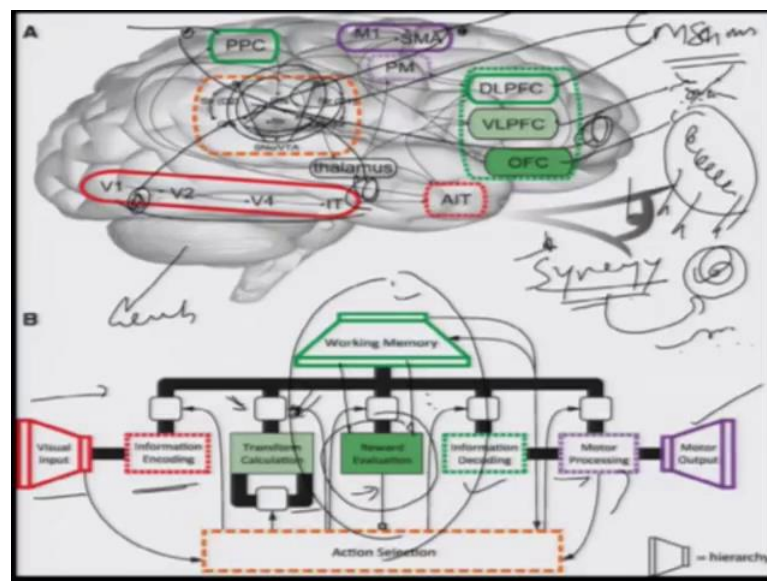


**How The Brain Creates Mind**  
**Dr. Alok Bajpai**  
**Department of Humanities and Social Sciences**  
**Indian Institute of Technology, Kanpur**

**Lecture – 17**  
**Sleep–2**

Beginning from where we left last time. So, what is the brain doing? Brain is actually taking information from outside, creating a memory bank based on the physical attribute of the information and the emotionality in your brain as many as possible to help you survive on a daily basis, running your bodily process and at the same time keeping you safe from predators, which has been coming from ages and then making you act proactively sometimes, sometimes in reactions, sometimes in response with the external world.

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So, in the process it has to take information, put it in a sort of electro chemical signal and encode it and keep it ready for you to retrieval. So, this wonderful there are lot of other theories, but Tononi and Edelman, have brought out the, theory of Integrated Information Theory. So, process the brain according to them is a synergy, now when you talk of synergy you also go back talk about (Refer Time: 01:38) when he is talking about association. So, it is in separate areas of brain whatever information is going, it is not useful for you in the motor area in sensor area your separate information is here, it is

here (Refer Time: 01:53) visual here, hearing here, some information of motor action here. What is the use of all this separate? It is the integration of all this, the synergy of all this which creates consciousness.

So, now this synergy; that means, that at the base line there has to be some synergy in the network system and over and above as information comes, that is encoded that differentiation happens and again further integrated to which into a different state of synergy; that means, at every minute, every second, every instance, this synergy an association is changing. So, every instance, brain is evolving. No two states of brain can be same then because if it is about information inflow and an encoding of information and there is an association between say one at x, y, z, z whatever and new things are being added all the time, then the whole thing is evolving is this, what we call a emergent consciousness.

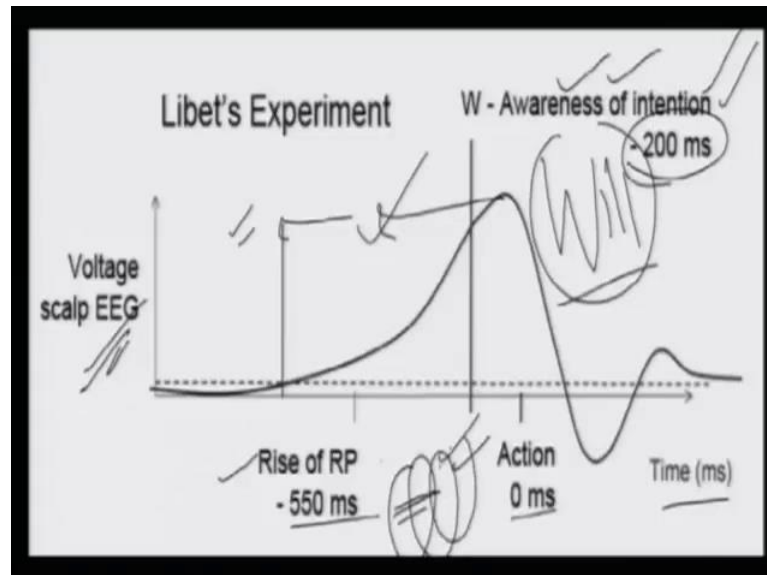
So, with all the imaging thing we have not been able to find the seat of consciousness, there is not one area where although we have areas if you damage them there will be loss of consciousness, but they not prove to be the seat of consciousness. Consciousness seems to be a global property of the brain, with so many, information through senses coming in.

So, for example, visual input again, visual input comes in here. There is information coding, there are transformational calculations, which are actually firing (Refer Time: 03:57). Then there are reward evaluation, now whether this, this is the limbic system (Refer Time: 04:04) limbic system. The information is decoded, working memory and limbic system control it, calculate whether there is a reward in it or punishment in it information is decoded, it sends to higher center motor processing and motor output. it simply means, this pen is here, this is the digital pen and I want to tell you something, visual input the information, this shape has send a information in my head, that this is a pen.

