Indian Institute of Technology Kanpur

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Course Title
Basic Cognitive Processes

Lecture-25
Attention - I
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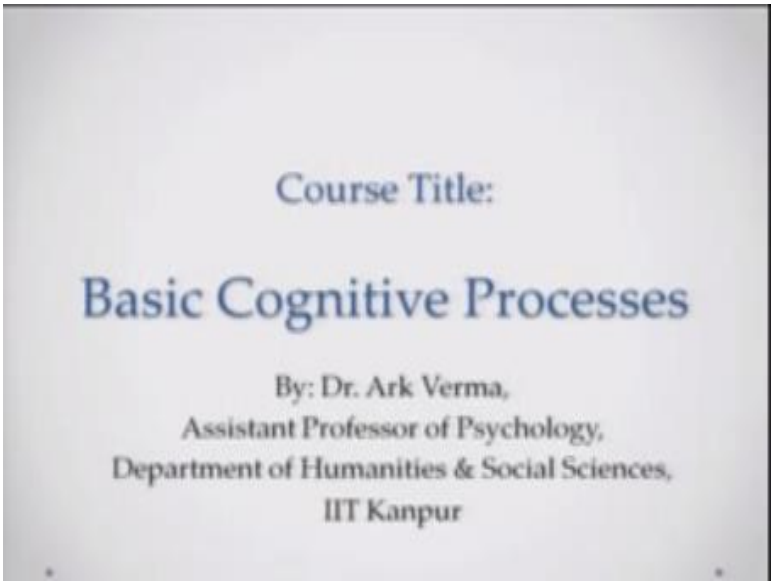

Hello everyone welcome to the course basic cognitive processes I am Dr. EricVarma from IIT Kanpur.

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Today I will begin to talk to you about a mental process called attention we have been talking till now about sensation, we have been talking about perception the variety of uses of perception being used for object recognition perfect perception being used for visual interaction with the environment we also talked in the more recent lectures about auditory perception we talked about theories of speech perception we talked about the physiology of the ear and such and in a broad sense.

What I have done till now in this course is given you an idea about what are the sensory processes and how do we get information from these sensory processes I have also talked to you about how do you convert information from these sensory sources and work upon them in order to let us say interact effectively with then I might say, for example you know reach words a cup and grab it for drinking out of it or say for example recognize the shape of something recognize.

The color or something and say for example if you are driving in the street how do you do that what is the kind of information you are using there, we have talked about all of these things and obviously there was scope for talking about other sensory modalities as well but given that vision and audition have received the most amount of attention from government scientists and given

the scope of the current course that I am taking I limited this to visual and auditory perception only.

But one of the questions and I hope you must be wondering about this as well is what really helps us gain information from these sensory modalities if you see yourself you know in this world and will imagine yourself walking in a particular part going around in a busy market place then you will imagine that the kind of sensory input, that we are getting all the time is too overwhelming okay.

So at any point in time you are actually you are in your senses are actually working overtime to get in all different kinds of information that are possible all kinds of information that you are collecting from the environment even, if you are just awake and you know just looking at things in your room you are looking at a lot of things your visual perception is giving you a lot of information imagine also you know if you are living you know if say for example you are standing on a balcony.

Somewhere you are also experiencing to many different kinds of noise there is too many voices maybe some conversation voices maybe some songs are being cleaned in the neighborhood maybe that is just traffic and that noise you are hearing you might be say, for example even you know party to some kind of odors or smells that around maybe there is you know nice breakfast being prepared somewhere something like that you are touching things you are feeling all those kinds of things.

So what I am trying to impress upon you at this point in time is that there is certainly a lot of sensory information that is constantly being bombarded on us as different kinds of simply as very rich stimuli, now the problem with the system or say for example in such a scenario the problem that appears in front of us and that needs to be resolved because, we can actively and meaningfully engage with the environment is which of these information do we select which of these information do we you know really attend to and process.

Further and which of the informations that we kind of let go the main purpose of this mental and cognitive function called attention is basically to resolve this dilemma you are constantly being bombarded with visual sensory information auditory, sensory information olfactory and gustatory sensory function you are doing a lot of you know sensory processing all the time but you if but if you imagine it is not that all of this information at the same time is being processed in your headmost of the time you are only selecting or working on or thinking about a subset of that information.

In this cutting chapter we will be talking about our ability to actually select some of that information and let some of the other information slightly live on the background this phenomena which allows us to do this is called attention there are some key questions one can ask if we are you know to talk about attention, if we are to discuss in more detail about attention and that we will certainly do in the course of the next few lectures before I talk to you in more detail about this let us try and look at these questions first.

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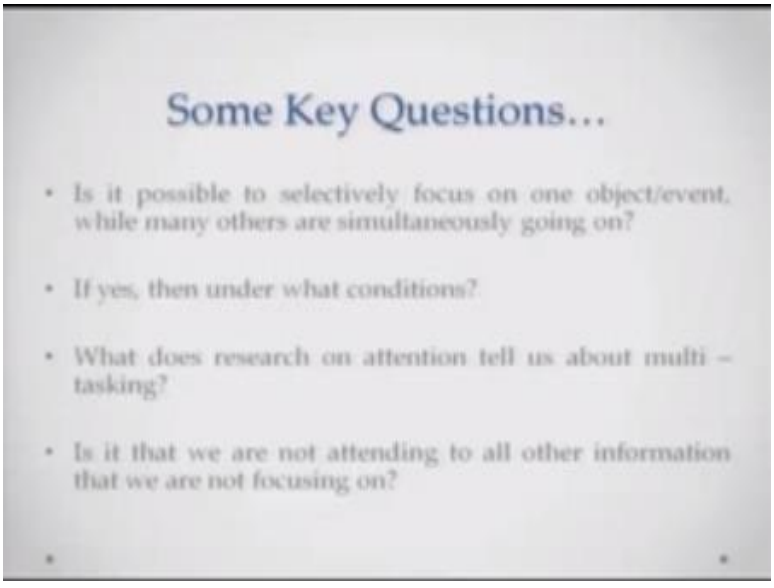

The first question that I would like to put forth is it actually possible to selectively focus on, one object or one event or two objects or two events why so many others are simultaneously going

on are we actually doing that say for example there was this famous phenomena called the cocktail party effect wherein you are in a busy conversation in a very you know dense party and a lot of people are there and they are talking and those kinds of things but suddenly somebody in some conversation may be 50 meters away from you mentions your name and you quickly orient towards that place maybe you are you get interested in your going 6 okay.

What is it they are talking about me you get curious how did you notice that this person was taking your name in the first place you were engrossed in a particular conversation this person who mentioned your name is standing 50 meters away from you how did you still get it, one of the possibilities is that you might, still be attending this information while this information is still not in your primary focus you know you can imagine attention or you can imagine this sensory input as part of your work desk.

