Indian Institute of Technology Kanpur

National Programme on Technology Enhanced Learning (NPTEL)

Course Title
Basic Cognitive Processes

Lecture- 30
Memory- II

by
Prof. Ark Verma
Department of Humanities and Social Science
Indian Institute of Technology Kanpur

Hello everyone welcome to the course on basic cognitive processes I am dr. Ark Verma from IIT Kanpur.

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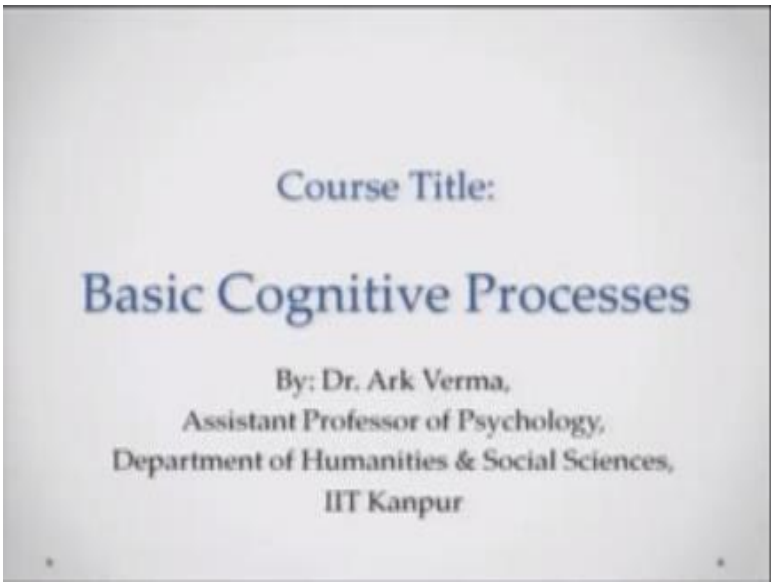

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In the last few lectures we have been talking about memory in the last lecture we talked about what memory means how is memory important at a cognitive function, how does memory help us get the sense of continuity of life get and it how does memory really you know act as a glue for all our sensory and sensory experiences all the things that we are you know we want to retain over a period of you know time in our lives.

We ended the last lecture talking about sensory memory which is one of the important components of memory as proposed by Atkins and Shiffrin in their model of memory. In today's lecture we focus up on something called the short-term memory and will try and see what short-term memory is and how do we deal with short-term memory.

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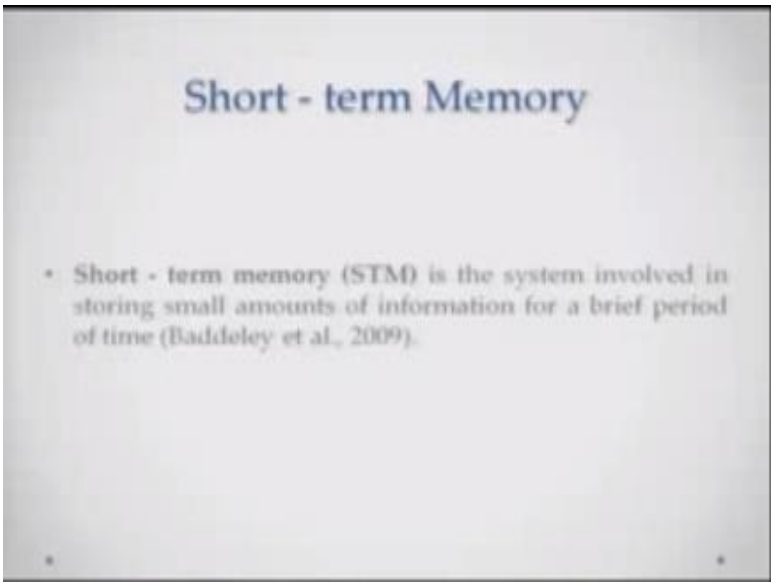

Now short-term memory is the system involved in storing small amounts of information for a brief period of time that is how badly defines it. Now badly says that short-term memory is basically about two things small amounts of information also what small amounts of time, why would you need these kind of small amounts of information and how will that be useful for it. So anything you are doing say for example if you are you know doing some arithmetic calculation mentally you would need just the two numbers and whatever operation you are doing this is relatively smaller information.

