**Lecture – 03**
Studying Cognition

Hello friends. So, we are back today continuing from the last class where we studied what is cognitive psychology and what is the subject matter of cognitive psychology. So, in that class earlier class we saw the basic subject matter of cognitive psychology, what are the various inputs from various schools of psychology to cognitive psychology, what is it that we study in cognitive psychology and the various paradigms which are there for the study of cognitive psychology how they explain mental events and mental facts.

In the last class we discussion cognition is about understanding mental events and mental facts how does mental processing take place or mental events and how does the mind come into play and what role the blame has in the mind.

In today's lecture we look at the various ways of studying cognition what are the various methods which are available for studying cognition. So, let us begin.

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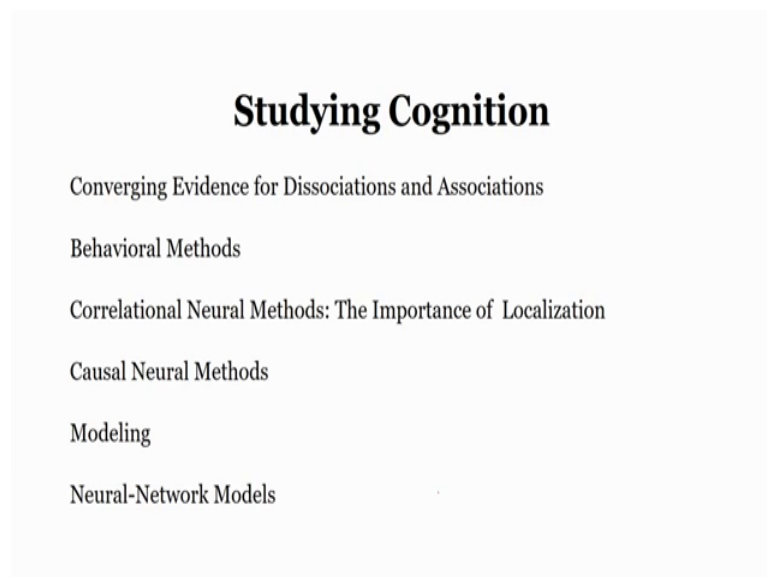
There from the start of cognitive psychology and the or the (Refer Time: 01:38) of cognitive psychology, there were several methods which was out there to study cognitive

psychology, the basic method that primitive cognitive psychology or artificial intelligence used did not employ any role of brain into it. So, the earlier the first advent of cognitive psychology or the first wave of cognitive psychology basically banked on information processing theory.

So, information processing theory was all about mental processing how mental events pro gets process to save several mental mechanisms and what is the input, what is the output that kind of process or that kind of structure was which have been studied by cognitive psychology. So, information processing theory as we saw in the last class actually looks at the events and the mechanism frosting mechanisms through which mental events or mental activity is generated.

In contrast artificial intelligence was also looking at how at the process level mental events are studied and both of these methods did not play or did not emphasize the brain in any ways, as we know today that the mind is actually a software or kind of a software or mind is actually a fact which is made by the brain and. So, studying of the brain is very important in studying cognitive psychology.

Now, some of the main reasons why the brain should be included in the study of cognitive psychology is to understand the dissociation and association the process of dissociation and associations, because these dissociation and associations will tell us what processes are similar if 2 mental acts takes place and what processes are different if in 2 mental events or 2 mental process acts.

To the heart of this debate is the idea of localizing those brain areas to finding out those brain areas which act up, which show activity when a particular cognitive act a particular cognitive process is initiated. So, what the new da cognitive psychology or the new field of cognitive psychology is looking at not only the information processing or the artificial intelligence approach, where mental process events and various other mental events are studied, but in relation to it the new wave of cognitive psychology is also looking at brain areas of how brain areas or what brain areas are really involved in producing cognition.

There are multiple methods of studying cognitive psychology as I said so each of these methods use a different measure a different way to study cognition. Now these methods all have their own problems and all have their own limitations and what has to have what

to study to you to find out the complete method or a perfect method to study cognition would take into account the (Refer Time: 05:25) all these methods why should we do that we should do that, as multiple methods when they provide information what would happen is that the limitation of one method, could become the benefit of other method, and the benefit of what method, could serve as or could add up to more affording information.

So, when looking at multiple methods one looking at multiple ways multiple ideas or multiple approaches to studying cognition this will give us a more complete picture or a more desirable outcome of what cognition is all about. Now the general goal of cognitive psychology is to study dissociations and associations at the level of the brain now when I say dissociation and association what is it that I actually mean?

Dissociation is a fact or a term which explains that 1 if 2 processes or if 2 mental acts give rise to activation in 1 area of the brain how to we dissociate it; simply stating what it would really mean that an event if an event or a variable leads to brain activation during the processing of one task, but does not lead to the brain activation on the other task this is what dissociation is.