It can be use it may not to be a pen actually it not be a truth brush, but then when I pick it up my brain decides transform the calculation of this shape with my existing memory of the pen. Reward evolution that if I pick this up I can write information is decoded I pick it up what are output. So, everything came in why did I pick up? Suppose it would have been a burning candle in this shape my mind would have, the emotional center would

have told that if you touch it you will get burn. It may just be burning and it may not be burning, but. So, this is how brain decides with this network.

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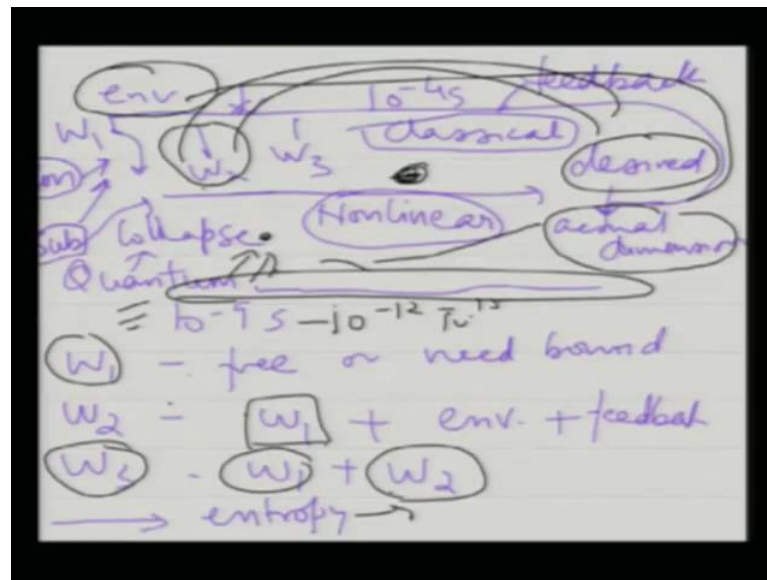
The other proof so, that brings us to the conscious and unconscious, but again as I said in the beginning being aware about aware or the will. What is will? Will is deciding. That I do this that is my will. Whether this is a free will or it is coming from the need behind that how 5 minutes I had been looking for a pen and suddenly I find a pen and I i find this if a will had arosen 5 millisecond before, but I find this now. This was the experiment done by Libet through, the recordings and he told us interesting finding, that before you become aware of the intention, before we have aware of the intention and decide 200 milliseconds before that, the decision would have been taken in the brain through the voltage scalp EEG.

This is the rise of potential 550five milliseconds action here so; that means, that is the time what I told you that, you do not become aware of anything before 200 milliseconds less than 200 millisecond all memory formation all firing or synaptic thing of short term reflex action everything is going on comparing information, decoding of reward and punishment evaluation all that is already gone in. Then within 200 to 500 milliseconds you come to choose your action.

Now, this may be will, I decide to pick up this pen I decided to write will, but to write this word will 200 milliseconds before or 300 milliseconds before my mind would have

decided it. You can call it transmission time if you want, but we do not know the big question is the transmission time of nerves the speed does not fitting to the way it happens, maybe we need some other mathematics of physics. So, the big question is that the field is occurring it, we really do not know at this point.

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This is something which I in my during my course of thinking I revised. Let me tell you probably this will verifies tough. Suppose we assume and we assume absolutely crazy thing. The absolutely crazy thing we have assuming is that all type of physics which we know is existing in the brain at the same time. See the behavior which we see in a external world is a classical cause, affect, deterministic, irreversible or reversible, if we have cause affect, it is reversible and it happens in seconds to minutes to hours. So, we are enveloped in the space time of minutes to hours. Get back to them what converts in the micro tubules, what is happening is quantum 10 to the power minus 9, 10 to the power minus 12 to 15 maybe within the sub cellular quantum process is happening.

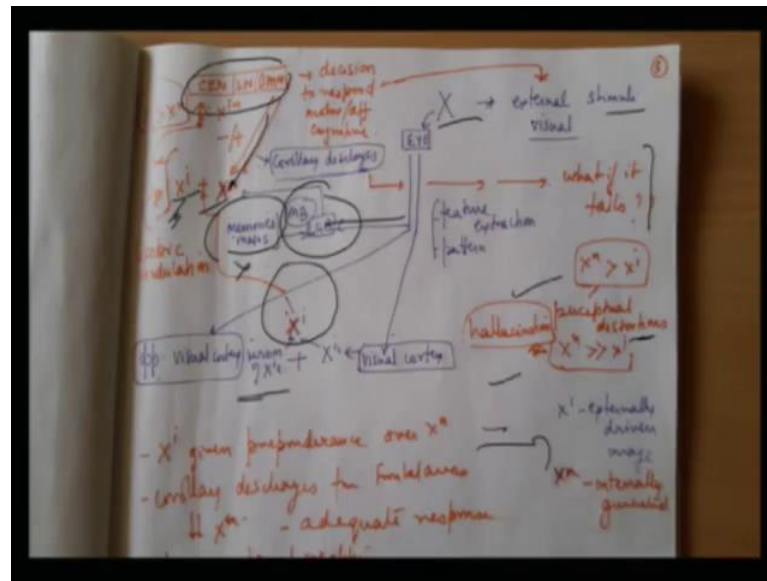
There could be quantum tunneling which is happening in the, within the cells between the synapse. So, ones the lot of quantum process is happening, they have free floating thoughts, images whatever. We really do not know how the electrical activity really converts to that. That is the heart problem all said and done network, electrical, firing everything we know. How does this electrical activity really form patterns of thoughts and emotions and all we do not know and if they are form, who is seeing it? are they

multiple video screens like in the Gleal cells, may be Gleal cells it reflected, again reflected, re reflection and then it is a something in the mind has to see. We do not have a projected screen, but what are these thoughts? So, possibly this pattern of quantum thing is on and on.