So what is happening is you have lot of items you have probably a lot of files maybe some things need to be signed some things you need to write all of that information is in your work desk, when you are say for example you know sitting and you want to work for a given period of time how do you start with it how do you start working and you know moving ahead with the job so you select one aspect of the job you select one part of the job you work on it push it aside bring another one then you work on it push it push it aside and bring another one probably attention.

Is also helping us do the same it is helping us prioritize the amount of sensory information that we are getting and also helping us say, for example and we talk about those modalities how does how can we prioritize this information but helping us select some information over others, so that we can in a sense meaningfully interact with that information with that, so kind of stimulus and then once that is done we kind of push it at the background and pick up a bit information now the cocktail party effect is a good example of the fact.

That whatever we are not working on at the moment is also not completely unattended it is not that you are not aware of those you know the presence of those kind of stimuli at all you are certainly aware of those you know the presence of those kind of stream likes maybe up to a particular level once they would cross a particular threshold they will grab your attention and

you will again maybe prioritize them work upon and work upon then and engage with them so attention is that phenomena, that will help you do this it will help you prioritize the kind of sensory interaction you will have with the environment taking a few things to work on and then you know finishing that and then moving on the other things.

Now another question that can we ask this what are the conditions under which you can do this selection I was referring to the cocktail party phenomena what are the conditions about this particular, information or stimuli that will help you select them over the other say for example you have you know five major files on your desktop and you want to work on each of them what will help you decide that which is the file you open first and which is the file you work on first and then how is this ranking going to be organized.

What are these factors do you decide or does the environment help you decide what is this selection process and how is this prioritizing is going to happen this is something which is also a very important question, in attention if you want to do it a research with attention if you want to understand attention as a cognitive phenomena you would have to ask these kind of questions and you will see that there have been loads of researchers that have actually asked these questions.

Another kind of question that will come up is say for example what does research on attention tell us about multi tasking so you might be aware and obviously it happens with all of us that we are not only selecting some information and working on it once and finishing it and then moving on to other informations, we are all also sometimes working on two things maybe sometimes three things simultaneously if you are talking to somebody on phone does not mean that you are not really doing something with your laptop.

As well if you say for example you know to the unfortunately people try and do this while driving etc. As well when they are talking on phone they are texting they are also I mean they are also sometimes I mean dry driving okay those can be really hazardous and we will probably in this chapter talk about those kind of questions as well and how you can really avoid and why it is so dangerous I mean it is you might have heard, a lot of you know advice from the police from

elders and so many other people but in this particular course we will talk about the fact that by it is actually, so dangerous to other chose to do other tasks while you are doing something as important and as resource consuming as driving what are the kinds of studies that have been done what does this research tell us about multitasking.

How can we do multitasking how can we say for example on our plate at the same time have two kinds of jobs and do justice to both kinds of we will probably talk something to the amount of that question as well, now finally something that I already said though is that is it that we are not really attending everything that we have deprioritized is it that we are not really conscious or the presence of everything that we have deprioritize we have probably just rang ordered information and stimuli as to what will be attended to first.

And what will be attended to later but does it mean that items two three and four which is not in our top priority are not being handled at all, or we are not doing some processing on them before they actually finally come us come upon our table to work for, so these are three four different kinds of questions there are other questions that can be asked a for example another good question could be do we sometimes work across modalities when you are selecting information say for example you are selecting some information.

Visually and at the same time you are kind of selecting some information orally as well and you are selecting some conversation that this is the one I want to focus upon while you are doing something with your you know is Israel, so multimodal selection and multimodal prioritization might also be an important question that we will ask and that has been asked in research on attention as well so we would want to do all of these kinds of things.

Now if I want to give you a very preliminary definition of attention a very simple definition of attention that will probably be in put forward by Goldstein is that attention.

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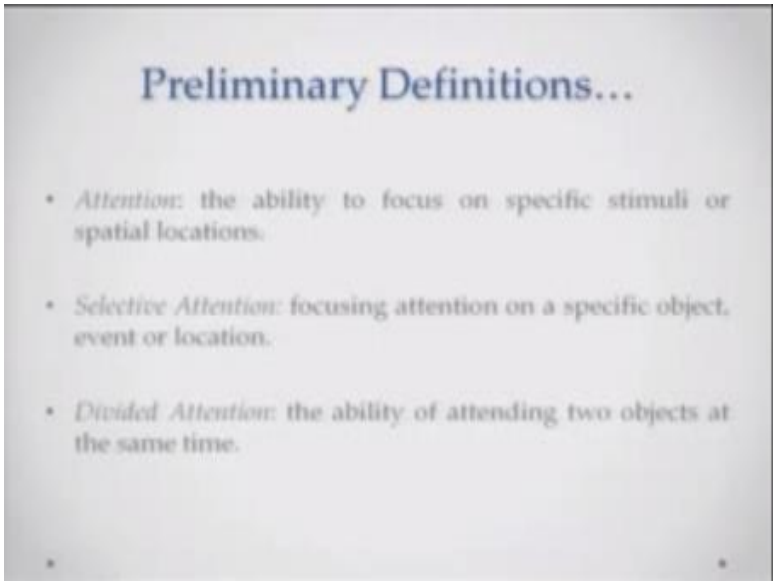

Is the ability to focus on specific stimuli or on specific locations, now this is a very simple definition of you know attention at a later point in time we will talk about theories about attention and what do these 36 in terms of how do we use attention we will be talking about that but at this point let, us just try and wonder you know how do we deal with you know for how do we define attention so is attention just the ability to focus on very specific stimuli or is it also the ability.

To defocus on irrelevant stimuli so this is something which you will see in the course of the next few lectures, that we will be talking about have we just selected something on the basis of a it is important some salient features or maybe it is important to us and there Is a deadline or what we have done if you have just D selected all that was is relevant , so selection or attention can happen through either of these two processes and why do we need attention at all can we not process all the information that in to us at the same time why do we need to select in the first place.

Is it a matter of resource limitation is it a matter of capacity limitation is it say for example now I mean you can now there nowadays it is the error of smart phones if you start opening too many

applications on your smart phone it kind of gets hand so it will not function none of these absolutely functions, so is it a problem of memory like say for example in the smart phone do we also have these kind of memory limitations we will talk about all of these kind of things in the course of the next few lectures now when you talk about attention you can talk about there are two kinds of attentions primarily the first kind of attention is selective attention.

When you are selecting something focusing attention of very specific object a very specific event or a very specific location, so that is something that you would want to do and the selective attention in there since there have been a few metaphors used for selective attention one of them being the famous spotlight metaphor it is like you are you know going somewhere and say for example you are in a dark and there are too many objects you switch on your spotlight and your push your spotlight one particular objects.

