Introduction to Brain and Behavior
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Lecture 17
Models of Attention

Hello, and welcome to the course Introduction to Brain and Behavior. I am Doctor Ark Verma. This is week four of the course and we are talking about models of attention.

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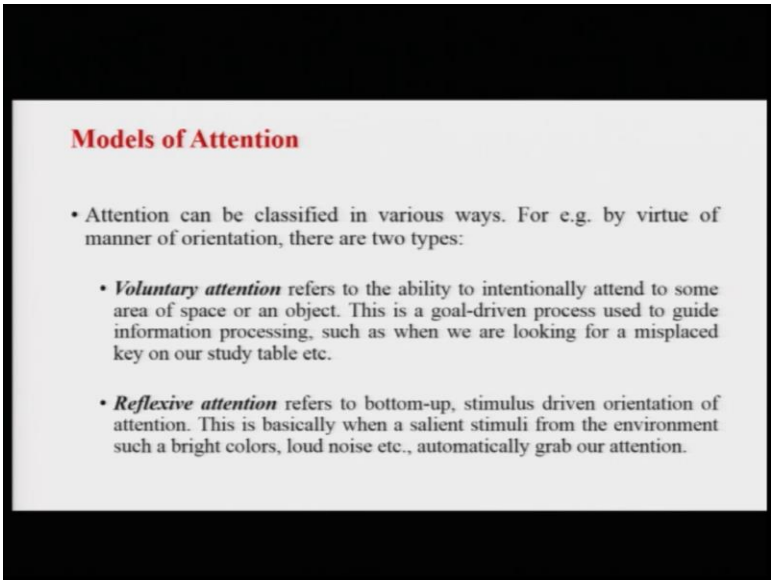

Now, attention we have defined briefly in the last lecture, refers to this ability of being able to select or prioritize some relevant pieces of information from the environment or others. Now, attention can be classified in various ways. For example, by virtue of manner of orientation, there can be two types.

Voluntary attention refers to the ability to intentionally attend to some area of space or some objects over others. This is more like a goal driven process used to guide our attention or information processing to specific you know ends. Such as, say for example, if you are looking for a misplaced key on your study table, which obviously has too many other objects as well.

On the other hand, reflexive attention refers to more bottom up or stimulus driven orientation of attention. Say, for example when a salient stimulus from the environment such as you know, something, having very bright color say for example, in a regular classroom, I will probably be startled if somebody is wearing a golden colored t-shirt and waving his hand.

Or say, for example, a loud noise or say, for example something that would typically automatically grab our attention, something that let us say, is just out of place, so the context wise as well.

Both of these processes of attention are different in the sense that in one, which is a form of voluntary attention, you are sort of controlling still in a way, still consciously controlling where an attention is going to be, how you are going to, you know prioritize the incoming streams of information, whereas reflexive or bottom up attention is more like say, for example, while you are planning and you know doing something completely different, some stimulus by virtue of its salience, by virtue of you know, its properties itself automatically grabs or orients your attention towards itself. So, this is one way to look at whether your orientation of attention is voluntary, or is more like stimulus driven.

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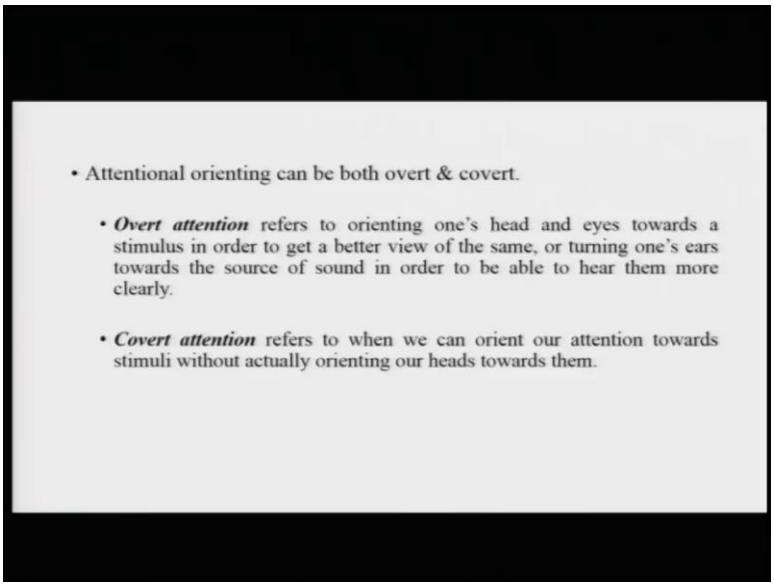

This orienting of attention can also be of two varieties. It could be overt orienting or overt attention, or it could be covert orienting or covert attention. Let us try and understand what this refers to. Overt attention actually refers to orienting ones head and eyes towards a stimulus in order to get a better view of the same. Say, for example, if I want to look at let us say, if there is a picture on this wall.

If I move my head, and I am looking at that picture, and I am processing it that is basically that I am overtly attending to that picture. Similarly, say for example you know sometimes, if you want

to hear, over hear some conversation you kind of overtly orient your ears towards the source of sound in order to get sound more clearly and to understand as to who is talking and what are they talking about and so on. So, that is overt orienting of attention.

On the other hand, covert orienting of attention is when a stimulus automatically as I said, covert attention basically refers to when you do not even, you know move your eyes or you do not even you know, automatically orient your ears towards the source of sound, but you just start paying more attention in a non-apparent way to that particular stimulus.

Say, for example there is you know, somebody or you know, something moving this side, while I am still focusing straight at the camera, I am not really, you know, actively orienting my eyes or my head towards the, you know, towards my right side, but I am still being able to process who is there or whether something or somebody is moving or not moving. So, that is basically an example of covert orienting of attention.