Now, will 1, which is w 1 at this instance decides to do something, there is a sort of a wave collapse from this quantum process and it and then the non linear process takes off, it goes to a dimension. Now whether this is a desired dimension where you wanted to go, and actual dimension differs, there is a gap between very what want to happen and what happened. This gap is sending a feed back to the higher centers. Mind again decides to try it again, but this will 2, the second decision is not free. It is bound to the previous. Similarly if you try third time, it is bound to the second attempt in the first attempt right. This feedback systems and every time this gap this is the. So, will is not free, this seconds will may be is bound to what was happening just in sense back and that we bound to the previous one or by next intension or will if you call it whatever uses interchangeably is bound to what I am doing right now, but every time I decided to something.

The gap between the desired dimension and actual dimension may be different because the non linear process is working there. This gap is being fed back to the higher cortical center may be that builds up what you call frustration. Every time, now translate it within this gap what comes is emotions, within this gap. Every sense of not reaching, if you translate it in the microscopic world builds in frustration that is the point where things have to be handled or maybe that is the point where mind can be trained. Now this is a big question.

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Now, this is another I told you that, there are external stimuli here and it goes here from the eye, goes the visual cortex, and goes to the letter geniculate body. There is internal image which is formed and there is external image at the same time. Now these two are compared with memories and maps in the mid brain and right. These two images are compared between the external and the internal and it is send to the higher center. The higher center suppresses the internal image and act on to the externally motivated image.

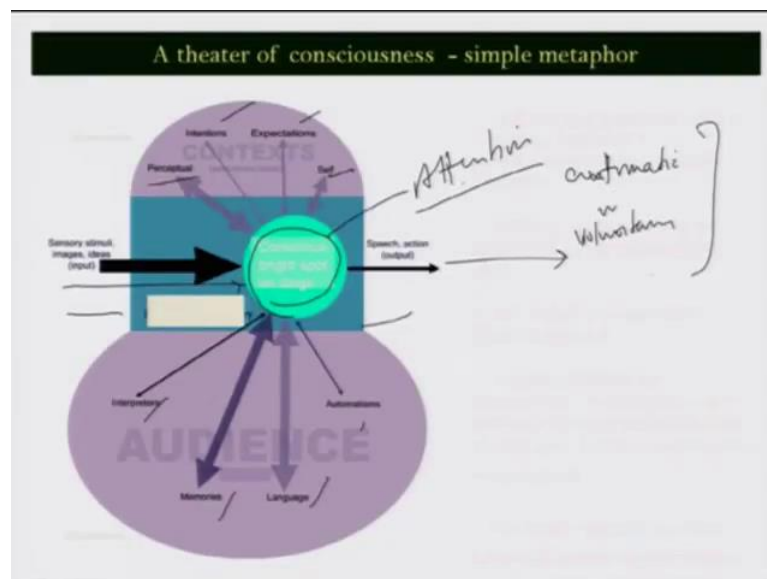
Because external motivation will keep you in touch with reality that is important for survival if both unite is the same thing if not the internally suppressed, but if this system fails, then you have perceptual distortions. The internal image actually rides over the external image and that is call Hallucination or Illusions. So, there is some physical module which we can think of it.

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- brain is aware of a small fraction of what these faculties are doing. These contents change continually, depending upon demands of the current environment
- 500ms.....frames of reality...

So, brain normally what awareness means, is a small fraction of what these faculties are doing, the inside faculties. These contents they keep changing continuously, depending on demands of the current environment. So, as I said there 500 milliseconds frames of reality is this about truth.

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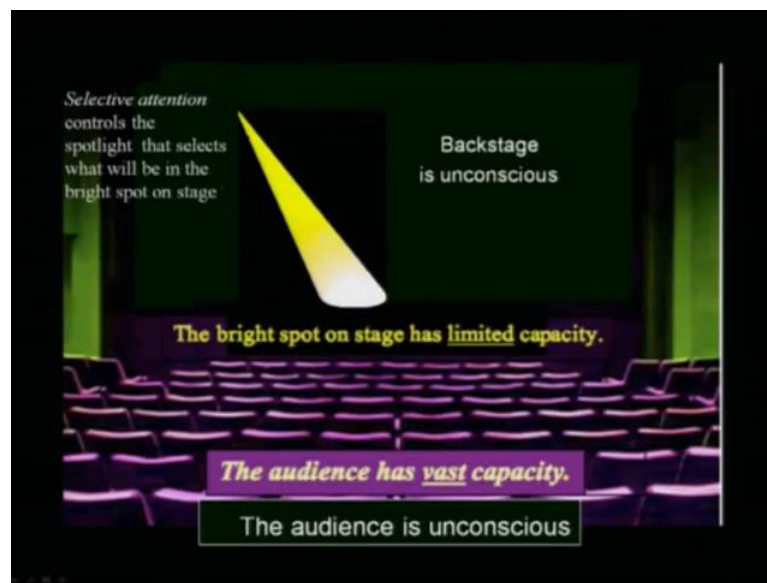


So, this is taken from a very good book (Refer Time: 13:52) brought out, the theory of work space and so it says that the, there is a conscious bright spot on the stage is a theater intentions, expectations, this is a self perception. Sensory stimuli are going all the

time right and I speech action output is going on all the time, this is conscious mind. So, where conscious mind and then within your brain language, memories, interpreters, automatism this spot light keeps varying. In other words you can call it attention right automatic or voluntary.

Wherever you put your attention or automatically where it goes, consciousness comes in rest all keeps hidden.