And once you have successfully let us say multiplied or divided or added something that information is not useful anymore you just take the result and you know move ahead with this, so this is our say for example let me take another example, if you are hearing you know somebody or say for example if I am talking to you or you listening to me the beginning of the sentence which I am saying remains there for a very short time after that it is gist it out and you just remember the gist of the entire message.

So those are some scenarios when in short-term memory can be very useful short-term memory is basically like you know the RAM of your system wearing all the things that you are doing all

the things you are currently involved in everything that is in the present is there in the short-term memory, because you are drawing constantly from the long-term memory using that information that you have drawn from the long-term memories and after using that performing some operation words in the short-term memory you let it go again back to the long-term memory, so that is what the importance of short-term memory is.

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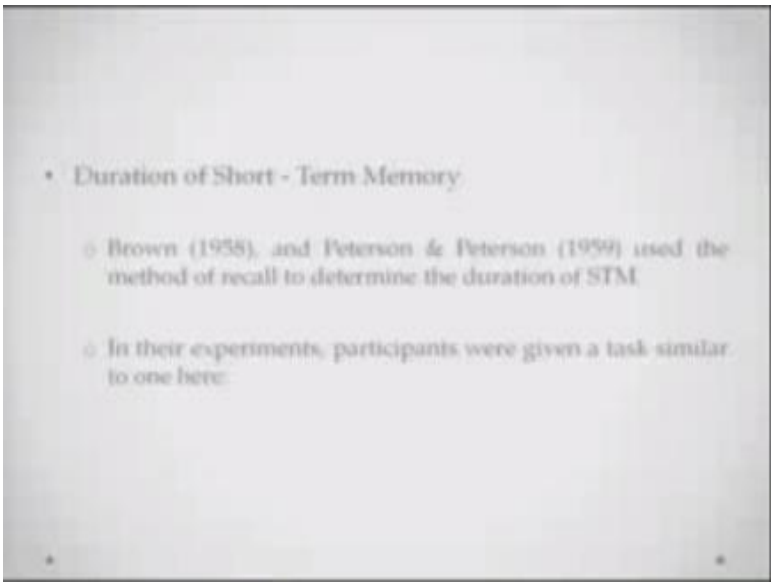

Now what is the duration of short-term memory so Brown and Peters and in Peterson they use the method of recall to determine what is the duration of short-term memory, so what they did was in their experiments participants were given a very similar task than one I am going to demonstrate to you.

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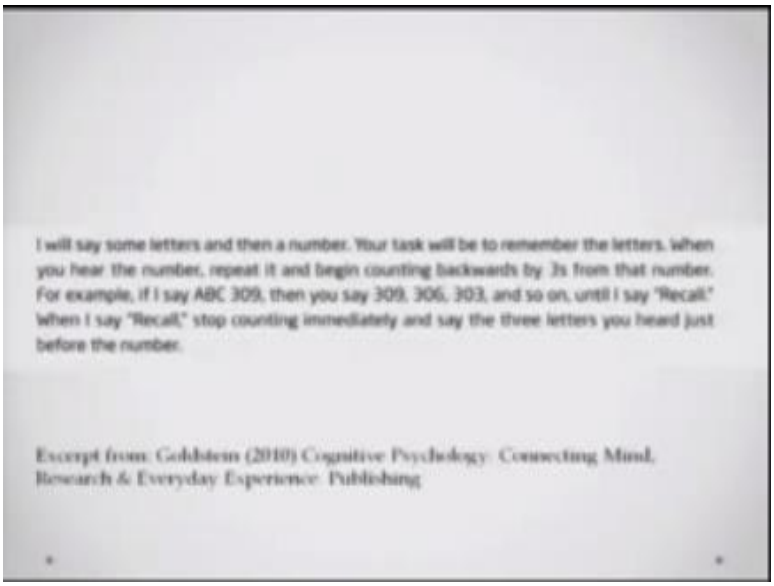

So say for example I could tell you that I will say some letters and then I will say a number, now whatever letters I say your tasks will be to remember the letters when you hear the number however repeat it and then begin counting backwards by threes so from that number say for example if I say ABC 309 then you already start counting 309, 306,303, 300 to 79 so on until I say recall as I am saying recall you have to stop counting immediately and say the three letters you have heard just before that number, so this is something which you can do it very easily so if I say ABC 506 and even kind of you know start talking backward and then I say after something recall we have to say which thing you did you have to constantly keep counting and constantly I will say some letters to you.

