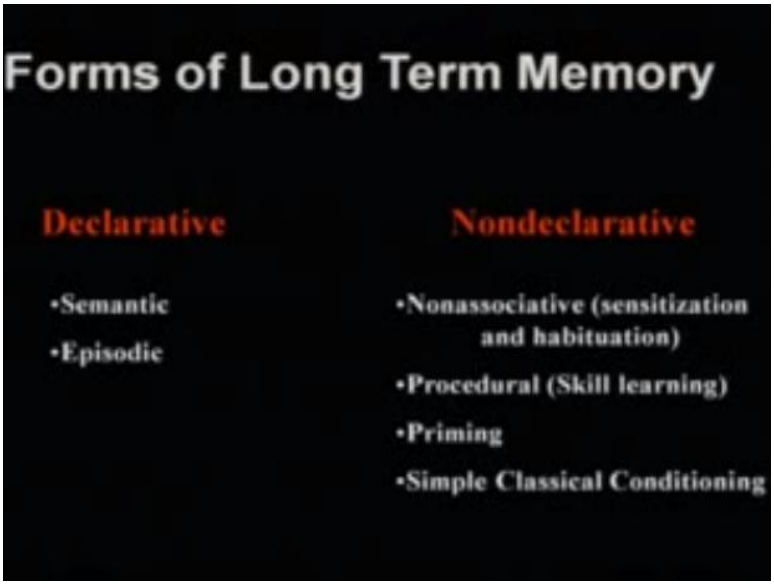

As I said semantic and episodic memory.

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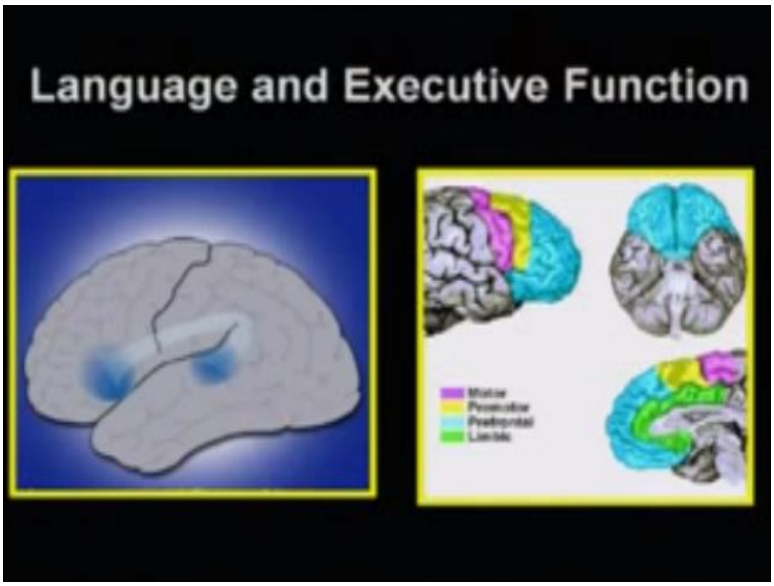

Languages we have already talk this conduction between the Wernicke's area we receive the words and were you create the words.

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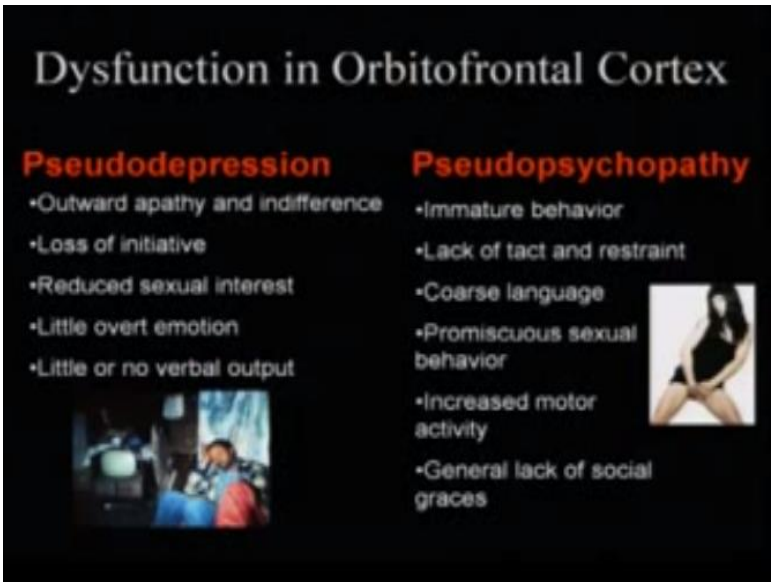

This is the sort of we can talk about it when we come to talking about illnesses.