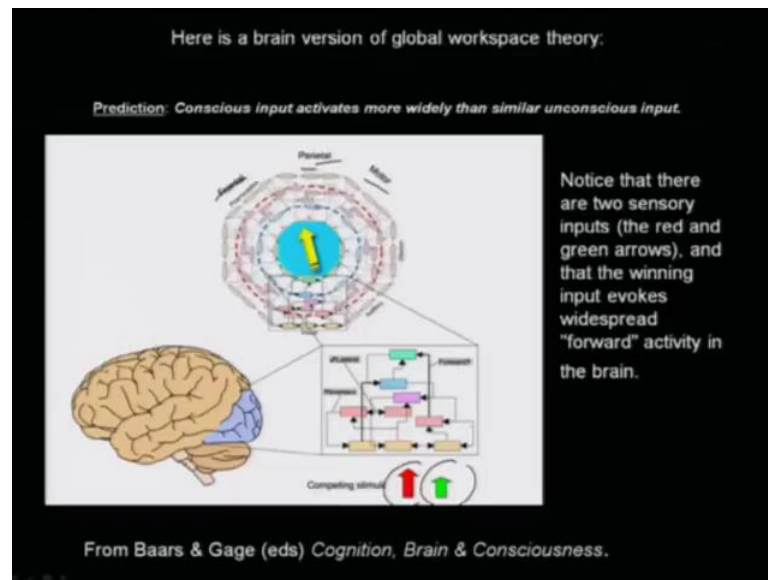
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So, selective attention controls the spot light that selects what will be in the bright spot. Back stage is unconscious the audience has vast capacity. So, is a brain version of global workspace there is a frontal lobe, parietal motor, two sensory input the red and green arrows.



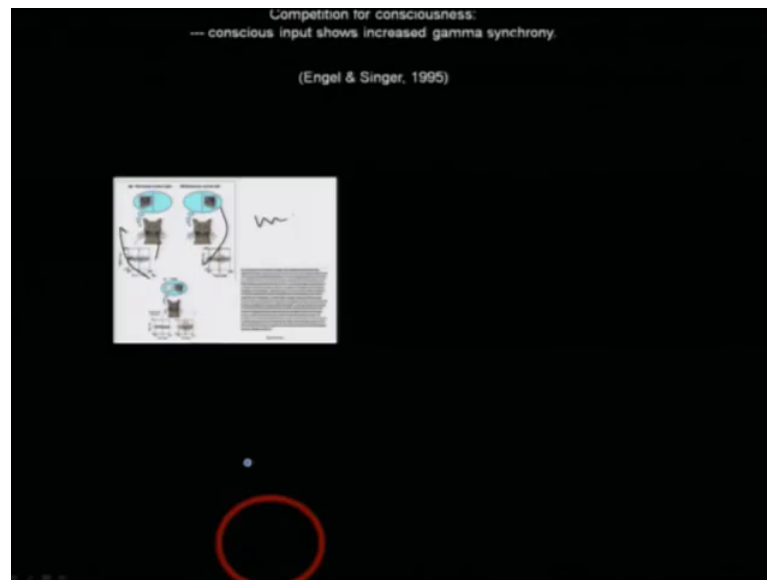
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If you see this something called letter renovation in vision. If there is a focus on something and if it the mind wants to focus it, it will inhibit the rest of the input things are not, so simple when I am talking of because at a given point of time sometimes in life they competing inputs and your mind has to decide which one. So you can put by the time you will free decide, the mind would have already process what is important.

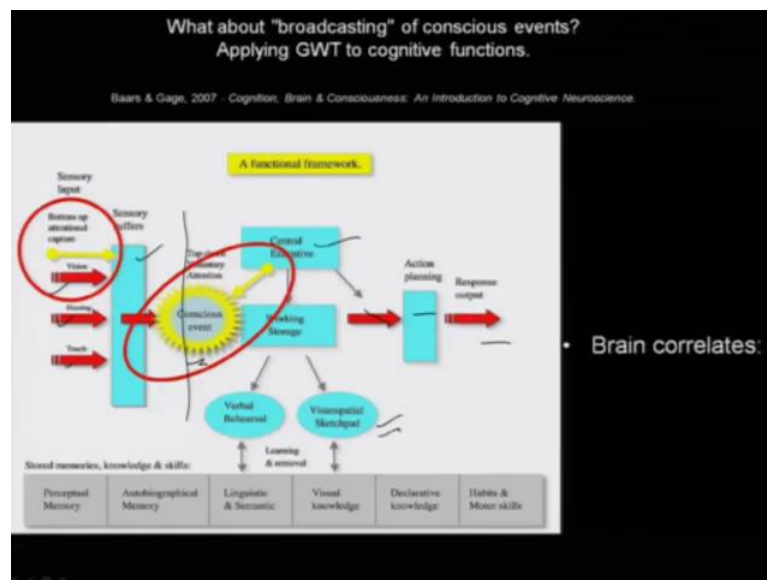
So, when two inputs come like, it is shown here by the time here is a conscious mind, by the time one of them reaches here. What do you thing? Who decides? You already the whole inside process would have decided competition of consciousness (Refer Time: 16:25), but gamma remember, your oscillations gamma oscillation which is binding. So, gamma suddenly becomes active when it has to really decide which one it has to go.