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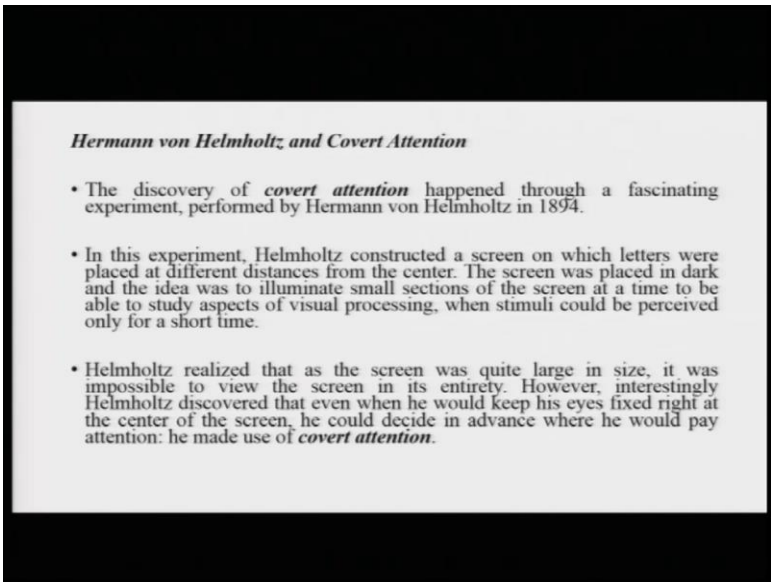

Let us talk a little bit about, how covert attention or how say for example, somebody stumbled over this concept of covert attention. In around 1894, psychologist Hermann von Helmholtz from Germany was performing a very fascinating experiment. And the experiment was basically about, that the goal of this experiment was that Helmholtz wanted to sort of study how is its that we process visual information for short spans of time, what is the efficiency of processing, what is the timing that will take and so on.

So, for this experiment, what happens is that Helmholtz constructs a large screen. And on this large screen, he points out a center point. And then, from various distances from the center point, he just writes a lot of letters. So, he writes all the alphabets different letters from existence from the center and fills the entire screen.

Now, immediately he realizes that, you know what he basically wanted to, was to eliminate small sections of the screen and study them for a bit. So, Helmholtz basically, once he was you know, up and he was trying to do this, he quickly realized that the screen was quite large. So, if I illuminate, if he would illuminate the light for a very small, you know, amount of time, the light was not enough to illuminate the entire screen at once.

So, all the alphabets that are written on the screen could not be illuminated at once. That would have been sort of, you know, more in the lines of what Helmholtz wanted. But he sort of discovered a couple of interesting things. He discovered that even say, for example, when he would keep his eyes fixed right at the center of the screen, he could decide almost in advance where he would pay attention and he was basically then making use of covert attention.

So, he would basically, he was deciding where in on the screen his attention is going to go next, which part of the screen he would illuminate now and studied for a bit and come back. So, he discovered that he was using a very, you know, interesting quality of attention, that which could be referred to as covert attention. He was automatically processing something outside his direct focus of attention because his focus of attention was at the screen. He was deciding it and then he was lighting the illumination at that location.

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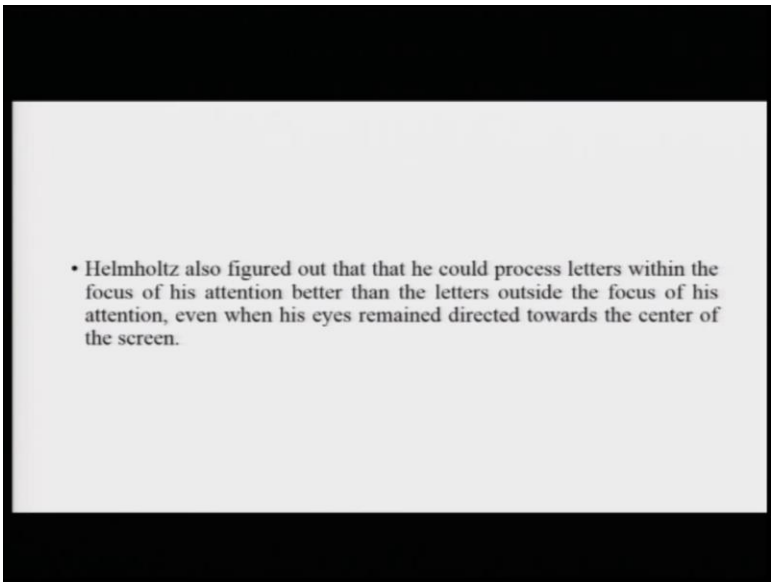

Helmholtz also figured out that he could process letters within his direct focus of attention, slightly better than letters which were directly, which were out of his direct focus of attention. So, this is also something that, you know, kind of could be made out that if you are paying attention to something, you are going to be able to process it much better in better resolution, let us say or in better quality, let us say, as supposed to things that you are not actively attending or not, you know, its not forming part of your, you know, attention part.