So what are you doing is by virtue of the spotlight you selected one particular area to illuminate and one particular area to process visually, is attention also like that we will talk about that in a more detail the other kind of attention I can talk about is divided attention when you are doing the multitasking thing when you are attending at two objects at the same time you know when you are driving at the road.

And you are talking to your friend sitting next to you is it is it compatible is it possible do we do it yes we do it all the time but what are the processes that help us to you know handle two objects or two kind of stimuli at the same time, we will talk about divided attention in adequate detail as well. As far as the operation of attention is concerned you can be say, for example using overt attention which.

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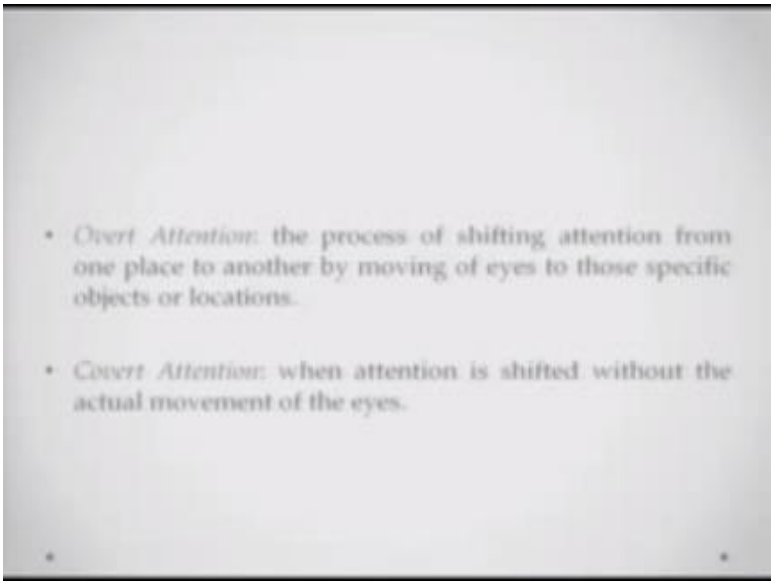

Is a parent and you can be using say for example covert attention where you know mentally selected something okay, now the distinction between attention overt and covert is basically that you use your eyes to select something specifically maybe, your eye works as your spotlight. So if you move your eyes and then you shift your attention from one place to another from one object to another that is what is called over attention.

So over attention is basically one that involves movement of eyes and by virtue of movement of eyes you are selecting some information. Covert attention on the other hand is that you have not really moved your eyes but your attention somehow is shifted from that specific place to another specific place, or from that specific object to another specific object.

But that is also possible sometimes we think that you know you attend only by virtue of your moving eyes, but they are having loads and loads of studies some done in my own lab, where we see that to shift your attention and to start processing objects that are not really in front of your eyes, you might not need to move eyes so much. You can attend to things that are not in your direct line of vision as well.

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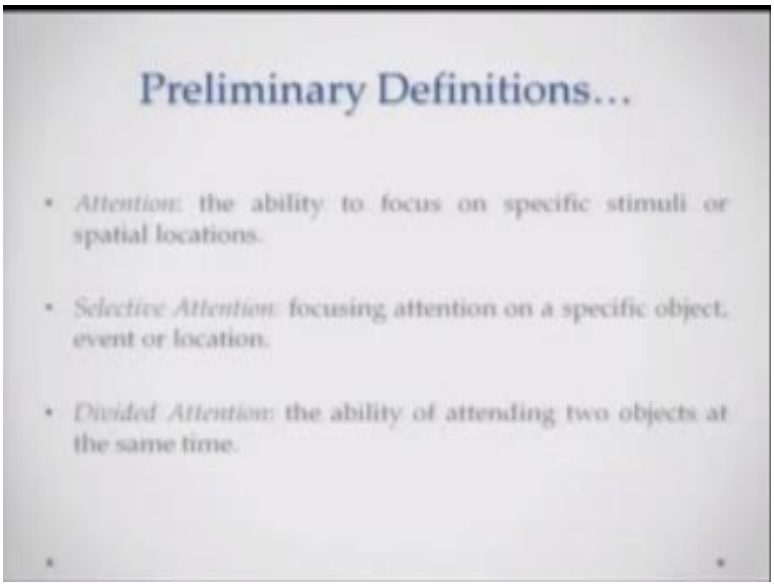

So there are these four kinds of attention I talked to you about the two currencies and the dichotomy between selective attention and the divided attention and, the second kind of thing I talked about was overt attention versus covert attention.

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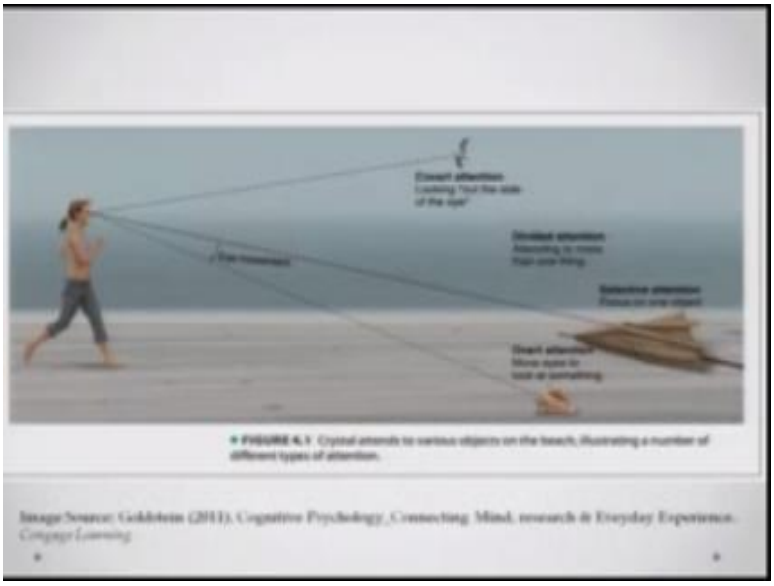

Here is an examples is somebody again something borrowed from ghosting is somebody is walking on the beach and they are actually doing some kind of is something like, if you go on a walk somewhere you can say for example you know some object lying somewhere it grabs your attention and you look at it that is your over and you were actually looking at that dog but you are also conscious of that there is somebody passing by maybe there is a bird flying in the sky that is your over attention. You have attended that as well also say for example you are safer now focus on walking on a particular path you are kind of navigating that path and not falling into and bumping into objects, so you are doing selective attention you are using selective attention to navigate your path as well.

The second thing what you are doing is you are basically also attending to maybe a song that is playing in your earphones, so you are having divided attention between that object between the song that is playing in your earphones and the path, so all of these four kinds of attention are constantly operating you are interacting with the environment when you are doing any particular tasks and that is how the nature of attention is. So in today is lecture I will focus on very specific example very specific application of attention which will help you realize all of these four kinds of things. Now one of the most important thing that we do use attention for is search behavior.