This will tell us which task requires that particular mental activity or that particular mental process and which of the task does not require that particular mental task. Let us understand with an example; Allen Bradley developed the idea of working membrane and. So, what Bradley said is that there is a whole conceptualization of the central executive component of memory, which executes most of the working process in in working memory and within the central executive or with the central executive or other parts of the working memory which is the spatial store and the phonological loop. The idea of working memory is conceptualized in this way that input or the encoding from the environment is thrown into the central executive, which then assigns the audio input, the auditory input into the phonological loop and the visual input into the spatial and spatial loop or the spatial store what does it mean?

It means that at the level of processing itself at the level of encoding itself or just after encoding the mind takes away 2 inputs from 2 difference senses and processes them separately. Now the same region of the brain is involved in storing the phonological loop or the phonological matter and the spatial matter is that true.

So, experiments are done to find out whether this as the assigning of the visual input and the auditory input into different stores or the working memory, whether they use the same mental process or the same brain areas. And if different brain areas were activated then we could say that both the task; the tasks of assigning the auditory input into the phonological loop and the visual input into the spatial sketch pad they require different brain areas and through this we can then specifically study one of these areas or deficit one of these areas.

So, Allen Bradley what he did was he did some studies to find out what really happens at the level of the brain. So, he specifically inhabited or the visual input and he saw that there was no deficit into the auditory input. What he did was he gave a visual task to his subject and with this visual task he actually loaded the working memory or the attention the attention span with more data more items. And when that happen the subject was not able the subject could not process the vision input, but the auditory input was intact plus understand this in the more easy example.

So, what Allen Bradley wanted to study is rather if the visual input is loaded whether the auditory input can function on it is own meaning, which both the processes are both the processes of visual input and the auditory input in the working memory are have dissociative processes or dissociative brain regions involved into it.

So, in his task he gave visual task and loaded the attention or loaded the central executive with more visual information. So, the subjects are not able to rehearse or not able to study back the visual inputs, but the auditory input the auditory information which was stored in phonological loop got a proper rehearsal. So, when the test was done it was found out that although the subjects are not able to correctly identify visual items or visual matter auditory inputs or auditory test or auditory inform information retrieval was not at all disturbed.

This particular experiment shows that dissociation is at the core of studying cognition why because dissociation can tell, but tell us which processes have similar although they have similar representations, but they use different mechanisms.

Similar to it is the study of associations in associations what we actually study is whether 2 different processes are linked or 2 different processes, actually excite the same brain region for example, in this case experiments were done to find out whether the frontal

cortex the frontal regions and another area of brain whether both of them have anything to do with spatial representations or of encoding of special into spatial encodings.

What they found out is that spatial information, when encoded through 2 different processes or 2 different brain regions gave rise to similar representations meaning which both the brain processes or both the brain areas although different, but they combindly give rise give rise to same interpretations.

Now, why is the study of dissociation and association important the study of dissociation and association is important to find out which processes although emanate from the same structure, but they lead to different task and which if 2 different processes, which emanate from different brain areas converge on to a particular task to find out the specificity to find out the process through this.

Now, the methods of studying cognition so there are 4 different methods through which cognition can be studied. So, these methods are the behavioral methods the correlation neural method the causal method and the modeling within the modeling we have the box model approach and the neural network model of approach.

So, let us start with the behavioral methods what the behavioral methods generally do is they look at directly observable behavior, like reaction time the time when pa person takes to react to something or accuracy of how accurate a retrieval is from encoding.

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Behavioral Methods

A behavioral method measures directly observable behavior such as the time to respond or the accuracy of a response. Researchers attempt to draw inferences about internal representation and processing from such directly observable responses.

So, these processes or these events responses are map on to behavioral methods. The accuracy of response or the time taken to response gives us an idea on to what behavioral processes are going through in the processing of a particular mental event. Now researchers they attempt to draw inferences about what kind of interpretations and what kind of processing leads to the differences in accuracy and differences in reaction time.

4 popular approaches that have been or 4 popular methods within the behavioral method have been used. So, what we will look at is; what are the benefits of each method, what are the drawbacks and that kind of thing into less. So, let us go into that comparison.

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Major Behavioral Measures and Methods Used in Cognitive Psychology			
Measure or Method	Example	Advantages	Limitations
Accuracy (percent correct or percent error)	Memory recall, such as trying to remember the main job requirements during an interview	Objective measure of processing effectiveness	Ceiling effects (no differences because the task is too easy); floor effects (no differences because the task is too hard); speed–accuracy trade-off ("jumping the gun")
Response time	Time to answer a specific question, such as whether you know the requirements of a certain job	Objective and subtle measure of processing, including unconscious processing	Sensitive to experimental expectancy effects and to effects of task demands; speed–accuracy trade-off
Judgments	Rating on a seven-point scale how successful you felt an interview was	Can assess subjective reactions; easy and inexpensive to collect	Participant may not know how to use the scale; may not have conscious access to the information; may not be honest
Protocol collection (speaking aloud one's thoughts about a problem)	Talking through the pros and cons of various job possibilities	Can reveal a sequence of processing steps	Cannot be used for most cognitive processes, which occur unconsciously and in a fraction of a second

As you can see the major behavioral methods and methods used in cognitive psychology, the major methods are looking at the accuracy of how accurate the retrieval is from the encoding percentage of that is percentage of correct responses response times judgments and protocol.