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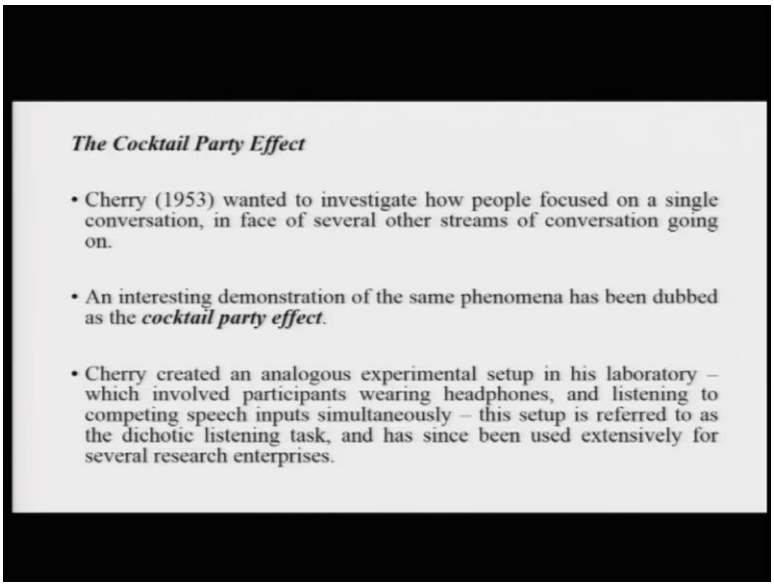

Moving further, just looking at a similar phenomenon, but now in the auditory domain. Let us talk of the let us talk a little bit about the cocktail party effect. Now, Collin Cherry in 1953, he wanted to investigate how people would focus on a single conversation in the face of several simultaneous streams of conversation going on, you know, typically when you are sort of in a classroom, in a party where people are sort of talking to each other and there are several groups and several people having these conversations while you trying to focus your attention on the conversation that you are having with this person right, standing right in front of you, alright.

So, an interesting demonstration of how this actually happens is referred to as the cocktail party phenomenon, where people are not able to sort of pay attention to several streams of things. But something very interesting happens, is there when somebody takes your name in that conversation, you would immediately your attention would immediately be oriented towards that.

And you will sort of you know catch that conversation and say yeah, you took my name. Do you need me to come there? Or is there something that you want to talk to me about something, like that, but we will come to this a little bit later. Cherry basically created an analogous experimental setup in his laboratory, something very similar to a cocktail party thing.

So, in this setup what was happening was that participants were asked to wear headphones, basically and they were asked to listen to competing speech inputs coming from both the ears. So, both, the different, both headphones would play different speech inputs. Sometimes both would be male, sometimes one is male, one is female. Sometimes, you know there is some sentence started here and completed here and so on.

But different speech inputs are entering through both of the ears. And this setup by the way was referred to as the dichotic listening setup or this task is known as the dichotic listening task, and has become very popular, and has been used extensively for various different kinds of research projects. Let us talk a little bit about what happened.

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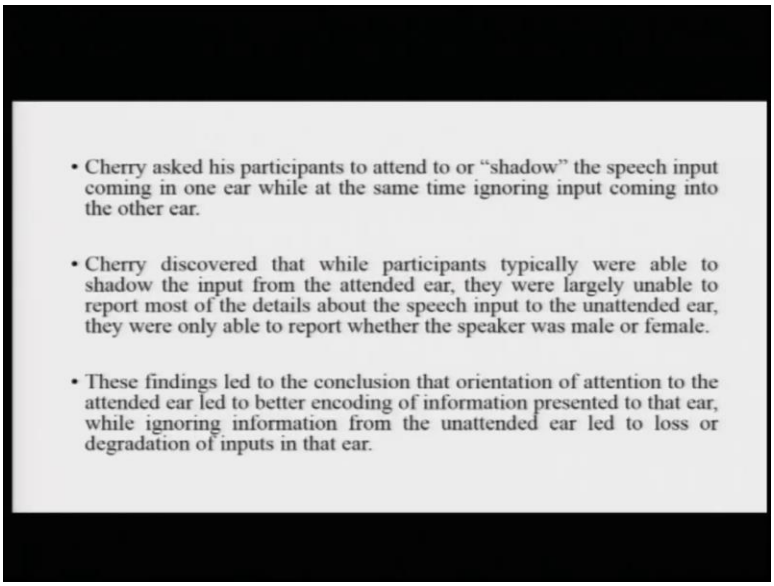

So, cherry asked his participants to attend to or shadow the speech input coming from one ear so this became the attended ear, while at the same time ignoring the input coming into the other ear, and this would change. Sometimes the left is attended, sometimes the right is attended and so on. So, while the ear that you were ignoring becomes the unattended ear, the ear that you are shadowing becomes the attended ear and he would typically ask participants to report what did you hear out of both of these ears?

Once the data was being collected and the information was coming through, Cherry discovered that while participants typically were able to shadow the input from the attended ear, most clearly, they were largely unable to report most of the details about the speech input that was coming to the unattended ear. At best, they were only able to tell, say for example, the speaker of the attended, of the unattended ear was a male or female or sometimes whether the language was known to them or a foreign language and so on.

Now, the analysis of these findings was done. Its led to the conclusion, that orientation of attention because you are actively focusing whatever is happening in the attended ear. So, orientation of attention to the attended ear led to better encoding of information that was presented to that ear. On the same side, ignoring information from the unattended ear actually led to loss or degradation of whatever input was coming from that ear.

So, because you are focusing on this and completely ignoring this one, any information that you otherwise might have registered coming from this ear is lost, you are not being able to attend it to any detail whatsoever.

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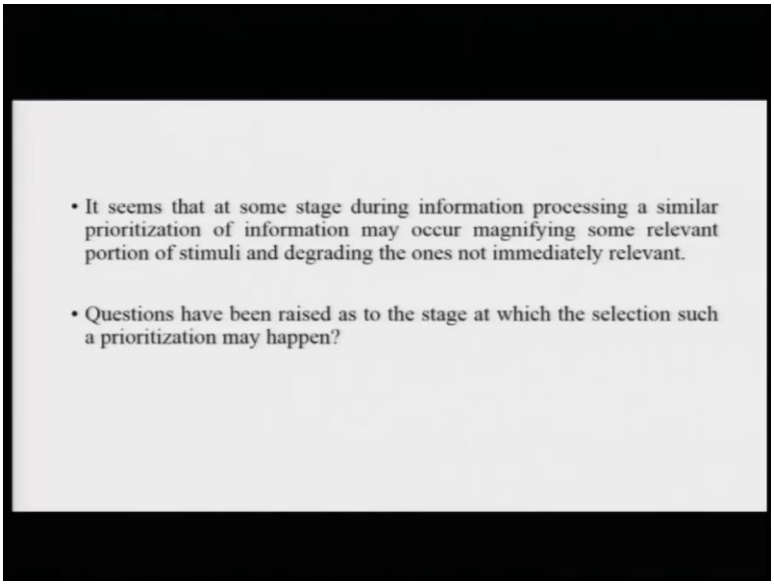