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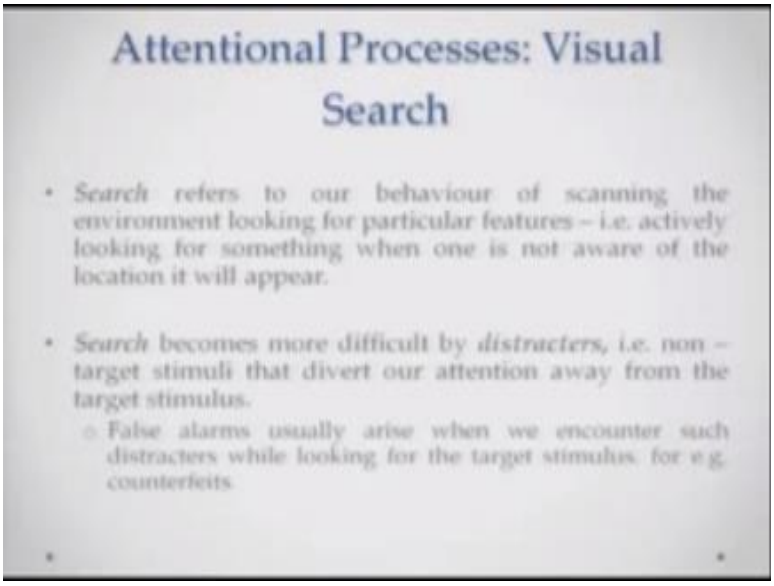

Search or visual search refers to our behavior of scanning the environment and looking for particular feature say for example I ask you to look for a red jacket amongst all of you know the jackets I have put in my wardrobe, so you are looking for a specific feature you are looking for a specific object in the environment so you are actively looking for something when one is not aware of which location you will find say for example you are looking and looking into a wardrobe that is completely filled with clothes. So you have to kind of scan everything pick up something and then you give it to me that is what you have achieved at the end of your search. Now search becomes difficult and it may it is made more difficult by the presence of distracters.

Now this factors are not the target stimuli but they divert our attention away from the target so say for example I have asked you to bring a red jacket but there is a pink and a maroon jacket also lying somewhere in the middle and a lot of times it might happen due to lighting conditions that you might think of pickup, a pink jacket or maybe pick up a maroon jacket and then say that may be that is something which is you know the red jacket. It will kind of reduce your accuracy towards selecting the red jacket. So when say for example you have picked up a maroon jacket instead of a red jacket that is called the case of false alarm you know you are usually connecting something that is not really you know the target.

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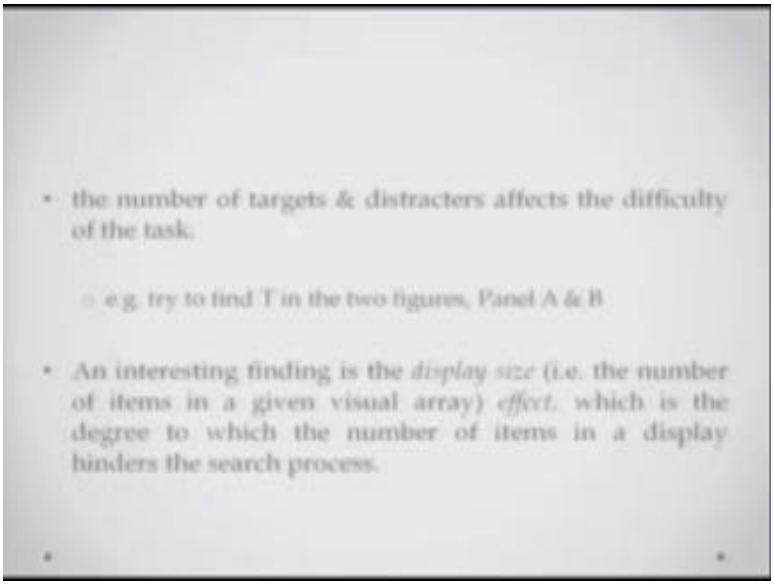

The number of targets and destructive effects the difficulty of the task if I ask you to find T you know the letter T amongst the two panels I am going to present you right now you will find that the interesting thing is that a display size that is a number of items given in a visual array will affect the search process.

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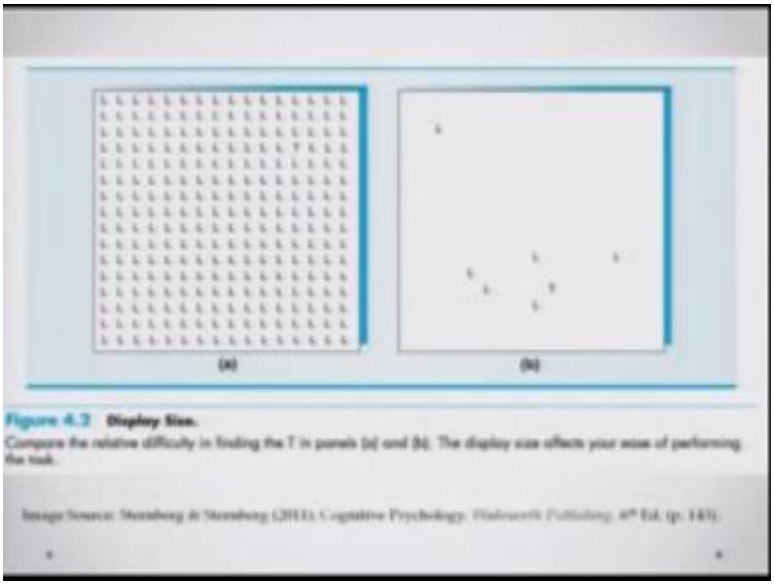

So I will quickly go to that so now if I ask you to find T in the you know panel A it will be slightly difficult to find T there versus if I ask you to find T in the panel number B, it will be much easier so the display size the number of distracters and the number of targets that are there in a particular visual arrangement will hinder, the search process too people to search from too much difficulty you will experience. Now the distracters basically cause much more trouble under some conditions than others.