Now, let us take these methods one by one the method of accuracy in this method of accuracy a very good example to look at is item recall or memory recall for item such as remembering a particular job requirements or a particular task. The advantage is this it gives an objective idea of the processing effectiveness how effective is the mental mechanism or the mental process, which is processing that particular event the limit to accuracy method or behavioral methods of accuracy is something called the ceiling effect and floor effect.

Ceiling effect is when a task is made too easy. So, that each person gets the highest score and. So, it will be very difficult to find out the exact processing mechanism similar to this is the floor effect in which a task is made. So, difficult that none of the people are able to solve it and due to this will not be able to a certain what processing mechanisms are at play. Also they suffer from something called speed accuracy trade of which means that as it want to be more accurate on something the more time it will it is going to take.

As accuracy increases more accurate we want the speed decreases or the time to perform a task decreases is a inverse relationship the second method here is response time, which is the time one takes to come up with a particular response the advantage is this that it is an objective method and suitable for measuring of processing mechanisms that is at play and also those unconscious processing mechanisms. Now this the limitation to this method is something called experimental expectancy effect and task demands.

What this really means is that each experimenter when he is gets into an experiment he has certain expectancy he has a certain want from the subjects. So, this gets transferred to the subjects subject identifies these expectancy and actually behaves in a similar way. So, if experiment of ones are subject to say yes to most of the things or take more time in responding what would really happen if the subject understands that or judges that from the from the experimenter and even if the processing is fast they take more time.

The third method is called the judgment method here what really happens is to find out what really what really is happening in or how does particular process really work is people are given a judgment scale. So, there are sev these are 7 point or 8 point, 9 point scales which are given to people who actually judge or go ahead and rate how they are processing a particular item. It is very inexpensive to collect and it excesses subject's reaction to a particular cognitive process for example, the thing like how are you feeling right now. So, test can be given to people and what they could do is actually go ahead and on a 7 point scales go ahead and tell on several questions or provide responses to several questions as to how they are feeling.

The problem with this method is that subjects are not aware of how to use this scale and. So, we get into difficulty the last of the behavioral methods which I use to study cognition is something called the protocol collection the method here allows subject to

verbally announce what is going on or what they are doing for example, if I ask someone to go ahead and show me how counting of 2 and 3 is done.

This person has to actually start the pa the experiment the subject has to actually go ahead and relate how his go how he is doing the addition process. For example, thinking of the number 2, thinking of the rule for addition, thinking of the number 3, going adding carrying off and so on. The protocol method really uses or really requires the subject to announce what is going on mentally. This method can tell you or the advantage of this method is basically it can tell you what are the steps basic steps through which a mental processing happens or any task what is the mental requirement for this task what is the mental process for this task.

For complex cognitive processes this cannot; obviously, be used because people would not be aware of what is going on and they could not or they could not accurately go ahead and describe what is being going on.

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Correlational Neural Methods: The Importance of Localization

Cognitive psychology has become extraordinarily exciting during the past decade because researchers have developed relatively inexpensive, high-quality methods for assessing how the human brain functions. These methods are *correlational*: although they reveal the pattern of brain activity that accompanies information processing, they do not show that activation in specific brain areas actually results in the task's being carried out.

Correlation does not necessarily imply causation.

The next method that we use in studying cognition a cognitive processes is the correlation or the neural methods. Now what does correlation really mean or what is this what is the heart of this method, the heart of this method is localization as we discussed at the start of the lecture that the new way of a cognitive science is looking up at the brain towards the brain to explain; how this cognitive processes or mental events are being processed or how is the mental event actually being processed, what is going on

inside the mind what is going on inside the subjects cognition, how is the processing input and output coming into effect.

Now, there I explain to you that the brain is a recent edition why because the brain can objectively tell you the processing the methods or by through which particular mental event is being processed. So, this method looks at finding out or localizing that area of the brain when a particular mental event is being carried out what this method does is actually tries to form a correlation between the fact that when a mental event happens which areas of the brain actually show activity. So, through correlation it tries to show off or tries to find out which area of the brain is responsible through, which kind of mental activity this will benefit us as we will be able to specifically, now tell that each mental process or each mental event or each mental mechanism is relate to a particular brain area.

The problem here could be that sometimes numerous other brain areas beside the area of interest also get excited and. So, it is a little bit difficult or I would say a little challenging to pinpoint the area that is responsible for the core mental process which is being carried out.

Another problem with this method is correlation does not lead to causation correlation simply means the 2 events by chance are related to each other they do not mean that process a leads to process b. So, we cannot with confidence say that this brain area excitation of a particular brain area leads to a particular mental event or particular mental process or particular cognitive event.

Now, there are couples of techniques which are here. So, let us look at those techniques let us look at the advantages of this techniques and the disadvantages of the technique and discuss how this method really works.