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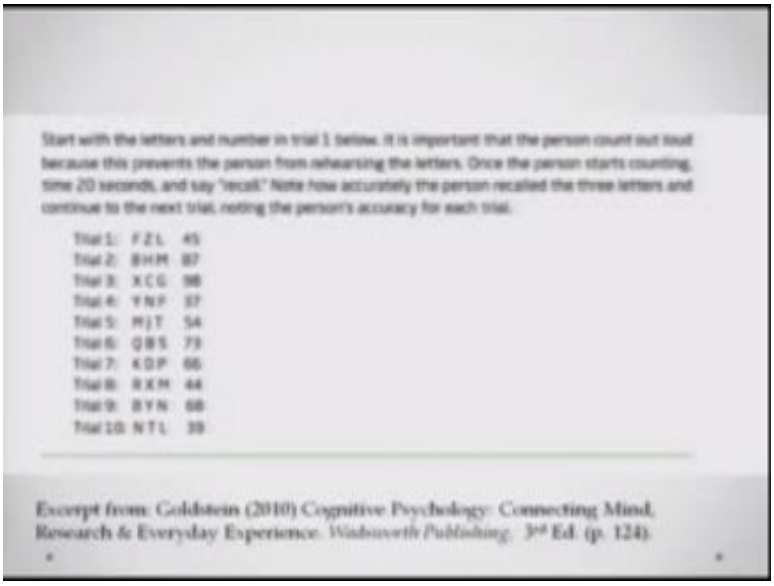

This is the whole demonstration so in the first side I could say let us say SEL forty five trial do I go do something else and you can keep counting and you know there could be different digits so this was the overall thing to actually admit it if you want to do it with one of your friends what you have to do is it is important that the person counts out aloud so it is constantly counting at the top of his voice and so that he is not rehearsing the letters the second most important part this once a person is started counting you kind of take around 20 seconds and then you say recall.

And then what you do is remember you accurately say for example see how much information what are the three letters the person has remembered accurately and before he continues to the next drive.

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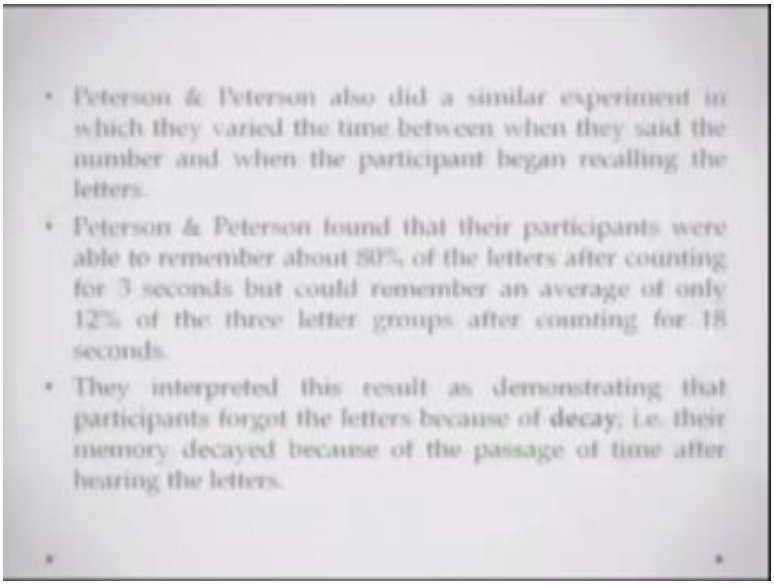

Now Peterson and Peterson also did a similar experiment in which they varied the time between they said the number and when the participant began recalling them, so they kind of tried to vary the time between the recall signals comes and the number is there. Now Peterson pieces and they found that their participants were able to remember around 80% of the letters after counting for three seconds, so after counting for 30 seconds their memory is intact they are doing very well they are remembering around 80% of these letter sequences that have been told.

But if they increase the time for which they have said recall by 15 more seconds the participants could remember on an average of only 12% of the three letter group, so they have to constantly keep remembering all those letter groups that you have said. Now Peterson and Peterson interpreted this result as demonstrating that participants are forgetting relatives because of the DK.