It seems that at some stage during the information processing system, a similar prioritization of information must be happening. And what this must be doing is that it must be magnifying some relevant bits and pieces of stimuli, some relevant portion of the incoming information and degrading everything else that is not immediately relevant. So, this sort of gives you a little bit of a peek into what is attention actually doing to your information processing stream. Now, questions have been raised as to the stage at which such a selection might be happening or at the stage at which such a prioritization of information might be happening.

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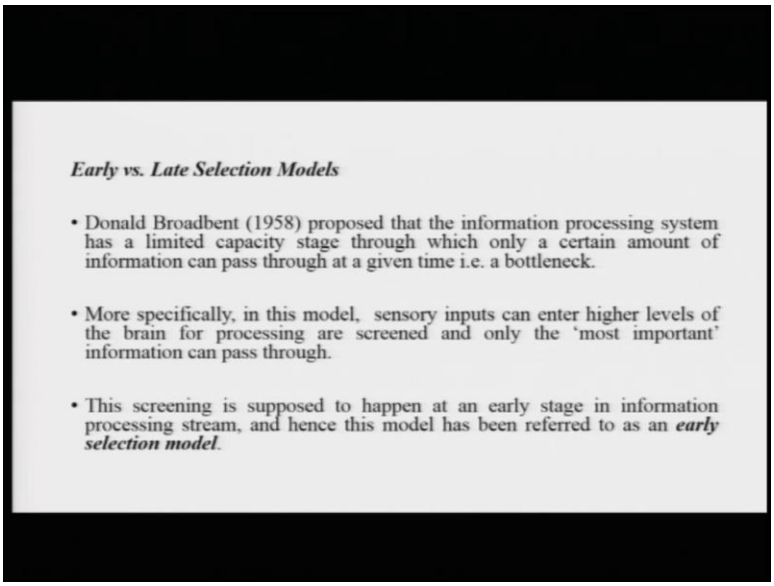

So, Donald Broadbent basically in around 1958 proposes that this information processing system that we are talking about is a limited capacity one. Remember I was, I mentioned this, that as soon as we start talking about attention and prioritization and so on, we are already getting in with the understanding that this system that you are talking about has limited capacity of processing information.

So, Donald Broadbent in 1958 proposed that the information processing system has a limited capacity stage through which only a certain amount of information can pass at any given time. More specifically, Broadbent's model suggested that sensory inputs can enter the high levels of the brain for processing only after their screens are actually screened and only the most important information can actually pass through.

So, all sensory information is coming in. It is being screened or filtered at a particular stage and only the relevant amount of information or something that you deem relevant and we can talk about what you deem relevant at a different point. What you deem relevant or important at any point in time is going to go through and is going to be processed. And the rest everything else has to be blocked out and it will not really reach any kind of processing whatsoever.

Now, this screening is supposed to happen at an early age. So, as per Broadbent's model, this screening is supposed to happen at a very early stage in this information processing screen. And

hence, this model is being referred to as a early selection model. So, basically, this model says that at a very early stage in the chronology of information processing, one selects information that is relevant and deselects or blocks out information that is irrelevant.

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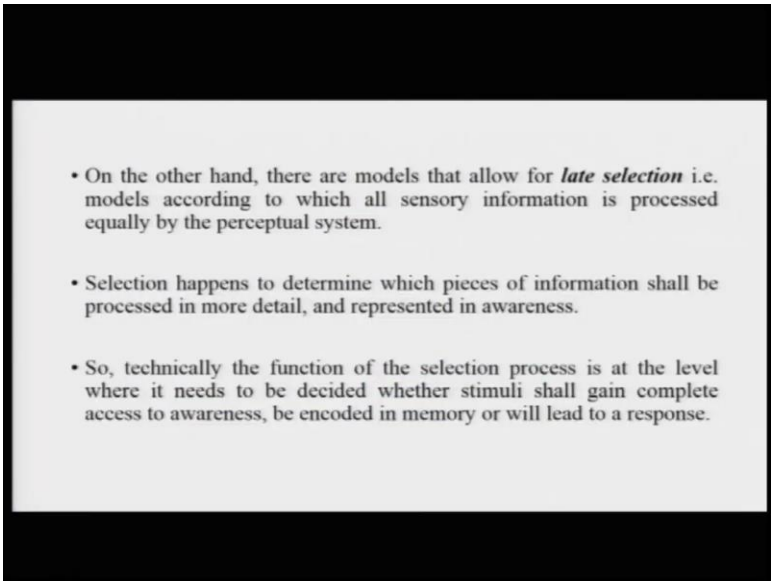

On the other hand, there are different kinds of models as well. So, the other kinds of models basically allow for what is called late selection. According to these models, all sensory information is actually processed equally by the perceptual system. What happens is that selection happens to determine which pieces of information shall be processed in more detail and then represented in awareness and so on.

So, technically here in these late selection models, the function of selection process is at the level where it needs to be decided, what degree of processing is going to be given to this particular bunch of information, which bunch of information is going to get complete access to awareness, which bunch of information will be stored properly in memory or will eventually lead to a response.

So, the process or so the function of the selection process is qualitatively very different. It is basically to enhance the detail, the processing of certain bits of information rather than blocking everything out.