Causal Neural Methods

Causal Neural Methods Used in Cognitive Psychology

Method	Example	Advantages	Limitations
Neuropsychological studies (of patients with localized or diffuse brain damage)	Examine deficit in understanding nouns but not verbs	Tests theories of causal role of specific brain areas; tests theories of shared and distinct processing used in different tasks; relatively easy and inexpensive to collect	Damage is often not limited to one area; patients may have many deficits
Transcranial magnetic stimulation (TMS)	Temporarily disrupt occipital lobe and show that this has the same effects on visual perception and on visual mental imagery	Same as for neuropsychological studies, but the transient "lesion" is more restricted, and the participant can be tested before and after TMS	Can be used only for brain areas near the surface (TMS affects only tissue about 1 inch down)
Drugs that affect specific brain systems	Disrupt the action of noradrenaline, which is crucial for the operation of the hippocampus	Can alter the processing of specific brain systems; typically is reversible; can be tested in advance with animals	Many drugs affect many different brain systems; the temporal resolution may be very poor

So, the causal neural methods have 4 different techniques to look at I am sorry 3 different techniques to look at and these ma techniques are the Neuro physiological studies the transcranial magnetic stimulation and the drugs. So, I was saying as I was seeing the correlation neural methods the problems with the correlation neural method. So, there are 2 problems with this first that many areas side along or they get along or an activated in addition to the main area of interest. So, what really happens the problem with this method is to localize the area of interest because the ma areas also which inside along gets activated.

And the second problem with the correlation neural methods is that correlation not causing causation now what really happens in correlation is 2 events a and b they although show in sink activity, but correlation does not guarantee that a is the cause of b or b is caused by a and. So, there is no way to find out what process leads to or what method leads to what structural activation in terms of the brain mind relations, it would be very difficult to find out whether the activation in area deep to the mental processing or where the mental processing leads to the activation in an area.

Correlational Neuroimaging Methods

Method	Example	Spatial Resolution	Temporal Resolution	Invasiveness	Cost (Initial; Use)
Electrical (electroencephalography, EEG; event-related potentials, ERP)	Track stages of sleep (EEG), brain response to novelty (ERP)	Poor (perhaps 1 inch)	Excellent (milliseconds)	Low	Low purchase cost; low use cost
Magnetoencephalography (MEG)	Detect activity in auditory cortex to tones of different pitches	Good (under 1 centimeter, but only in sulci, not in gyri (because of the way dendrites line up)	Excellent (milliseconds)	Low	High purchase cost (and needs a special magnetically shielded room); medium use cost (needs servicing so superconductors remain extremely cold)
Positron emission tomography (PET)	Detect activity in language areas as participants speak	Good (about 1 centimeter, but in theory higher)	Poor (an image every 40 seconds)	High (must introduce radiation)	High purchase cost (needs a cyclotron plus the PET camera); high use cost (about $2,000 per participant)
Magnetic resonance imaging (MRI) and functional magnetic resonance imaging (fMRI)	Show structure of the brain (for MRI), show activity in brain areas, same as PET (for fMRI)	Superb (millimeter range); fMRI often about 0.5 centimeter	Depends on level of resolution; typically several seconds	Low	High purchase cost (needs a specially shielded room); medium use cost (needs servicing)
Optical imaging	Show activity in brain areas, same as PET	Poor at present (about 2 centimeters)	Depends on level of resolution; typically several minutes	Medium/low (light is shined through the skull)	Low purchase cost; low use cost

So, there are 4 different methods here techniques here to study the correlation or the correlational localization of brain areas. The first of this technique is the EEG or the electroencephalograph. The electroencephalograph can also be used for recording something called the ERBS. Now what the EEG or the electroencephalograph records are potentials from the scalp when a particular mental activity takes place it believed that a mental when a particular mental activity takes place there are changes in neuronal polarity and due to this a weak electrical current actually passes to the scalp surface.

The EEG senses which are placed in the scalp at record these activities and based on that are able to predict, whether there is a activity change from the baseline activity a baseline activity is an activity when no mental processing is being taking place and when whenever an activity takes place there will be a change and. So, the changed activity subtracted from the baseline activity will give you the kind of mental activity if just being taken place.

EEGS are also used for recording event related potentials which are basically the potentials which are recorded when a particular stimulus is set. So, after a particular stimulus is initiated from there on to when the response of the system or when the response of a person takes place the EEG the electroencephalographic patterns of the brain recorded and the time codes of this EEG, the time the changes in EEG from the stimulus onset to the response is calculated or recorded or studied and this gives us an

idea of what processes and what areas or what kind of pattern of activity is being shown by the brain.

Generally there are some very fixed patterns that the brain show there is something called the base activity that mostly happens in everyday life is the alpha activity, which falls in the 8 to 13 hertz 13 cycle per second region then if as a person gets more relaxed e the amplitude of these waves increases and the frequency lowers down when it comes back to something called delta so on and so forth. So, as you get more worked up as you are doing more general activity the amplitude is less the frequency is more and the banned pattern or the activity pattern of the brain is generally in the 8 to 14 hertz cycle per or cycle per second region.