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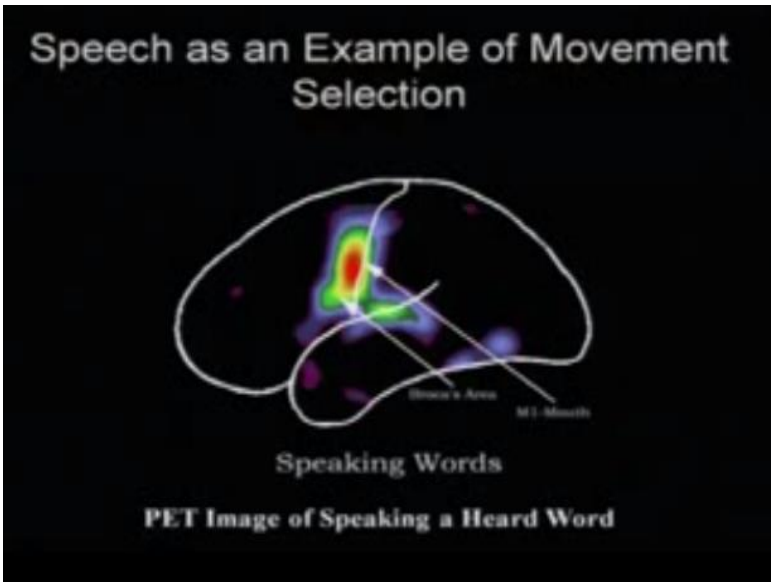

Speech it as I said we have told you hearing words and creating.

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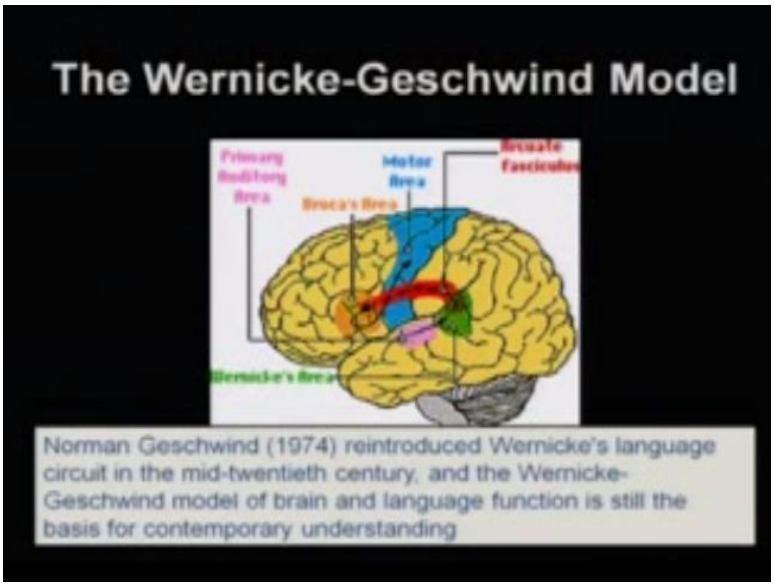

There is a whole network which works there.

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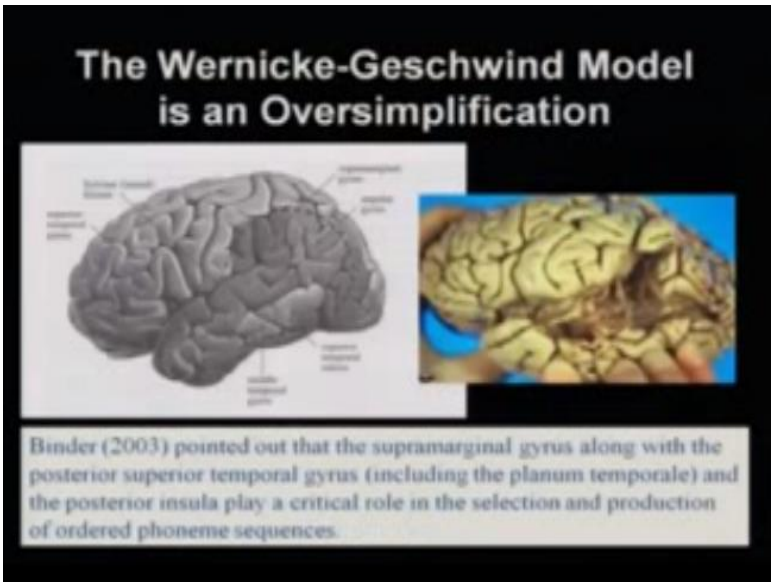