So they are maintaining the letters but the time gap you give between saying recall and between saying the first sequence of letters as long as the Stein Gattis increasing the memory for those letters is decaying off because you have to constantly maintain the letters which I am saying you still have to do the counting but you to maintain the letters which I am saying, now this is what

they say that memory is decaying because of the passage of time after hearing the first sequence of letters.

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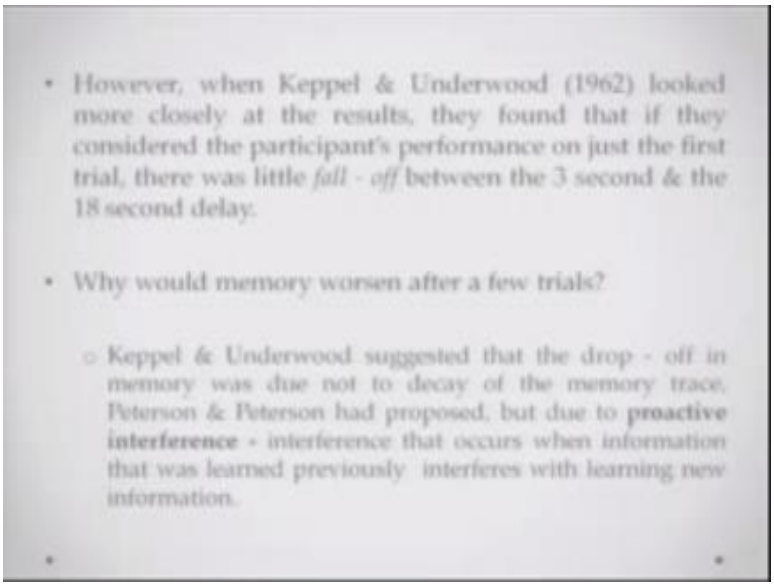

Keppel and Underwood later at a later point in time they actually looked more closely at the results which Peterson and Peterson reported and they found that if you consider the participants performance very closely and on just the first trial there is a little fall-off between the three seconds and the 18 secondly. If you are just talking about the first owl so for example if I set ABC 309 now ABC 309 after 3 seconds and ABC 309 after 18 seconds there is very little fall-off for this amount.

Now why should the information, why should the memory for this is getting worsened up after a few tries is it just time or something is happening. Now Keppel and Underwood suggested that the drop of in memory was due to the decay of the memory trace Peter in Peterson the Peterson and Peterson had proposed it is not due to just the decay of the memory stress but it is due to proactive interference.

What is proactive interference proactive indifferences that interference which occurs when information that was learned previously interface with learning of new information so as soon as I am adding on the sequences of letters you are kind of finding it more difficult to remember those sequences of letters that is what is happening okay. So it is not only time but it is build-up of information that is leading to this decay and leading to this inaccuracy in performance.

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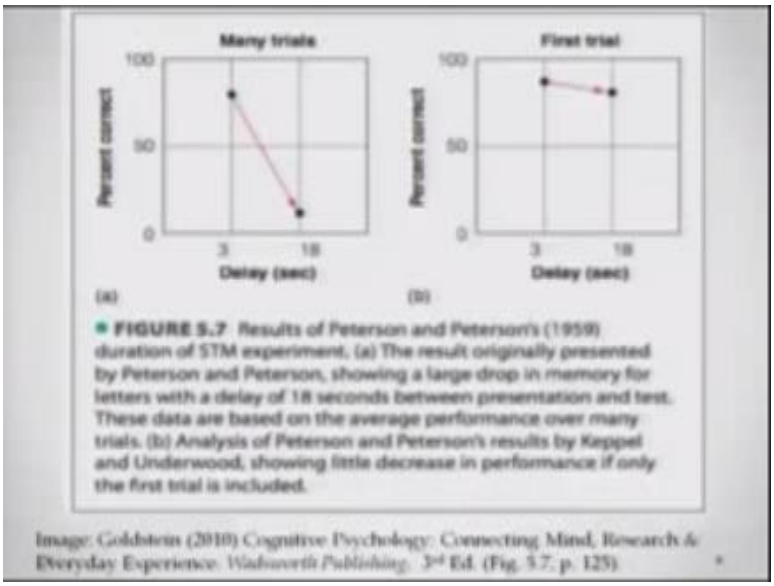

Here you can see the results so if you see the three-second delay and the 18 second delay on all the trials you see that the performance kind of dips off significantly. But if you are just taking the first trial in mind you see even on the 18 second delay the performance is not veered off you know very significantly.