An example of using EEG is to find out brain patterns during sleep or something like in terms or ERP something like P 300 now P 300 is actually a component which happens P 300 is when I say component what does it really mean a component is a deviation in an electrical activity which takes place after the start of a event. So, when a stimulus is given when a stimulus is initiated and the EEGs are recorded 300 milliseconds after the stimulus initiated on the positive direction if a peak is recorded this is called the P 300

Now, the P 300 generally the component P 300 generally is associated with novelty. So, when the brain the process the mind looks at something which is noble which is new it generates the P 300 activity and. So, these this this can be recorded.

The spatial resolution of a EEG is very poor because it cannot locate the area from where or the neuronal group from where this activity is being recorded as current passes or current moves from the base of the brain towards the surface of the brain it forms a conical structure and. So, it loses most of it is strength and it is very difficult to go back in or to reverse engineer from where the source of this activity is.

Although newer techniques do allow for something called source localization from actually from an EEG will pin point gross area of where it is coming from.

But generally speaking the EEG s have very poor resolution in terms of temporal resolution an EEG is excellent because it can show you, within milliseconds of the activity will, within milliseconds of the mental event the mental activity and can show a correlation to that. So, in terms of time of processing in terms of time course of

processing of mental events the EEG is very good can tell you, what events in in that on the time axis, what events process it is a process or what even processes take place that that kind of information can be there gathered from an EEG.

The invasiveness of this particular method of the EEG is very low as you know have to put anything inside the body the surface senses actually captures the information. So, not much of an invasive process and the cost for this particular method is very low it is smaller units are available in in very few dollars you can buy them and start using them.

Similar to the EEG is the MEG the magneto encephalogram where electrical activity instead of capturing the electrical activity the magnitive activity is captured an example is detecting activity from the auditory cortex different picture stones.

So, here there are several sensors which are put around the brain the magnetic activity that is generated when a particular event happens, a particular stimulus; after the particular stimulus the particular event which happens are recorded or the magnitive activity of which is generated by the neuronal group which is processing the event are captured through it

The special resolution of the magneto encephalograph is very good it is up under 1 centimeter, in terms of temporal relation also it is very good this is excellent the invasiveness since we are not putting anything inside the body it is very low and. So, invasiveness wise MEG s are very good, but the problem is buying an MEG or establishing an MEG requires a very high cost. So, cost too high it requires system which produces this magnetic moments or this prod produces magnetic fields, which actually are able to process or which actually are able to record changes in brain activity or neuronal activity when a particular mental event is going on.

Third method that we use as a correlation method or for localizing brain areas that are responsible for a particular mental event is the positron emission tomography the PET in cognitive psychology we ge, we generally use the 15 O isotope the 15 oxygen isotope as a method for doing PET. So, what really happens is that the oxygen the 15 the O 15 isotope which is radioactive is injected with normal within the normal body?

So, this particular isotope is moving around the body. So, when the brain does it is believed that the when the brain does a particular function it pulls up more and more

blood and with the blood more and more water also transports to the brain. So, when a particular at region of the brain shows more 15 the accumulation of more 15 Isotope that is the region, which is correlated or which is assume to be active in a particular process and this is how the PET or 15 oxygen isotope is done.

Generally it is used to study or mostly it is used to study language areas of the brain of how the language areas process or what is the processing that happens in language area when we actually speak. The special resolution is very good up to one centimeter, but the temporal resolution is very poor because it takes almost 40 seconds to generate an image out of the PET of 15 oxygen isotope or the o 15 isotope.

Invasiveness is high as we in as we inject an isotope of oxygen which is radioactive into the blood and. So, this has radioactive properties which could lead to problems although the kind of radioactivity that happens with an oxy with O 15 isotope is as less as what a airline pilot would actually get through in half a year of his work. So, it is very very less, but still it is radioactive. So, it is best to avoid it.

On terms of the purchase cost it is a high purchase cost because PET need cyclotron and PET cameras and things for noticing those senses which can go ahead and record the radioactivity the low radioactivity of this oxygen isotope. So, it is very costly in that method and improvement on the PET is the MRI and the f MRI which was which is a new addition to the study of the brain or the brain processes or cognitive processes. The MRI on 1 hand is actually stores the structural integrity of how the structure of the brain is the f MRI on the other hand shows the blocks blood oxygen level depending or how much oxygenated blood is taken up by the brain when a particular activity is being processed by the brain.

The MRI works on the principle of body magnets or atoms of the of the body and how they aligned to an external magnetic field. So, what the MRI generally does it produces a uniform magnetic field to which most atoms of the body aligned and then radio pulse is created or radio puls is it is generated which disturbs the alignment of most atoms of the of the area, which is in the MRI scan the speed of returning back is calculated when the magnets disaligned, when the particular pose or the particular elements in the particular atoms of elements in the body, when radioisotope disaligns them from the aligned from the alignment that the MRI magnet does it returns back and the speed with which the

return back is calculated and from there an image is generated. And these images or the speed at which the different atoms get back or they come back is different different media like bone, skin or that other issues in the body they have different speeds of returning back or this is calculated and an image is generated.