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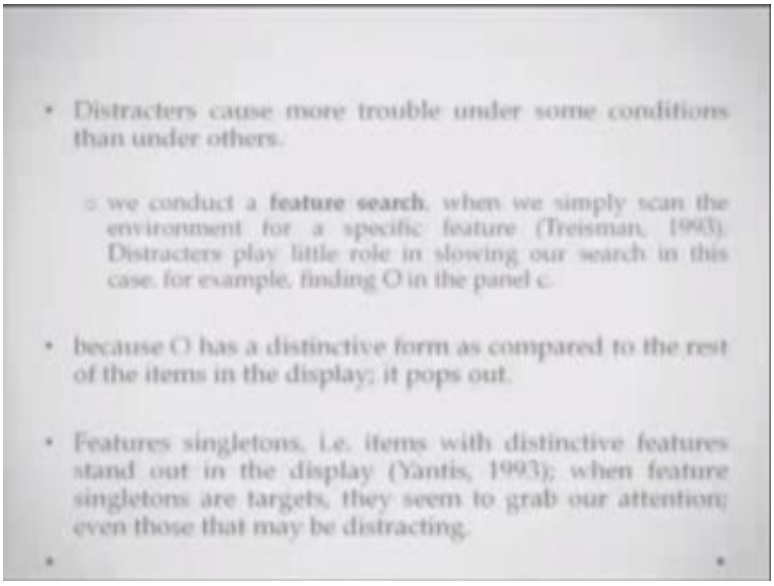

We basically conduct a feature search when we simply scanning the environment looking for a specific feature, say the Red Jacket distracters plays little role in slowing our search, in this case if you are doing feature search the distracters might play a small role in doing, this say for example if I ask you to find the letter O in a panel C and but you know that o has a distinctive form as compared to the rest of the items it will pop out.

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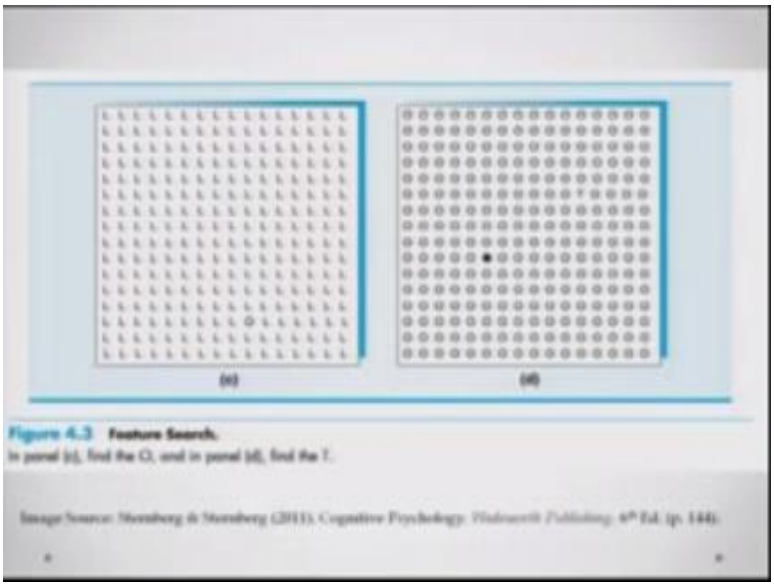

So if you see the panel see all our else but one is o and O is very different feature from all the else it pops out and your search performance is much better and quicker.

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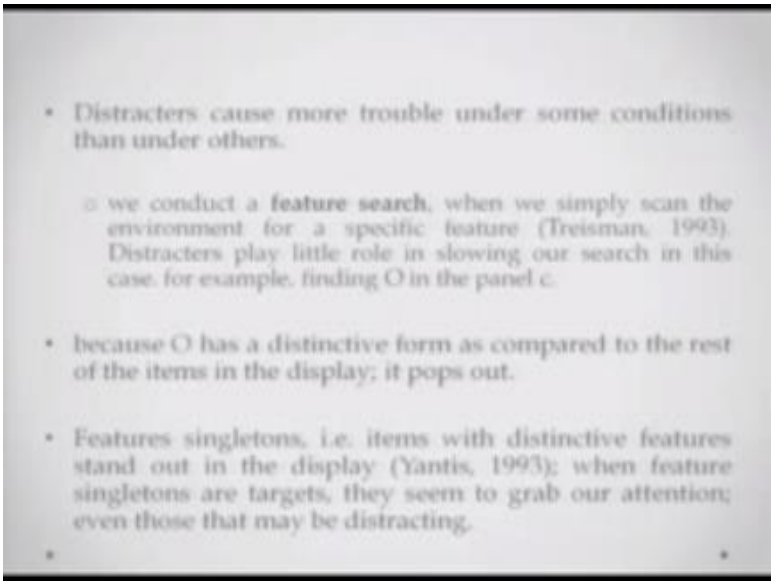

Feature Singleton is basically which have one simple feature with have distinctive features and they generally stand out in the display and your search performance is better, so when feature Singleton's our targets they will certainly grab our attention and even those with the presence of too many distracters. On the other hand when the target stimulus has no unique or even distinctive features then it becomes slightly difficult, in these situations the only way we can find such an item which we are looking for is by using what is called conjunction search.

What is conjunction search? Conjunction search is when you are looking for a particular combination of feature; say for example if I ask you to look for a red square okay. So you are looking for red and you are looking for square among array of visual elements say for example the only difference between your T and L is the particular integration of line segments, so there were horizontal line segmentation.

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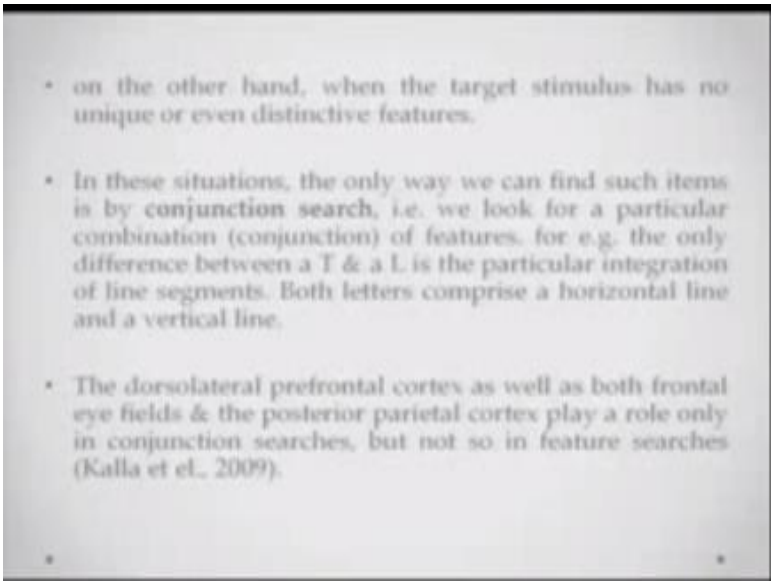

On top entity and in bottom in the air they are both letters however comprised for a horizontal and a vertical line, now the docility frontal cortex of the brain as well as the frontal eye fields and the posterior parietal cortex are the areas of the brain that play a role in only conjunction searches but not so much in feature searches.