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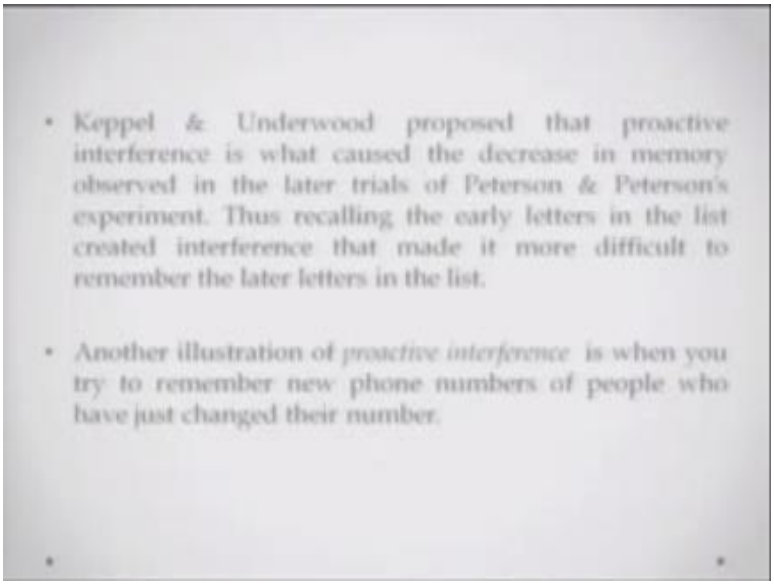

Now Keppel and Underwood they proposed that proactive interference is what caused the decrease in memory observed in the later trials of Peterson and Peterson experiment, thus recalling the early letter letters in the list you know created interference that made it more difficult to recall the later letters. Now you might have also seen this happening with you say for example if I give you my mobile phone number and five days later 10 years later I tell you that my wife phone number has changed it might actually make it difficult for you to remember which is my correct number.

Nowadays it does not really happen because you will update your cell phone with the new information, but suppose if you were to remember this information and I keep giving you new information say for example it is my address so I give you a 1 address and I ask you to come to my home next time I kind of change the address and I give you another address and expect you to remember that, what will happen is obviously some time you will kind of confuse which is the address I am living on basically my earlier address will make it difficult for you to remember my later and more recent addresses that is typical example of proactive interference and there are many ways you will find this happening.

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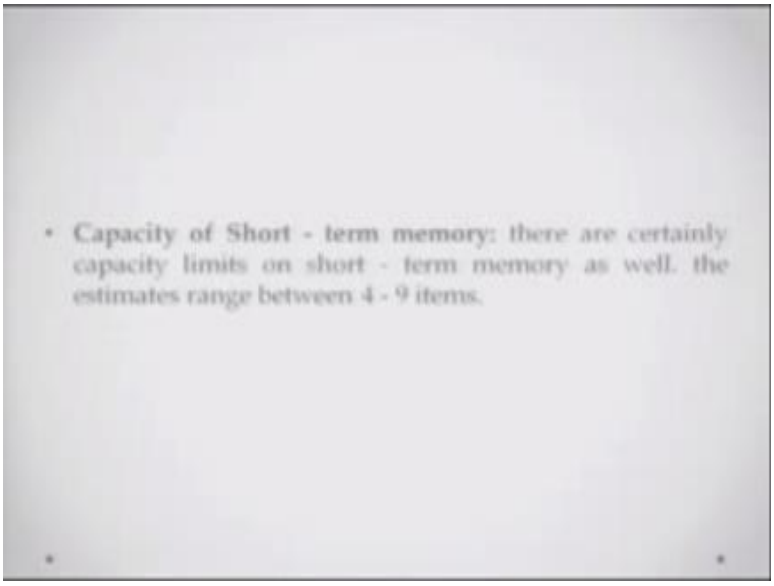

Now let us we talk about the duration of short-term memory now let us talk about the capacity of short-term memory, now there are certainly capacity limits on short-term memory as well the estimate ranges between around 4 to 9 items. So they are having different kinds of estimates made and they say that is just around 4 to 9 items. Now we have in the earlier class talked about short-term memory has very small capacity store so a very small amount of time but it is it as short as four or nine items only how do you remembers other information.