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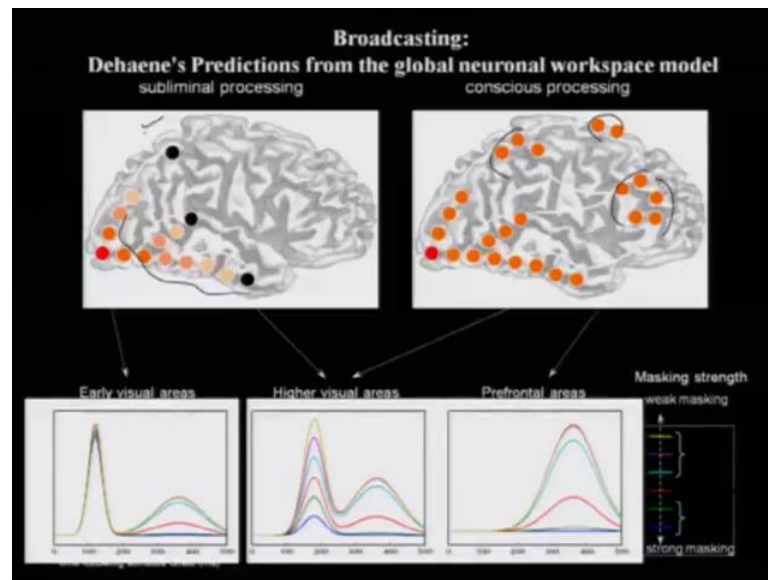
So, again the global work theory sensory input, this is right from bottom up attention vision, hearing touch, sensory buffers.

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I have shown in this diagram central executive, working space, action planning, response output by the time it goes down here then it becomes conscious and if you remember I told you about the visual spatial sketchpad when you speak being already have designed.

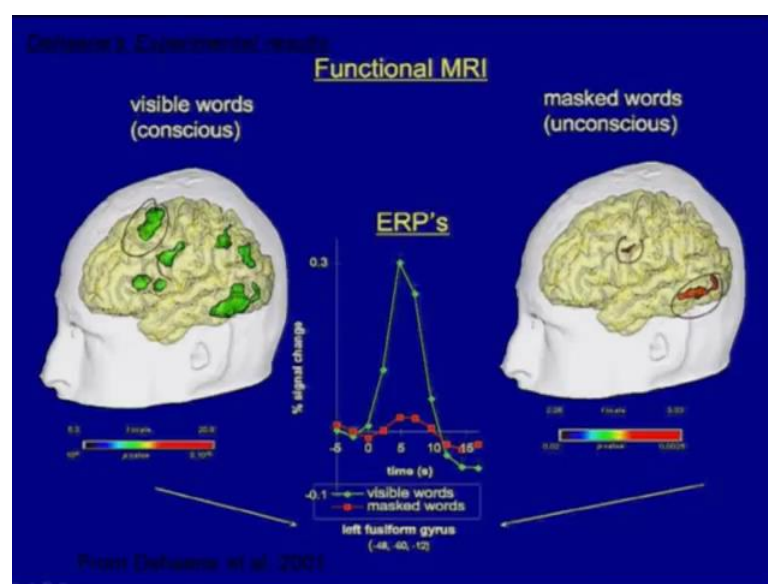
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And the part of it, this is like a subliminal Dehaenes, one of the frontrunners of Neuro sciences. This is a conscious processing.

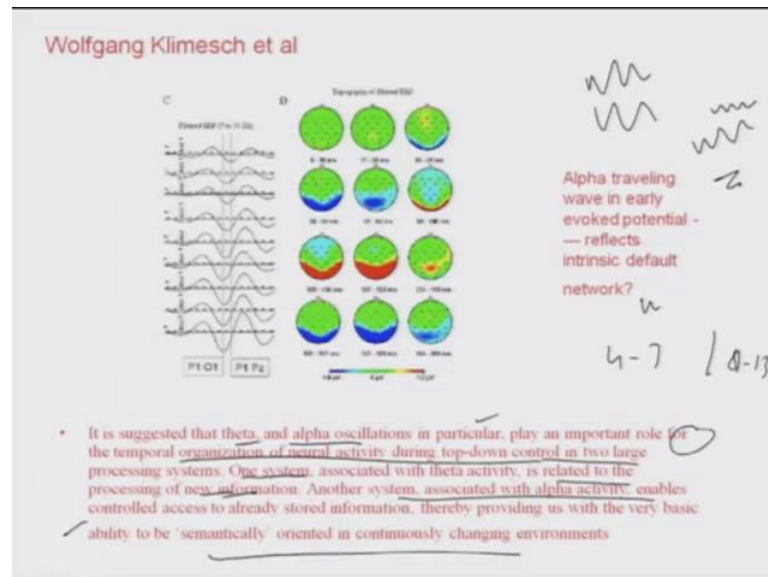
Now, how where do you point out consciousness, many areas parietal this and this is subliminal; you really not aware of all this, this is a masking experiments masking experiments are very popular in psychology and masked words have processed here conscious word.

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So, again a structural correlates are also different, but, again they do not tell us anything because lot is happening inside the brain in which part of the brain is happening because; obviously, you take this by a slice.

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And slice have you heard of something call pilot waves. Pilot waves are part of the (Refer Time: 18:18) Bohmian Quantum Mechanics. This is the background pilot waves over and which these quantum phenomena keep happening. So, he says the pilot wave actually carries the information and all the probabilities of the states in which it can exist. So, we just have to know the wave equation and within this pilot wave, we can tell where it is a, but anyway that why I was mentioning I was just thinking today morning is that this waves are they very important in brain.