In an f MRI what we really do is the amount of oxygenated blood in comparison to the deoxygenated blood at a particular brain region, which is processing a particular event is taking that is calculated and that gives us an idea of which region of the brain is showing an activity through a sensor.

The spatial resolution of an both the MRI and f MRI is very superb it is very good in the terms of millimeter inch the temporal resolution is not that good, but depends upon the level of resolution that you want or generally it is in terms of several seconds. So, not like the EEG, which can give you the millisecond kind of a temporal resolution; but not as low as the PET which gives, which takes almost 40 seconds to produce an image.

So, MRI s have decent time requirement or this takes decent time to produce images the invasiveness is low because MRI does not the MRI and f MRI does not inject anything into the body. So, the invasiveness is low, but here the purchase causes very high because the kind of magnets that the MRI and f MRI uses are huge electromagnets and they have huge amount of cost involved into them.

The last method that we use here is called the optical imaging method and here this is a recent addition. So, it has been found out that the brain is transparent to certain kind of light waves and when these light waves are shown into the brain through a through a laser the speed with which they return back can give you an idea of how much blood is flowing through that particular area. So, this can be used this method is now being used to find out the amount of blood travelling through a particular area depending on how much light laser light is being reflected back through various tissues and various substances in the brain.

It is the special resolution at present is very poor and the temporal resolution it depends on the level of resolution and several minutes takes up from forming an image. The invasiveness is generally medium to low as lasers are shown on to or lo lasers are focused on to your brain. So, it has some level of an invasiveness, but not too high the

cost of purchase is very low, but the temporal (Refer Time: 38:59) relation is not appropriate.

One of the examples of f MRI which is functional optical imaging suit which is available these days, another method of studying cognition is through using the causal neural method of studying cognition. What does this method do in this method it is assumed that if certain regions of the brain are required for certain activity, what would happen if that vision of the brain is somehow not allowed to do any activity or stops from doing activity. So, one of the one of the particular methods within this approach is using patience who have certain brain damage.

So, suppose the broca area is responsible for speech. So, if somebody has a deficit in the broca area and if certain type of speech related experiments are given to them and compared to a particular normal person, it would be easy to understand what kind of what kind of activity does the brain does what is requirement of this area and so on and so forth. So, here in this in the neurophysiological studies patients with localized brain damage or brain damage to certain areas are used and they compared with people who have no brain damage and this is how the cognitive processes or the mental processes that go on when a particular mental activity is being done is actually studied.

Example could be deficit in understanding the how nouns and verbs are processed. So, people who have deficit in this area if you give them a noun and a verb the area since it is deficit. So, now, it will show no activity whereas, people who do not have deficits will show different activity. So, that will be enough to say that this area is responsible for a particular kind of act that is being required the advantages is of this method is testing theories of causal role of specific brain areas testing theories of shad in distinct processing and used in different task relatively easy and inexpensive to collect.

The limitation is we do not find too many people who have damaged areas and. So, the idea is it is very difficult to find people with damage areas also when damage to a particular area is there will be related areas which might be affected by the damage. So, it is very difficult to localize whether the this damage is to this area or which this is damage the damaged brain area also has any relation with other areas.

The second method in this particular group is called the transcranial magnetic stimulation. Now in TMS there are 2 types of TMSS 1 is called the single pulse and the

other is called the repeated TMS or the repeated trans pulse may transcranial magnetic stimulation, what really happens here it ha is that a huge coil is put into a near or on the surface of an area to temporarily inhabit and a large current is passed through this coil.

The magnetic field that is generated by this coil temporarily inhabits a particular area and through that we can find out whether the disrupt how what will happen if a particular area which is known to be associated with a particular activity cognitive activity if it is disrupted what really happens. So, what we could or studies of how visual imagery is different from perception can be done by using TMS TMS or using AR TMS and blocking the occipital lobe.

Now, there is a difference between single pulse TMS and r TMS in single pulse TMS a single pulse is given after the stimulus is generated and the time course of this pulse is recorded and that gives us an idea of how the or what activity is happening in that area.

Whereas in R TMS repeated pulses are given over a particular area so that these weak pulses they add up together to inhabit a particular area the inhabition happens because the neurons under that area becomes too extended they fired. So, many times that they go through a phase of non-firing and that inhabits the area or that that depolarization inhabits that area activity in that area.

So, advantages it is it has the same advantage as the neurophysiological studies, but here the lesions are restricted and also the idea here is that in these regions in the TMS the disruption is for a very brief period of time and. So, patients can come out of it or subjects can come out of it.

Also TMS S can be done for surface areas it cannot be done for deep areas of the brain.. So, it is one of the disadvantage on limitation of this particular method, another method which can relate or which can show how a particular brain area disrupting or particular brain area has effects on the particular mental process is using specific drugs. So, here what happens is first a particular drug is specifically used and these drugs inhabit a particular area of interest. So, once this area of interest is inhabited the same task is given to a person who has taken this drug which inhabits area and a person who has not had drugs which inhabits this area and comparisons are made.