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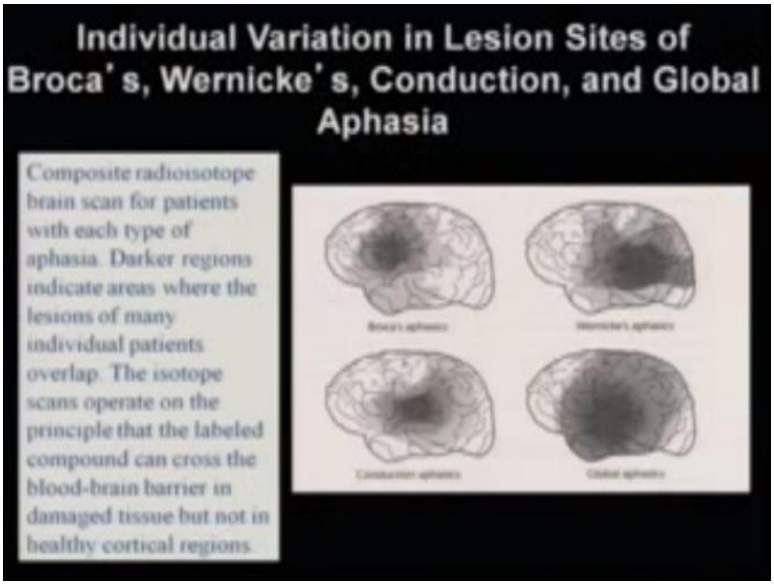

Will skip all this.

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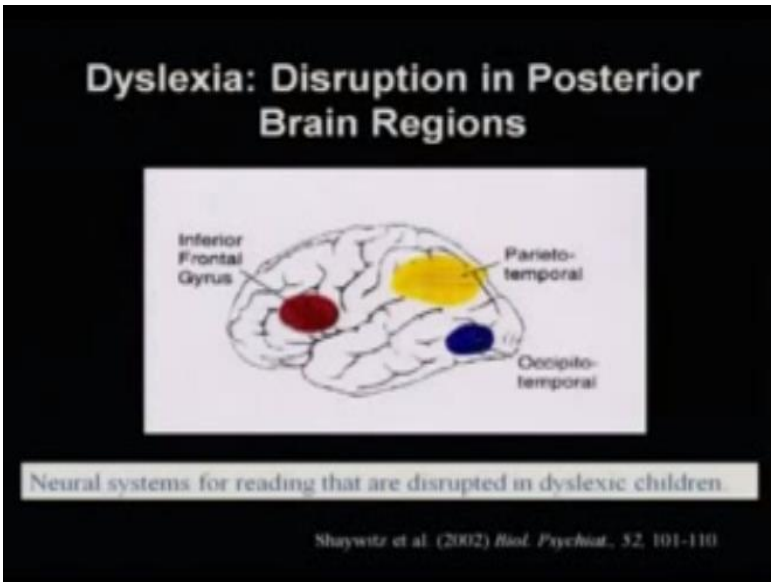

Just let me give an example of dyslexia, dyslexia is a illness in children will talk about it this is just a disruption in the brain area than the connectivity between them.

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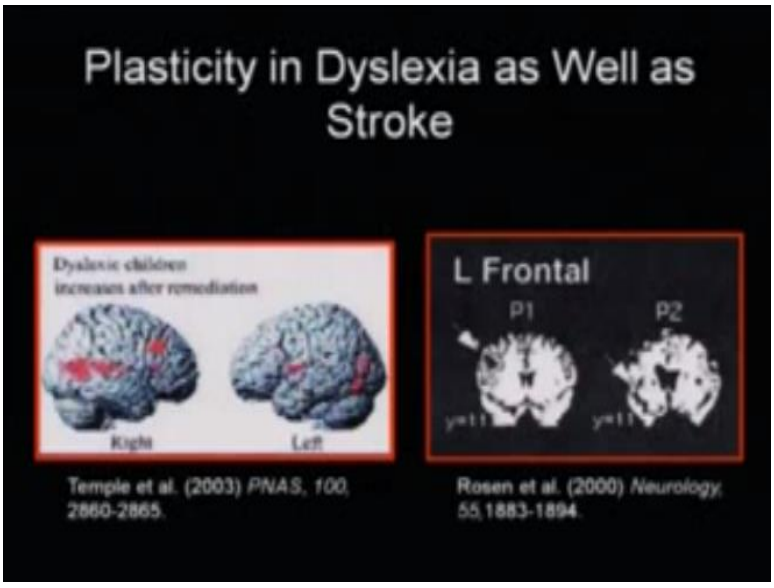

So we will stop at this I think we got a broad idea of how the brain works through networks and connections and in the next lecture we will talk about how do we actually look at it that is the imaging the brain thank you.