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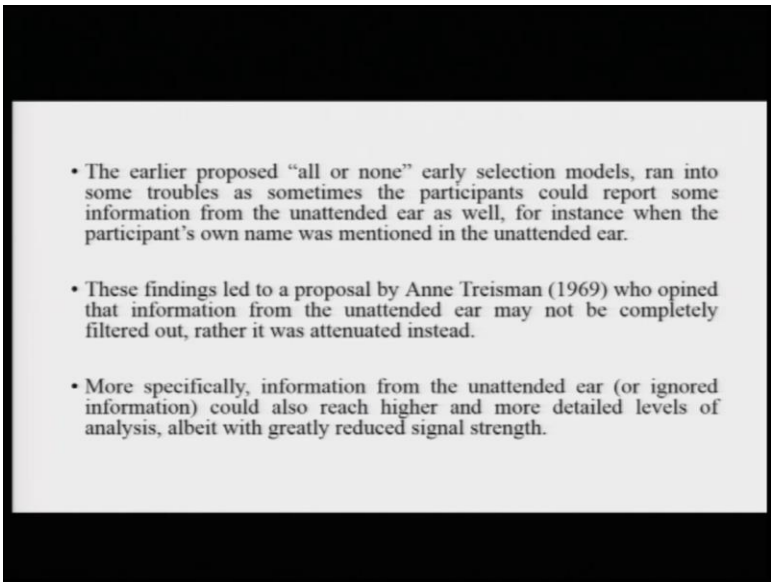

Now, the earlier proposed Broadbent kind of all or none early selection models, actually ran into some troubles at a very early stage because it started coming up, that sometimes participants could actually report some of the information from the unattended ear as well. For instance, if the participant's own name was mentioned in the unattended ear, participant would be very quick to report that, even though that is coming in the ignored unattended ear. Now, these findings were analyzed by many psychologists.

Anne Treisman at that point in time in around 1969 opened that this information from the unattended ear is not really being completely blocked out, rather, it was just being degraded or attenuated. So, what is actually happening that this you know, filter or at this screening system is that it is basically creating a sort of a divide information that is relevant, information that you are going to attend and you want to sort of attend is basically being allowed to reach and pass through the entire processing cycle.

But information from the unattended ear that you have already deemed irrelevant is also going to reach the higher processing stages. But say for example in a very attenuated or in a very degraded stage, so that you know with a very reduced signal strength, so that it may or may not reach awareness unless there is something very very important.

Say, for example in the case of the of participants own name being mentioned as soon as that information reached the processing systems and it was deemed dead my name is being you

know, is being mentioned here, the processing sort of takes care of that and you become conscious aware of that your name has been mentioned in the unattended ear. While everything else also from the unattended ear is not really paid attention to. So, that is basically something that is probably happening here. So, this is a little bit about the kinds of models of attention that are present.

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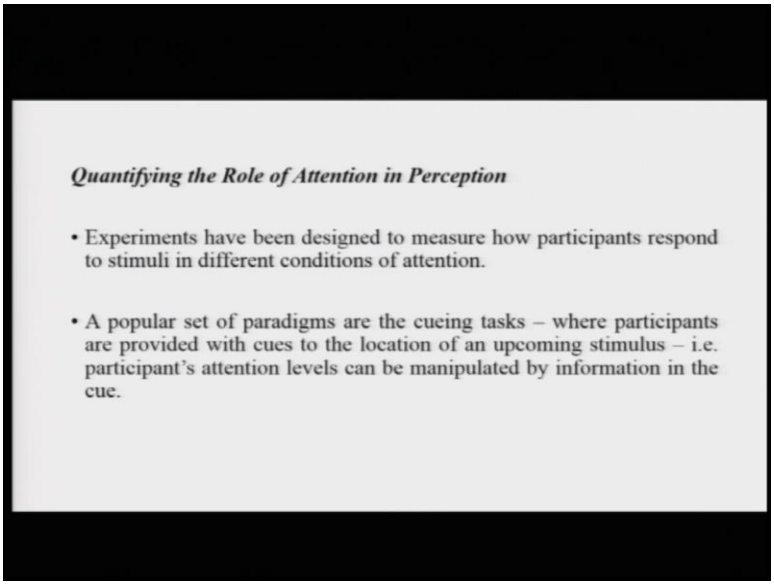

Now, let us talk a little bit about an experimental paradigm that has been used extensively to work with the participants in different kinds of attentional conditions. So, a popular set of paradigms basically are known as the cueing tasks, where participants are provided with cues to the location of an upcoming stimulus, let us call it a target stimulus and parts of the attention levels are manipulated. And basically then it is seen as to how do they respond to this target stimulus.

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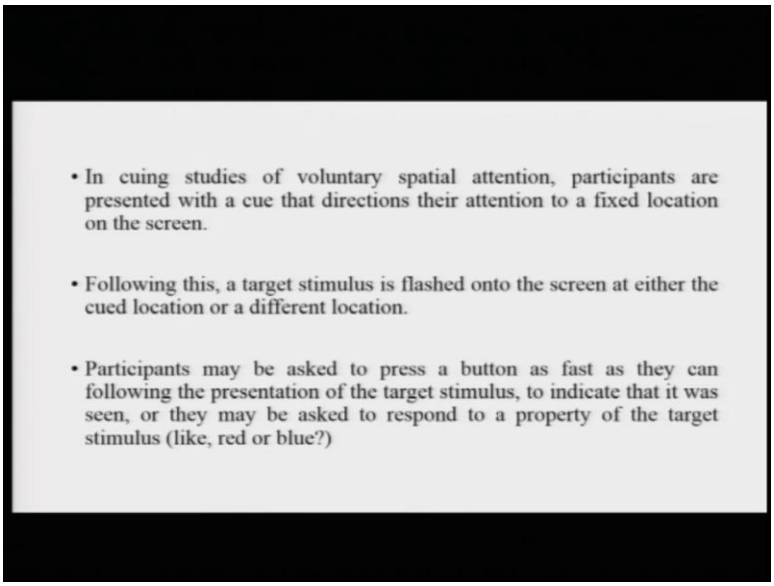

Now, in cuing studies of voluntary spatial attention, where you are actually orienting your attention towards a regional space, participants are presented with a cue that directs their attention to a fixed location on the screen. So, the screen is there, a stimulus might appear at any place in the screen. But suppose there is a cue or you know, let us say an arrow kind of a thing that is pointing your attention out to, this is the exact region in space where the target stimulus is going to come up.