These comparisons give us an idea of what really happens or how mental processes what brain areas are involved what mental processes is being processed and what is the time course of process of this mental events.

The problem example was disruption of disruptive action of not adrenal in which is crucial for the operation of hippocampus non adrenal injection is given to the hippocampus and though hippocampus actually becomes temporally disturbed. So, when you give a memory task to this person he will not be able to process this memory task and not come up with the better of how or the particularly travel paradigm in comparison to somebody who has no disruptions and this will show how much or to what extent does which part of hippocampus relates to a particular memory type.

Drugs when used to inhabit a particular area effects not only the area of interest, but also effects other area which is related to this area. So, this effect can also be can be generalized to other areas similar to this effect the TMS also has this particular disadvantage where activation of a particular area can lead to activation of subsequent areas. So, what would happen is the disruption will not be in that particular area, but also move out or generalize to other areas of brain and. So, to stay with confidence that this is this disruption of this area is responsible for particular mental act is becomes a little bit dicey.

Also the limitation is that many drugs can create many other problem and. So, this is this has to be used under supervision.
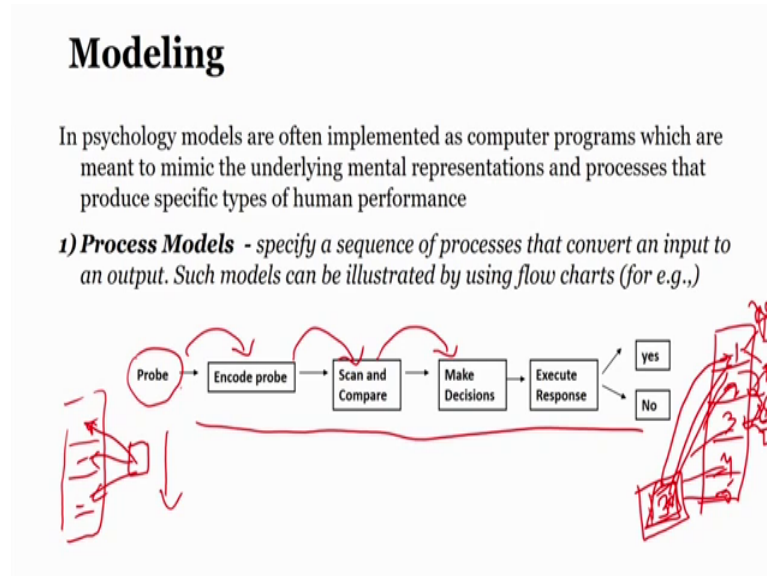
The last method that we discussed here of studying cognition or cognitive psychology is using modeling.

So, in psychology models are implemented as computer programs which are meant to be make; the underlying mental representation and processes that produce different specific types of human performances. So, generally models are made and these models try and explain the different processes events that actually happen when a particular mental event or a particular cognition happens. There are 2 types of models which are studied in cognitive psychology one of these is the process model and the second is the neural network model. So, what is the process model?

The process model specifies the sequence of processes that converts an input into output and can these kind of processes can be used to generate flow charts. So, basically it is a box diagram kind of a thing where you get from one pa one phase to another one event to another event and the processes which relate these events together.

Coming back to understanding the process model let us recall the structure process trade off that we saw in the last class and. So, in the last class and. So, in the last class Steinberg's example in which what he did was he wanted to study the mental process of how comparisons are made in the comparisons are made in cognition. So, what he did was he gave his subjects a particular number of items to remember and then these items were tested the retrieval of this the memory for this item were tested through a probe and

what Steinberg proposed is that this search for the target in the list of item that is being studied or the that is being remembered happens through a serial process.

Generally speaking this idea that a serial process look through a list of items, which administrate in memory, can be explained through a process model and this is the process model which explains how this serial processing takes place.

So, generally how this experiment would work is when a probe is given the probe is first encoded prior to this people are given a list to remember and the list has several numbers or several letters into it. And what the job is the subjects look at a probe and then found out whether this probe is present in this list or not. And to explain this process a process model can be developed how will the process model really works look at this in finding out or scanning whether the probe is present in the list, which is remembered the first step is encoding of the probe. This is followed by scanning and comparing where processes internal processes take the probe and match it with each item, which is represented which is stored into the memory for each item after a comparison a decision has to be made.

So, let us say this if we have 1 2 3 4 and 5 stored list of items stored or 5 numbers stored in a memory and if you want to compare whether 3 is present or not how this model will really work or how this process with really work in terms of mental effect is that 3 is first encoded later on 3 is matched scanned and compared; with the first item this which is one. So, a decision has to be made here whether 1 is 3 or not since both the representations for 3 and 1 are different response has to be executed here the response is no and the process moves to the second item.

Now, 3 is take it in compared with 2 since both the representations are different response here has to be generated which says the 3 is not equal to 2 and so we do not find a match and we move to the third item which is 3. Now here 3 and 3 had the same representations and so we get a yes response make a decision the yes response comes in and so in terms of serial processing the process does not stop here it continues to the end of the list and then gives the final answer.