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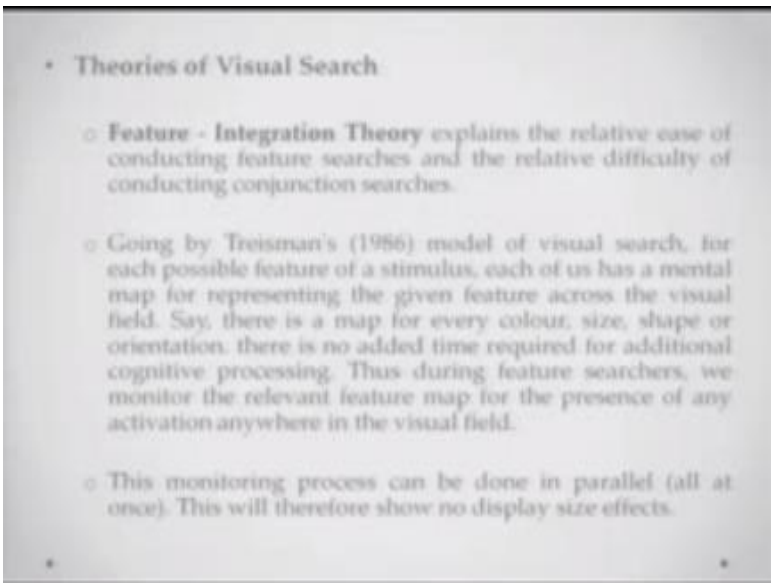

There are some theories of visual search that we can talk about, the first theory is the feature integration theory now the feature integration basically explains the relative ease of conducting feature searches and it talks about the relative difficulty of conducting conjunction searches and gave this model of visual search and it says that each possible feature of a particular stimulus each of us has a mental map for representing these features across a visual field.

So for each possible feature we will have some mental map and then we will select each of these features according to that mental map. Say for example there will be a map for every color for every size, shape or orientation so there is no added time required for additional cognitive processing, thus during future searches we monitor only the relevant features we are not really looking for everything else we are just looking for the red, as soon as the spot red we collected, this is easy and this is useful for feature search.

So viewing feature searches we monitor the relevant feature map for the presence of any activation anywhere in the visual field we quickly find it and we select it and our search is complete. This monitoring process can be done in parallel and this will therefore show no display

size effects because whatever the display size if you are the target has a distinctive feature and you can look for the distinctive feature your case is easily solved.

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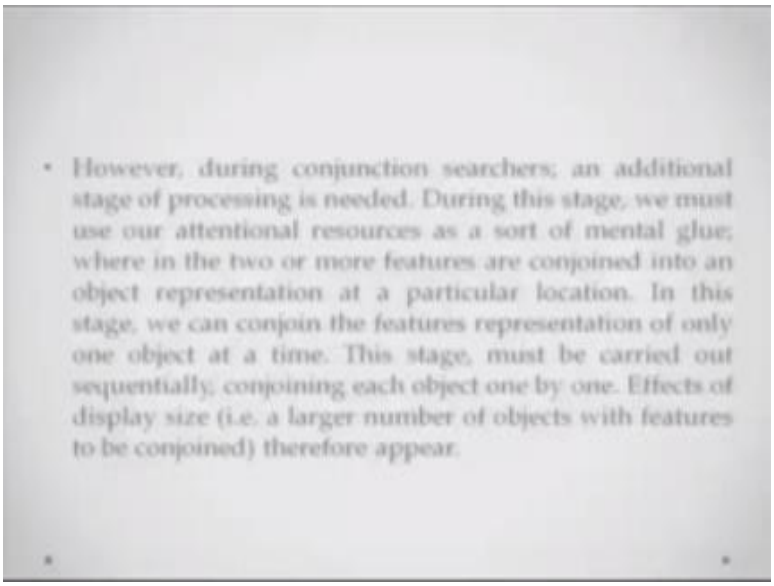

However during conjunction search it becomes slightly difficult because an additional stage of processing is needed during this stage, we must use our attention sources as a sort of a mental glue so what you have to do is you have to look for one feature and the other feature and then combine them to look for both features together in a particular object. So what you are doing is you are actually looking for two or more features conjoined is an object representation and you have to look for a particular location. In this stage what we what happens is that we can contain the features of features representation of only one object at a time. Now this stage must be carried out sequentially conjoining each object one by one.

So we look for first feature for second feature and then you try and conjunct and then check effects of display size therefore will definitely appear in this kind of thing because this is a slightly cumbersome process, such a model of a visual search.

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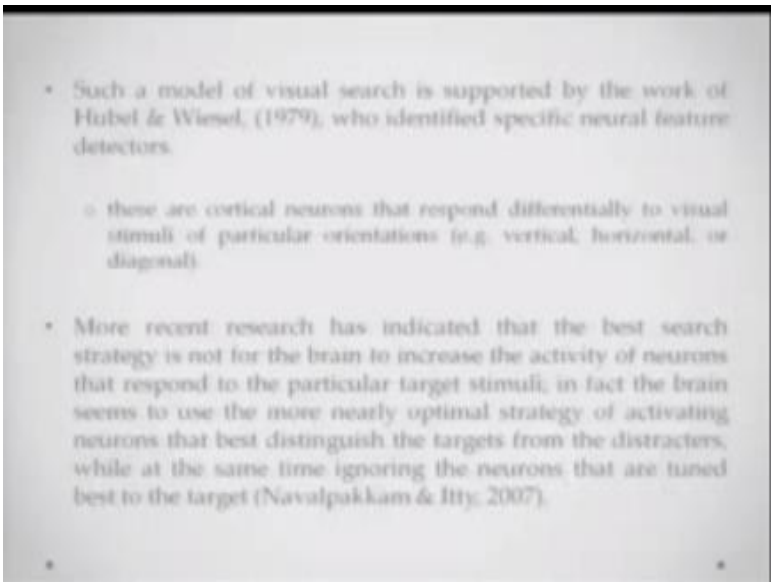

The one we were talking about has been supported by the work of Hubel and Wiesel in 1979 they identified specific neural feature detector, so they found that there are specific neurons in our brain that only code for specific feature say for example they could be caught, the neurons that will respond differently to visual stimuli of particular orientation, so really there will be a set of neurons that will only react to straight lines there will be set of neurons that only react to the horizontal or diagonal lines.

Now more recent research has indicated that the best search strategy is not for the brain to increase the activity of these neurons that respond to particular target stimuli, in fact what the brain does it seems to use a more optimal strategy of activating neurons that best distinguish the targets from, the distracters. While at the same time ignoring the neurons that are tuned best to the target, so for example the brain is kind of optimizing its a search algorithm and it's saying that you have to find the neurons that will distinguish this particular target from all the other targets and not really the neuron, that is only looking for that specific feature and it's tuned to look for that specific feature.

You see this which have a particular advantages, the auditory you can talk about is the similarity theory.