And your task is basically to detect this target stimulus. As soon as this target stimulus comes, you have to press a key. So, as to indicate to the experimenter that you have now registered the target stimulus. Or different kinds of questions can be asked whether the target stimulus was red in color, blue in color and so on. But the idea is to just know whether you have registered this target stimulus or not.

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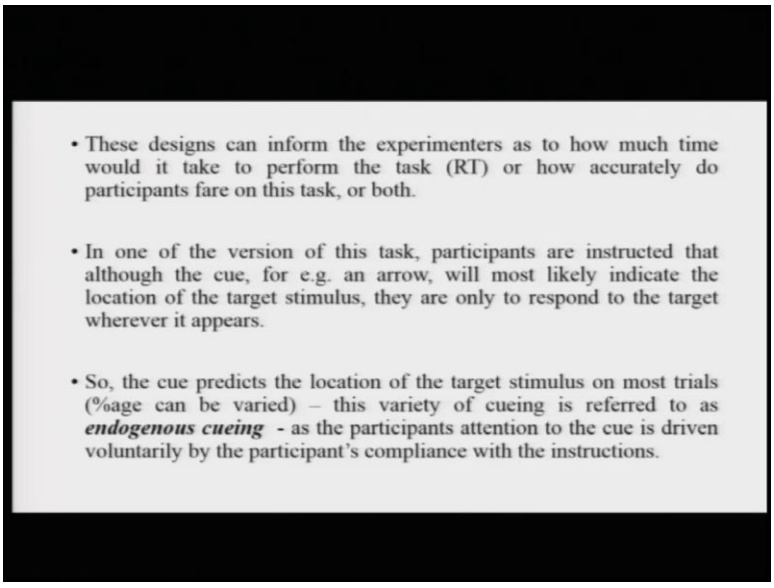

Now, these designs basically, where there is this possibility of cueing the location of the upcoming stimulus can basically inform us as to how much time would it actually take to perform the task, how much time will it take, let us say to detect the presence of the stimulus, reaction time, or how accurately would people generally do it? 70% accuracy, 90% accuracy, 100 percent accuracy? What is the accuracy with which people will do it?

Let us talk in a little bit more detail about a particular version of this task, where participants are instructed that although the cue say, for example, in the arrow will most likely indicate the location of the target stimulus there actually to respond to the target stimulus wherever on the screen it appears.

Now, it could happen that the cue is so its basically in this condition what is happening is that the cue is predicting the location of the target stimulus on most trials. And we can sort of vary the percentage of these kinds of trials. This variety of cueing is referred to as endogenous cueing, because what is happening here is that participants attention towards the cue is being driven voluntarily by participants compliance with the instructions, because the participant is believing that this cue is going to direct me to the correct location. And hence the attention is being oriented with respect to let us say the direction of the arrow. This is what is endogenous cueing.

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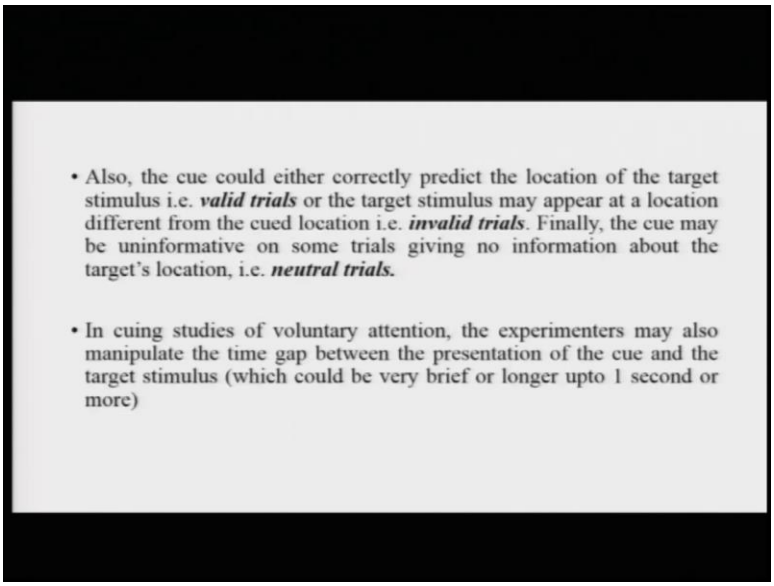

Now, let us look at the kinds of trials that might be. The cue could either correctly predict the location of the target, which is your valid trials, or you could mislead the location of the trials and the location of the target stimulus which is invalid trials, or in some cases a small proportion of the overall trials could be where the cue is non informative, it is not giving any information about where the target is going to come.

So, these could be called as neutral trials. Now, in studies of voluntary attention, in cuing studies of voluntary attention, the experimenters may also what they can do is they can vary the time gap between presentation of the cue and the actual appearance of the target. It could come very briefly just let us say after a gap of 50 or 100 milliseconds or 200 milliseconds maybe, or it would come, let us say, after one second 1500 milliseconds, 2 seconds, and so on. And these timing manipulations are done for answering specific questions. We will talk about those things a little bit later.