So, that is how the process model explains the process model ex actually goes ahead and explains how this simple job or simple task of comparing a probe with the list which has been already remembered actually goes ahead.

The problem with this process model is it tells you about the processes that goes through or the processes that happen when this list comparison or probe list testing is done, but it does not tell you how does the brain or what neural factors play role into this particular whole structure. So, this has this is basically this kind of process models are basically influenced by the behaviors, which believe that the input output sequence is what is of important to us, but what is inside is not of importance to us.

So, it does not give you the brain structures the brain processes which actually go ahead and lead to the final answer of comparisons or final comparisons that are done. So, to counter that neural network models were done or thought of now what are the neural network model it relies on interconnected units which has not just input output units, but it has a hidden unit which is generally called the brain unit into it. So, most inputs are connected to a hidden unit and the hidden units are further connected to an output unit. So, if I encoding if a input unit is given this input unit then goes ahead and makes connections with this hidden units which are generally neurons.

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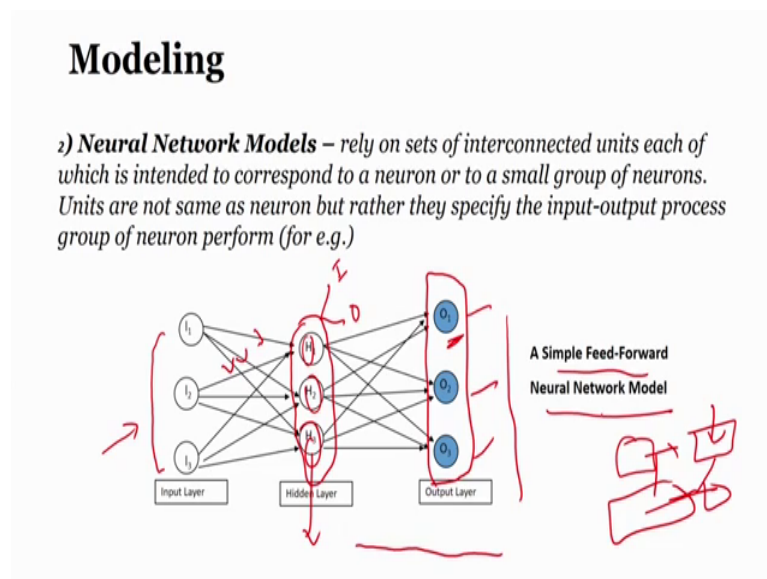
Now, this type of neural network structure that I am showing you is A Simple Feed-Forward network, what happens here is there are 3 units l 1 l 2 and 3 3 which inputs which have been taken and these inputs are then compared or then processed through H 1 H 2 H 3 3 different brain networks or neuronal networks.

Now each of this network can have only 2 activity 1 is either it can be excitatory which is the I response or inhibitory of response.

So, when a particular input a particular representation from the environment is encoded this particular network or this particular response neuronal network will either be excitatory, will either passed along with either move along this information to the next network and show a connection or it could show inhibitory whereas, it will not process this information further.

Also these connections that the input layer or the input item has with the hidden layer has weights into it and depending on what weight it is what is the strength of this connection will decide, whether this inhab whether this response of excitation or inhibition will these will this hidden units actually show. And based on the excitatory or inhibitory input or mode of the hidden layer and the weights of the input layer the output layer is finally or the outputs are finally, determined.

So, that is how we see that l 1 or I 1 represents gives to give rise to o 2 and the hidden layer the neural network or the group of neurons which actually process it how does it really function.

So, this particular model shows us gives us several benefit for example, it shows us what are the neural codes, which are there which are responsible for this kind of an output and it distinguishes this neural codes for mental representations. So, it does not just tell you mental representation of how a event is represented in in memory, but also what are the brain states or what are the neuron of the states which are processing this particular neuronal unit.

So, that brings us to the end of this session and to do a quick recap in this session what we did was we looked at the different methods of studying cognition and we looked at the heart of this study the use of different methods that the basic point being that as we use different methods, we get several whatever the loophole from one method turns out to be the benefit from another method.

So, we get a more comprehensive picture if one method explains process a, but cannot explain process b may be there is another method which can explain process b and comes up with another limitations and. So, looking at the benefits and limitations of all these

methods give us a more complete picture of how cognitive or cognitive processes develop.

So, within that we looked at 4 different types of methods or 4 different techniques of studying cognition right from behavioral techniques, where we look at accuracy response time judgments and protocol to coming up with techniques which actually go ahead and localize or pinpoint a brain area which is active when a particular mental process is being carried out and the methods like EEG PET M MRI or f MRI and optical imaging to looking at casual methods which actually disrupt a brain area, which is believed to be active when a particular event is being taking place or ventricular mental event is being taking place to the methods of modeling where a process is designed a computer stimulation is designed which mimics what the brain does.

So, instead of studying the brain itself um a mimic or a model of that is done and studied in a through computer stimulations to find out what will happen if a particular input or a particular group of brains brain areas, which are known to respond in particular ways if they take in an information how what is the possible output that can come in.

Thank you.