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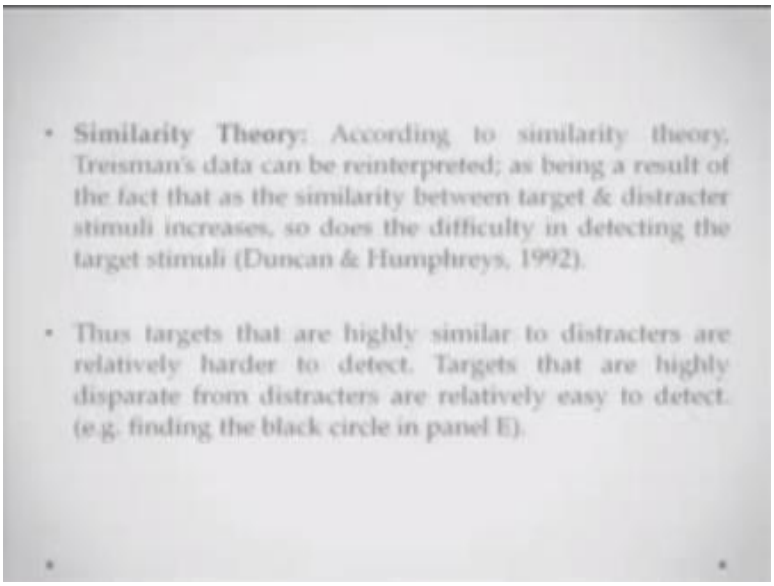

According to similarity theory treasons data can be reinterpreted how it can be reinterpreted as being a result of the fact that similarity between targeting distracter stimuli increases, the so does the difficulty in detecting time would increase if the target and the distracters are very similar to each other, say for example if you are looking for you know a red triangle in a visual array which has all the other red objects then it will be more difficult to look for the red triangle, you know it is a very simple thing in that sense, so targets that are highly similar to the distracters are relatively harder to detect targets that are highly disparate from the receptors are then relatively easy to detect, so for example if I ask you to find the black panel in the black circle.

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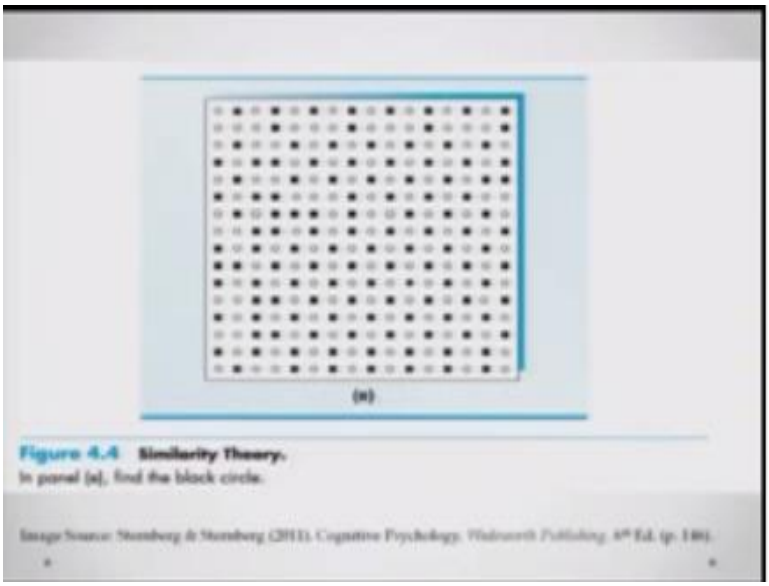

In this particular panel you might be able to find this out slightly easily because all the other circles are white target is highly similar to these factors here because you have black circles and black squares and white circles so it might be relatively difficult to find this black circle in this kind of a panel if it were only consisting of these circles then might be it would be easier.

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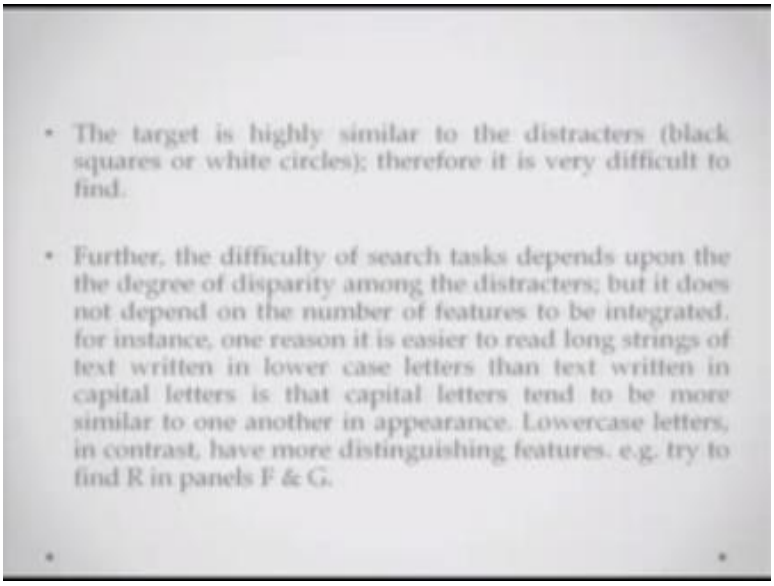

Now the difficulty of the search task also depends upon the degree of disparity of the distract or for how desperate they are they desperate by one unit to in there is a way of quantifying that but it does not depend on the number of features to be integrated, so it's not really about one feature to feature those kind of things it is how different how desperate the distracter is from the target for instance one reason it is easier to read long strings of text written in lowercase letters then takes written in that capital letters tend to be most similar to each other in appearance.

So if you are kind of reading a particular message everything is in caps lock they will find it slightly difficult your reading tanks will get predictably slower, if you're reading a smaller case lowercase letters like we read texts in books it becomes that much more easier.

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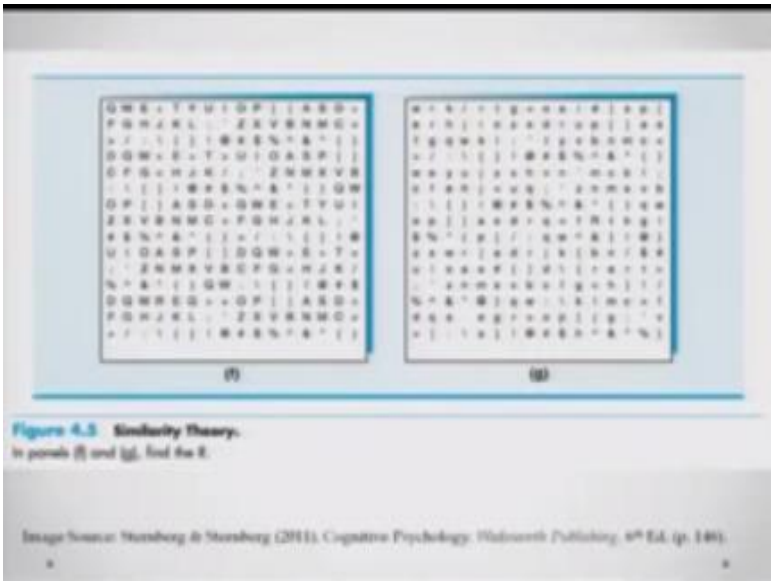

So for example try to find are in parallels F here trying to find capital R that is in panel F is slightly more difficult than trying to find capital R in panel G here again something borrowed from Sternberg and Sternberg.