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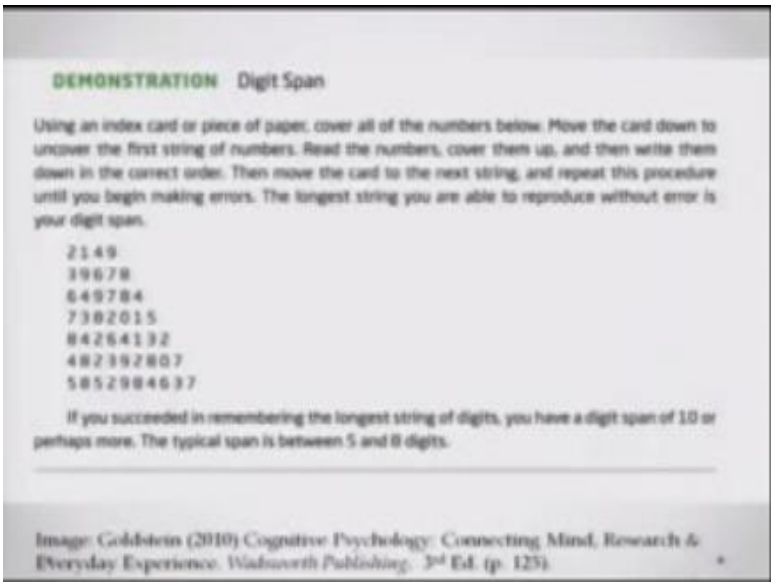

If you really want to check somebody's short-term memory capacity what you could do is you could use this demonstration from Goldstein's book on cognitive psychology what you just have to do is you can just write first sequence of three letters then add one more letter at the ask then to recall a sequence of four letters or digits may be you can do it so three digits four digits, five digits, six digits and you have to ask the person to repeat that digits back to you without making any errors and doing it in a particular order.

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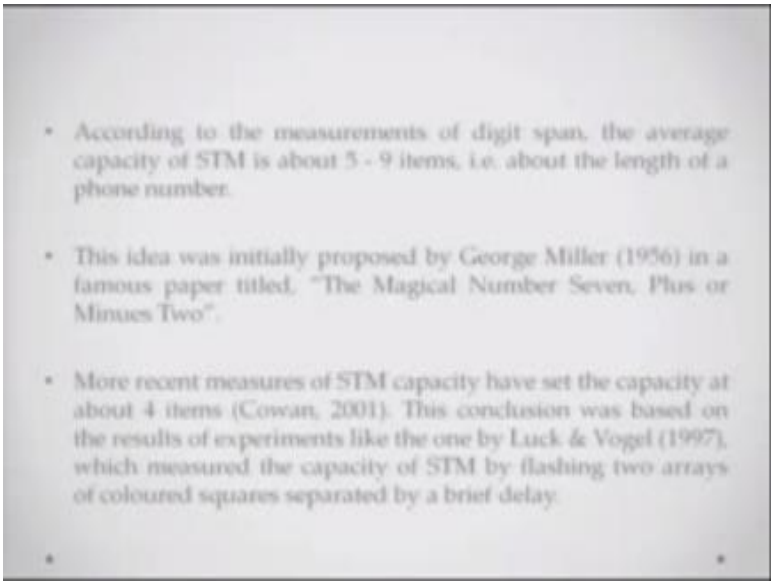

According to the measurements of digit span the average capacity of the short-term memory is somewhere around five to nine items that is basically about the length of a phone number. Now this idea was initially proposed by George Miller in 1956, where he wrote a very significant and very important paper called the magical number seven plus or minus two facing the size or the capacity of the short-term memory is around seven plus minus two items.

More recent measures of short-term memory capacity however has said the capacity limit to be about around four items this is a more recent thing propeller found in the work of Koval in 2001. Now this conclusion was basically based on the results of experiments like the one done by luck and Vogel's in 1997 in which they are measuring the capacity of the s and short-term memory by flashing two arrays of colored squares separated by a brief delay and then they kind of say how many squares they correctly remember. So I will show you this in a demonstration say for example you see this array of squares and then there is a gap and you see this other area of squares.