It is suggested that theta and alpha oscillation, in 4 to 7, 8 to 13 play an important role for the temporal organization of neural activity. During top down control, one system associated with theta activity is related to the processing of new information that is, if you remember I said is a gamma going on over which (Refer Time: 19:18) 4 to 7, 4 to 7 theta activity in hippocampuses about learning the new information. Another system associated the alpha activity enables controlled access to already stored information. So, when you are learning in hippocampus, it is 4 to 7. When you are recalling, it is the variation in the alpha which is fine because if you are sitting and recording alpha and you at some activities given to you; obviously, the variation will happen in alpha, mental


activity whether it will go in to the higher side, but it is the variation in alpha activity, but the change in alpha probably triggers this beginning of activity. Even if I ask you to do mathematics, you will have to recall something at least some letter and all. So, it will be the variation alpha which will trigger the activity level.

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Lawrence Ward:

**Lawrence M. Ward**  
 Department of Psychology, University of British Columbia, 2136 West Mall, Vancouver, B.C. V6T 1Z4, Canada

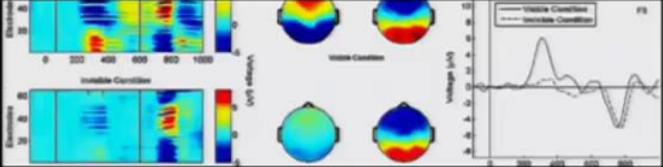
The central problem for cognitive neuroscience is to describe how cognitive processes arise from brain processes. This review summarizes the recent evidence that synchronous neural oscillations reveal much about the origin and nature of cognitive processes such as memory, attention and consciousness. Memory performance (Box 1). There is increasing evidence that this relationship is revealing, and an increasing theoretical understanding of how it might come about based on computational neural models (8-10). Here I review recent data and two provocative models from the large literature linking EEG (and MEG) recordings of the large-scale



Explainable it may not be a real mathematical calculation. See lot of this tough is calculated recorded and it is compiled to, whether to understand the global functioning of the brain.

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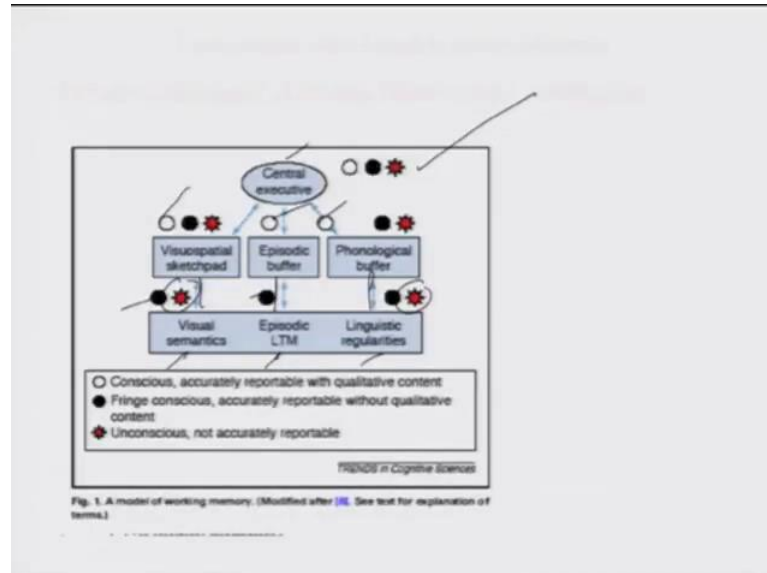
Lucia Melloni et al, Long-distance synchronization of neural activity across cortical areas correlates with conscious perception. *J. Neuroscience*, 2007.



L. Melloni: In my talk I will present evidence which suggests that long-distance synchronization in the gamma frequency range plays a crucial role in conscious perception. I will present several studies where long-distance synchronization and local gamma synchronization were measured during the presentation of visible versus invisible stimuli.

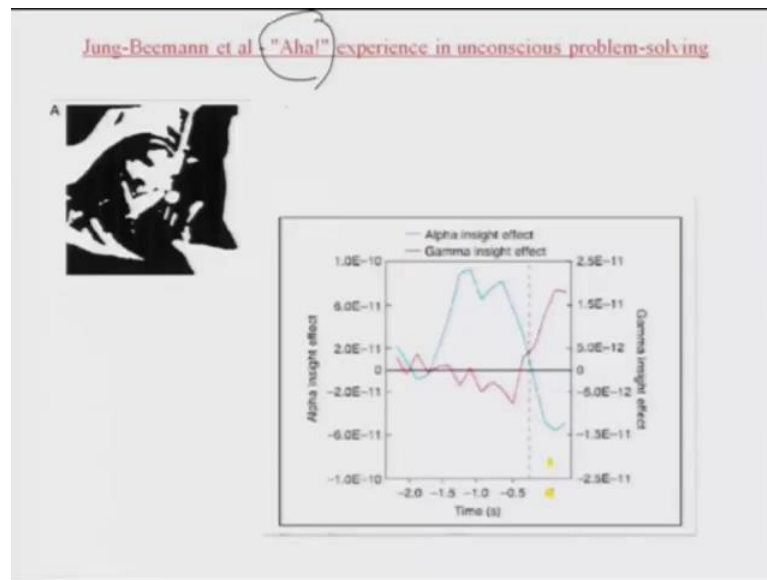
So, central problem for cognitive neuroscience is to describe, how cognitive processes arise from brain processes? So, this is again similar type of experiment.