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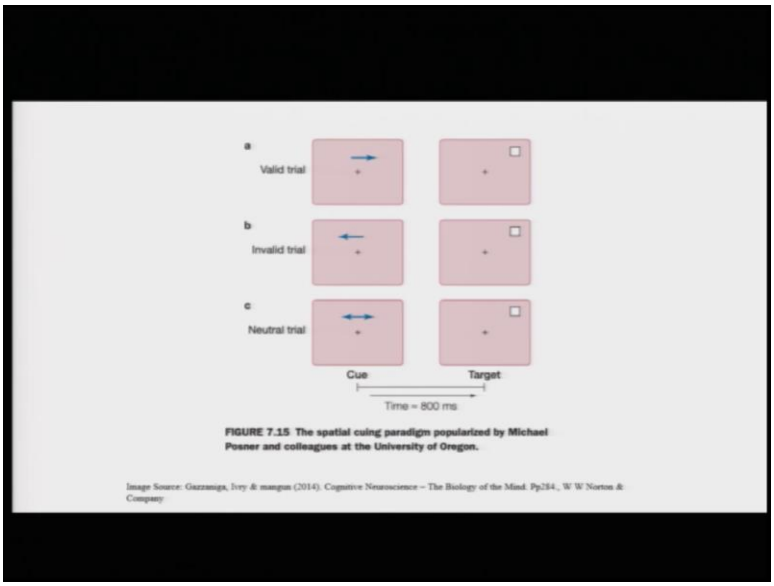

This is just an example of how the trial would be. So, you can see this is a valid trial. The cue is actually the cue is this blue arrow is correctly pointing out that at the location of the target stimulus. You can see the invalid trial. The cue is incorrectly pointing out that the locational target stimulus. And the neutral trial where cue is completely uninformative, its not really telling you whether the stimulus is going to appear on the left or the right visual field.

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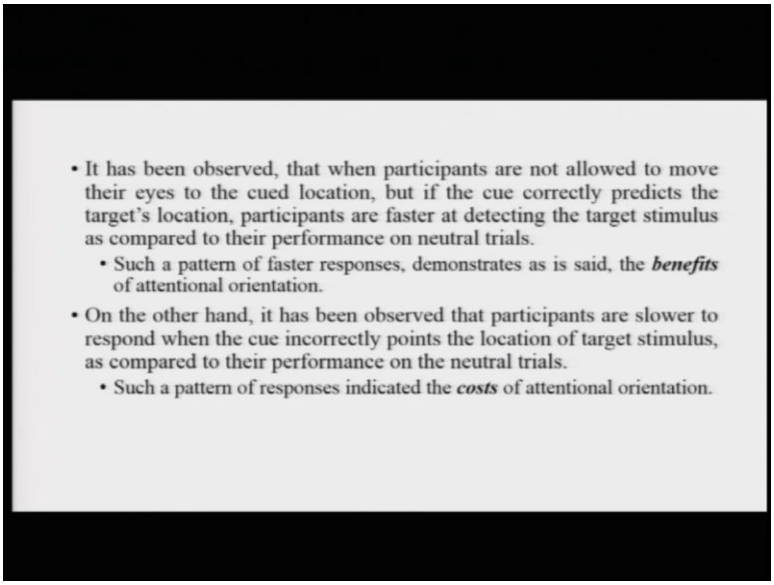

Now, it has been observed that when participants are not allowed to move their eyes to the cued location. But if the cue correctly predicts the location of the target stimulus, participants are much faster at detecting the target stimulus as compared to their performance on neutral trials. Now, this can be referred to as the benefit of orienting attention. So, this is basically the benefit of attention.

On the other hand, it has been observed that participants are slower to respond when the cue incorrectly points to the location of the target stimulus. Say, for example, on invalid trials, the reaction times are even lower than the neutral trials. So, this is referred to as cost of orienting attention incorrectly let us say. So, there are benefits of attention and there are costs of attention. And it, at least what it does is it tells you that attention is a very very important player in say, for example, the manner of information processing that will go on.

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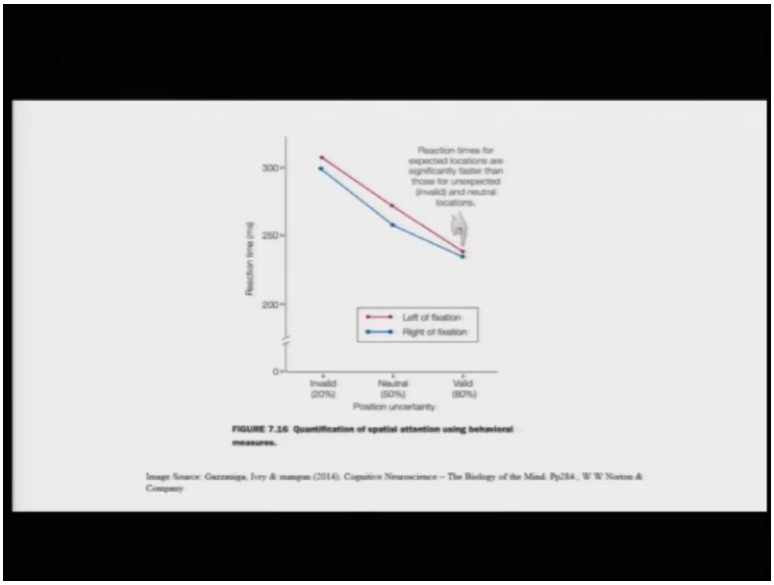

FIGURE 7.16 Quantification of spatial attention using behavioral measures.

Image Source: Gazzaniga, Ivry & mangun (2014). Cognitive Neuroscience – The Biology of the Mind. Pp284., W W Norton & Company

Here you can see, say, for example, the reaction times for valid trials are much lesser, whereas invalid trials are much higher, and the neutral trial reaction times are sort of in the middle.