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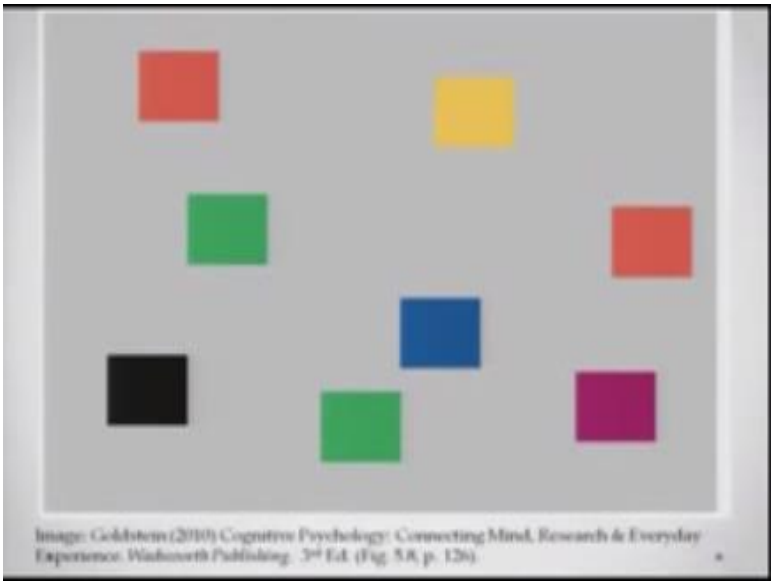

What you have to do is you have to judge whether the second area of squares has all the same element as the first area of squares.

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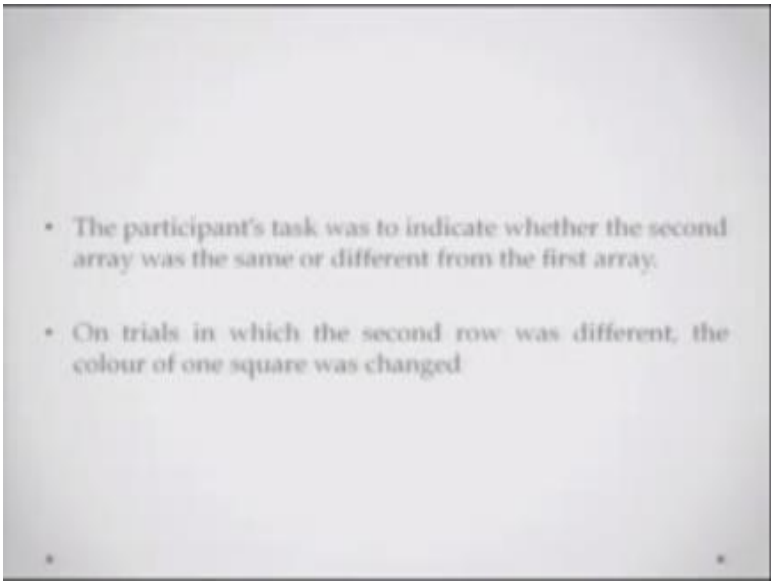

So participant starts care was to basically indicate whether the second array was the same or different on the first array and on the trials English the second error was different a second array was different the color of one square was only seen, so you kind of have to be really attentive and check which square has changed its color maybe we can do this again so here is the array the short delay is already did you recall did you make out which color which squares color was changed.

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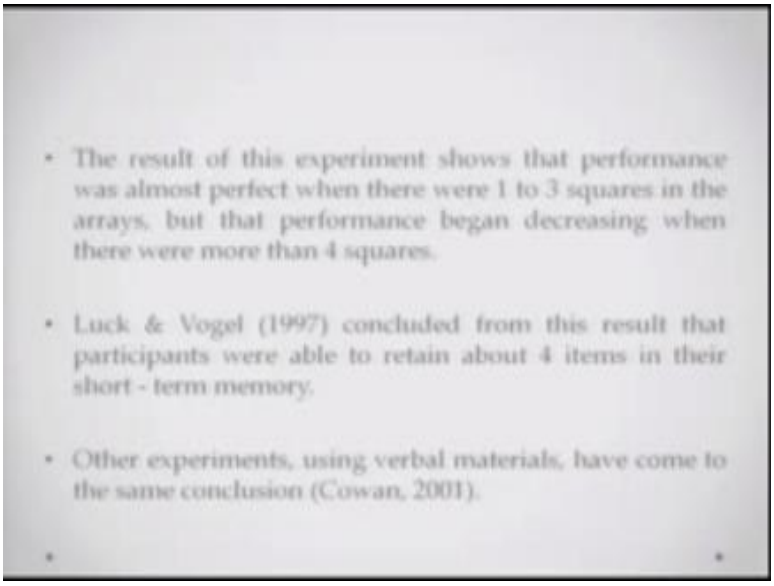