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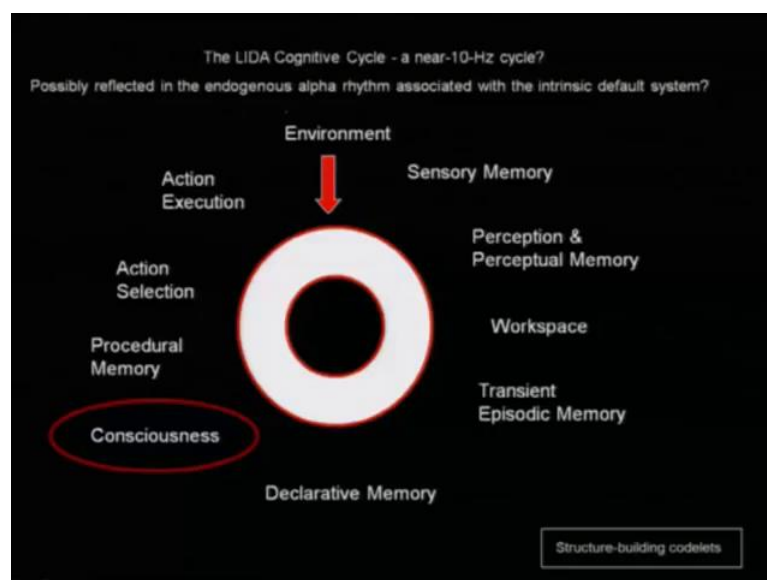
Right so, this is again a central executive. Visual semantics, episodic long term memory, linguistic phonological buffer, episodic buffer, eventually what language. See if you see this thing, these are unconscious not accurately reportable. These types of stuff are fringe consciousness. They can be reported, but without any qualitative and these are the real conscious words, images and whatever format wants to come out there is something call experience. Have you wonder that when you are thinking many times, you are sitting with the problem you are breaking your brain overrate.

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And it will not get anywhere and suddenly you sleep over it and when you sleep over it next morning you suddenly get think, is this conscious? No because your brain even when you are sleeping is working on the same phenomena behind the track and there when you sort out is suddenly crosses the threshold and comes to your conscious effort, a conscious awareness.

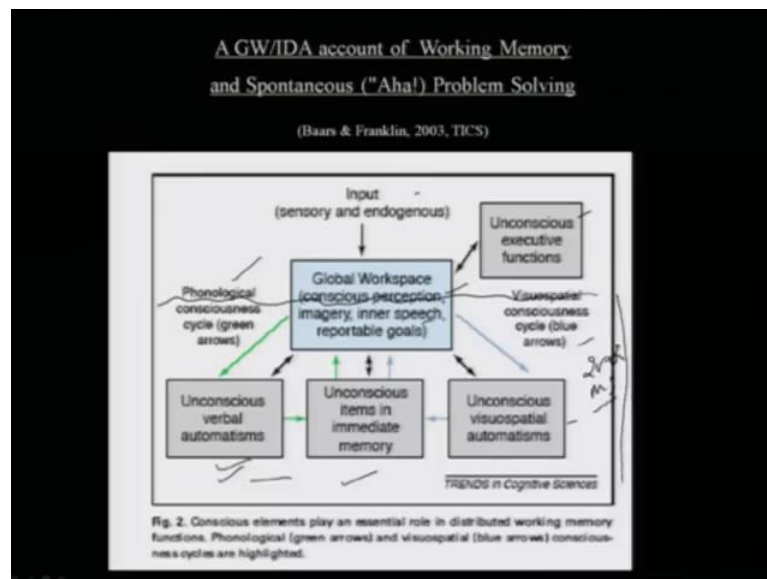
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Again, what is consciousness? The 10 hertz cycle action execution, consciousness or because; obviously, when you are this 40 hertz or 30 hertz gamma oscillation, you are

not aware of. How was it binding? What you are just aware of is when you do things. So, when you do things, awake resting stage the variation is in alpha only. So, what part is conscious? 8 hertz, 9 hertz or 10 hertz or 13 hertz because 13 hertz is pushing towards the activity, 8 hertz is pushing towards more memory formation 10 hertz we do not know.

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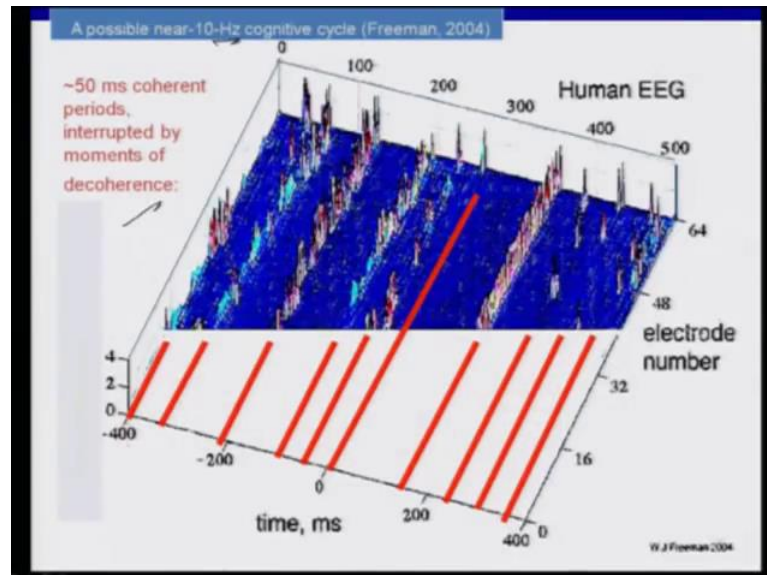
So, this is again similar thing of experience, unconscious same thing. Unconscious items in immediate memory, unconscious verbal automatism, there is lot of subconscious speech which is going on. Thoughts it have been lot of people come and tell me as a psychiatrist, the lots of thoughts come to my mind and I do not know why I am thinking it? So, they are sitting doing something else and suddenly, students all of you students know it. When you open your book and after 2 hours, you suddenly realize that you are on the same page.