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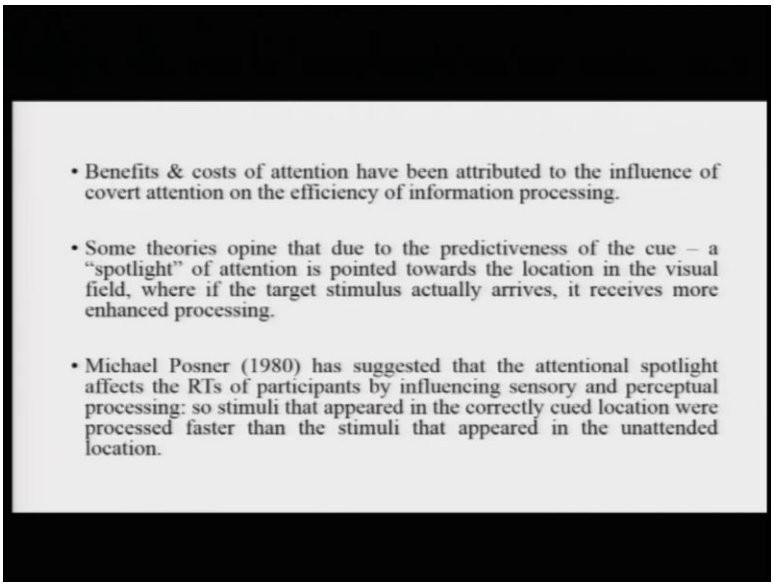

Now, benefits costs of attention have actually been attributed to the influence of covert attention on the efficiency of information processing. So, the idea is that because you would covertly orient your attention, in case of these you know, valid trials that is what has led to disadvantage of the stimulus being processed better when it actually occurred at the cued location.

Some theories opined that you do the predictiveness of cue I am just sort of, in some sense, describing this in other words. So, some theories opined that due to the predictiveness of the cue, a spotlight of attention is pointed towards the location in the visual field, where the target eventually actually arrives.

And when the target arrives there, it receives enhanced processing. Michael Posner, in around 1980 has suggested that the attentional spotlight affects or basically affects reaction times of participants by influencing the sensory and perceptual processing. So, basically what is happening is that the stimulus that appears correctly in the correctly cued location is processed faster than the stimuli that appears in the unattended location because sensory processing is faster for that kind of stimulus and that is one of the functions of attention.

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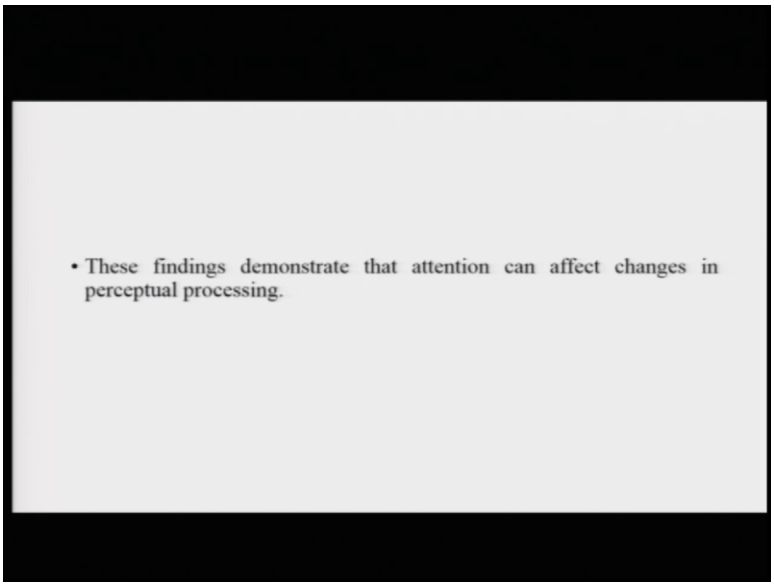

So, just to sort of sum it up, it, kind of these findings or this kind of experimental paradigm demonstrates very clearly that attention can affect or say for example, can influence the flow of information in perceptual processing. So, this is all that I wanted to talk about in this lecture.

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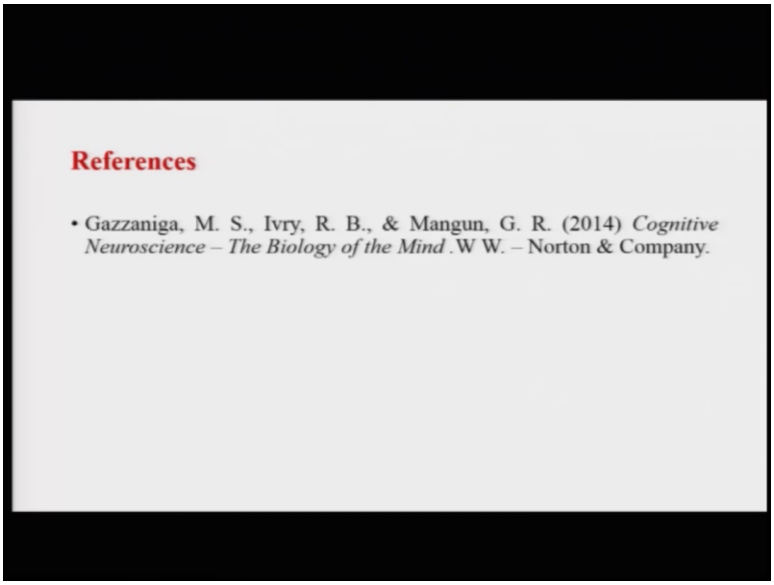

We will talk about other aspects of attention in the next lectures. Thank you.