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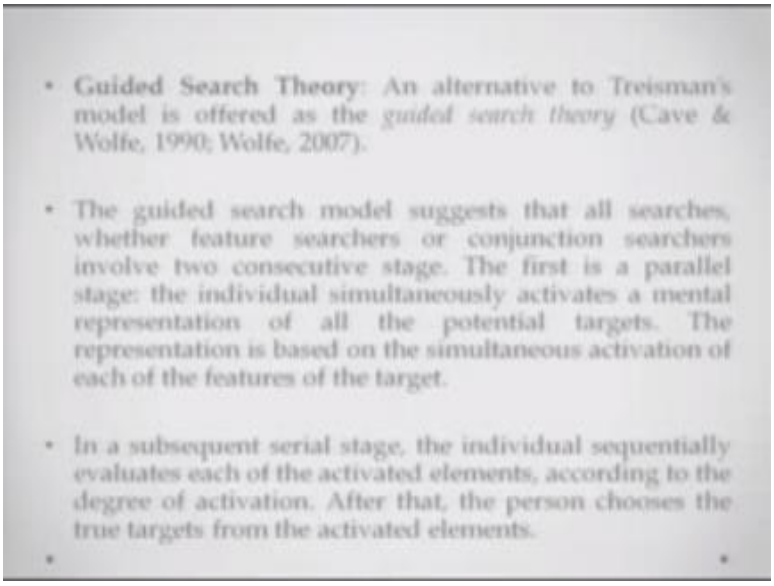

Now another theory the final theories that you could probably talk about is the guided search theory, now guided search theory basically came as an alternative to treatments feature integration model and it was given by Kevin wolfe in wolfe in 2007 the guided search model said is that all searches whether you know a feature searches or conjunction searches involve at least two consecutive stages, what are these stages the first stage is a parallel stage individually and wherein the individual is simultaneously activating a mental representation for all the potential targets, the representation is based upon the simultaneous activation of each of the features, if I'm asking you to find me red filled triangle red and filled and triangular three features and you will kind of you know you will have a mental map of each of these features.

And you will see what are the levels of activation of each of these features when you are looking in you know a visual element or searching a particular visual array. In a subsequent serial stage that the second stage the individual sequential evaluates each of the activated elements according to the degree of activation that is what you know needs to be done that, what I was saying after that the person chooses the true targets from the activity level, so you will say for example have a feature representation for all the individual elements in the array then you have you have

specific activations for each of these features and from there you will be able to say elect the actual target.

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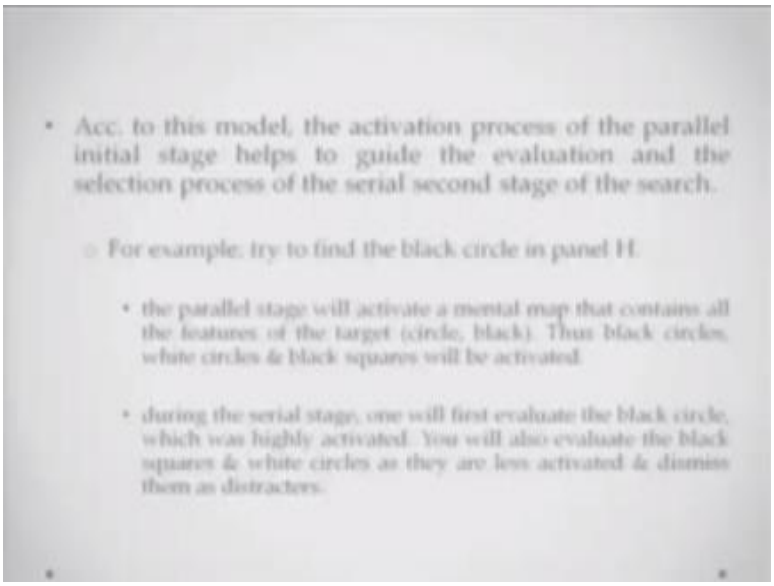

According to this model the activation process of the parallel initial stage that was the first stage helps to guide the evaluation and the selection process of this serial in second stage okay, for example if I ask you to try to find the black circle in panel H here.

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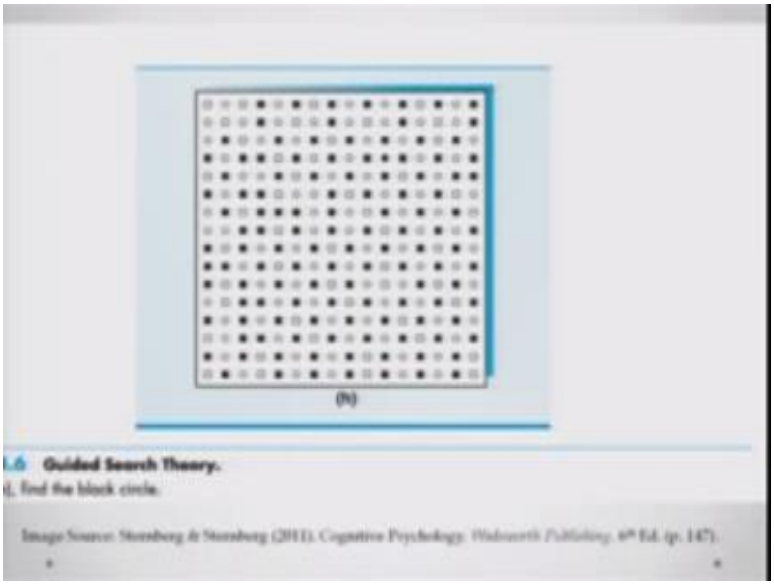

If I am trying to find ask you to you know just find a black circle in this particular panel this barrel stage the first stage will help you activate a mental map that contains the features of all the features of the target, so that it is black that it is circles so this black circles white circles and black squares will all be activated because they share some feature with the two features you are looking for.

During the series stage that is the second stage one we first evaluate the black circle which was highly activated and you will also evaluate the black squares and white circles as they are less activated and then this was them as distracters. So this is again one particular model of searching for particular items from the visual array that is all for today in the next lecture we will talk about some other important aspect of attention thank you.

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