Because your mind is wondering somewhere, your mind is thinking, where are this thoughts coming from? Where are these words coming from? No have nobody has any idea, but it is all the process of the brain. That is why say if you aware of your become aware of your whole brain whether you will be able to survive or not survive is a million dollar question. Unconscious verbal automatism unconscious items in immediate memory, visuospatial, there is a left side of the brain, left temporal verb is verbal



memory right is a visuospatial memory, unconscious verbal automatisms, visuospatial automatism phonological.

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So, global workspace has conscious perception imagery inner space reportable goals. Again the same process, somewhere here along the line along these 200 milliseconds, things will really switch on. Again is a set, 50 milliseconds coherent periods interrupted by moments of de coherence.

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**Dave Edelman**

**Fig. 2. Possible neuroanatomies of primary consciousness.**  
In humans, primary consciousness is associated with the highly reentrant thalamocortical system. In birds, a functionally analogous system may involve regions of the telencephalon, the thalamus, and basal ganglia. Cephalopod neuroanatomy is currently insufficiently characterized to advance functionally analogous structures with much confidence.

**Squid brain!**  
Present by thalamocortical system (T) - Conscious

The neurons are all gathered around to look at the back and back - the conscious weight of the brain is 22 grams and surrounds the cerebellum. The cerebellum is 11 cm in diameter, therefore everything 2 cm has to be changed into 11 cm as it has to pass through the brain!

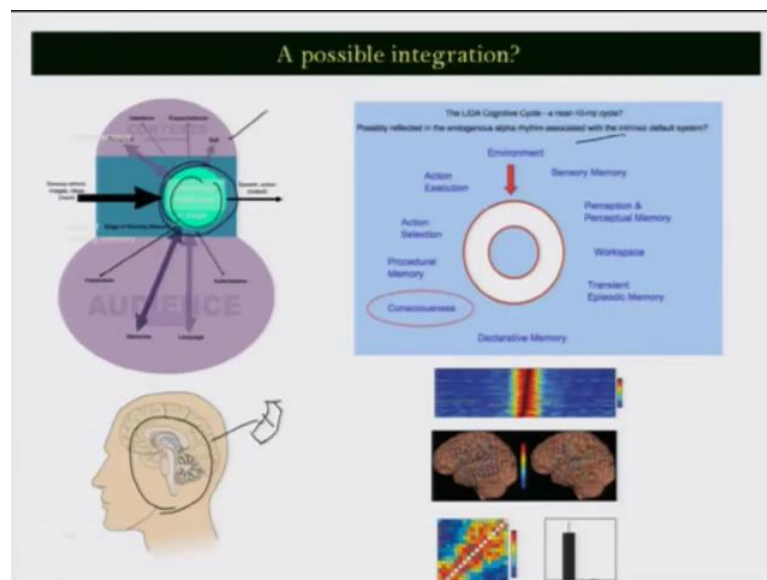
**What kind of brain reveals these functions and mechanisms?**

- Simulation of the thalamocortical core in mammals - shows regular rhythms.
- Izhikevich, Edelman & Gally, 2008

So, possibly at 10 hertz cycle is working at the brain which may be so, Edelman brought out this possible Neuroanatomies. In human primary consciousness is associated with the highly reentrant Thalamocortical system between the alpha and the gamma binding and (Refer Time: 25:18). Thalamus is a trigger for all this. Thalamus has lot of input coming from what you call reticular activating system and that triggers the whole cycle.

In birds possibly again basal ganglia and all these things again these are type of experiments which they have been trying to Thalamocortical shows everywhere. In mammals Thalamocortical connections are very important because if you study across animals what you will find is that the Thalamocortical loops vary in the size.

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And density so, these are possible integration of the whole story. As I said this is a structure we know, over which we form networks, graph networks and whatever form we want to do. This is a possible theater where there is a conscious attention thing and cooperative cycle possibly near 10 hertz and these are all the investigative facilities we have. So, I will ended this, but I hope you would have got an idea of how tough the whole thing is, that in spite of knowing so much stuff, when it comes to making a theory of it and explaining the whole thing of what is human? So, most people tend to brush it off because there no answers, but in spite of being a neuroscientist and in spite of delving and believing in the biology of it, I my guess is that we should not be too arrogant in rejecting the other models. All though philosophy may not have a base right now or may

be the spiritual religious traditions will not have a, but they believe systems have, on the gross appearance it appears that everything is in control of.

But then unless we have real explanation because we see it at least in the case of conscious and unconscious mind it may not be the (Refer Time: 27:25) way which working, but just after 60 years we are talking of a strong unconscious component in life. So, we do not know, we also do not know about the other state of life in which we spend 1 third of our life and that is sleep. So, there is awake conscious, there is a awake not so conscious and there is sleep. What function does sleep do? And within sleep itself we have so many complex dynamics. Now one thing which we I should mention that, in spite of knowing this network and studying them in task oriented way, is this the complexity is conscious the reflection of complexity of activity? And complexity of activity simply means not getting too many complicated firing patterns; it is the complexity is at with every dynamics the dimension increases.

Now, what is the range of these dimensions? If we observe any human life behaviorally you will be able to define certain things, nothing moves that is normal, but there what is abnormal? Is autism just another dimension of brain? Is schizophrenia (Refer Time: 28:54) other dimension of brain? Which is not, we are not able to fit in because most of us like are like into 1 parameter. Is it that? Or is it some something else is something which we have to see. Next time we will talk about sleep, this is another state of consciousness, and takes it from there.

Thank you.