Now the result of this experiment showed that the performance was almost perfect till they were one into three squares in that array but the performance gradually and steadily began to decrease when they started adding more than four squares. So luck and Google concluded from this is that participants were able to retain only up to about four items in their short-term memory, other experiments using verbal materials have also come to around the same conclusion.

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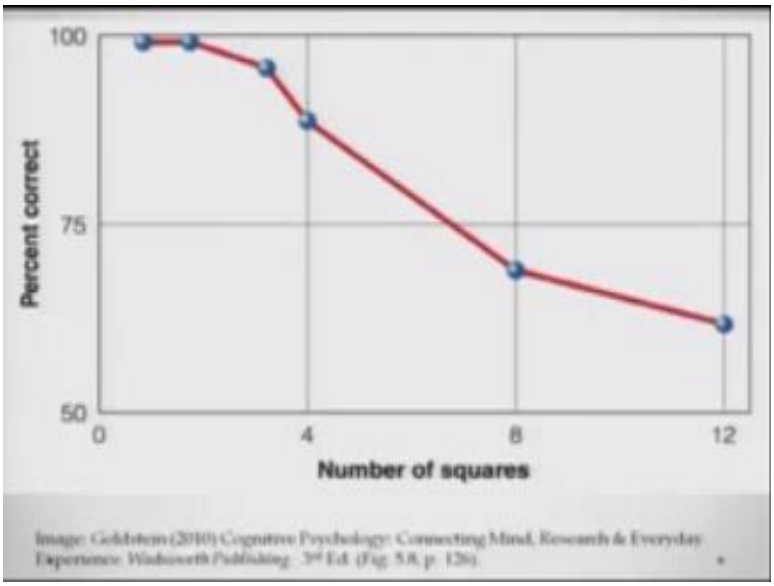

You can see this result of luck and robust experiment here you see as the number of squares is increasing from 1 to 3 to 4 to 8 to 12 the performances steadily and significantly declining.

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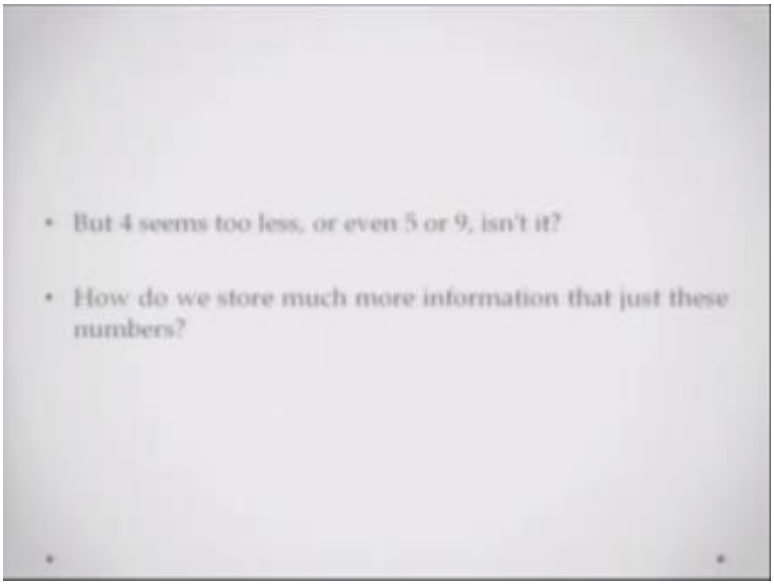

But 4 seems too less is in it as I was saying earlier as well 4 seems too less information to be aware you know that we can recall that we can retain so how do we store so much information even in our short-term memory say for example if you have to recall you know my phone number which has ten digits it is certainly 10 digits and not just four numbers okay, how do you do that how do we say for example if there is a long sentence we have to remember how do we remember that long sentence these kind of questions can be asked and let us see in the later things how do we do it.

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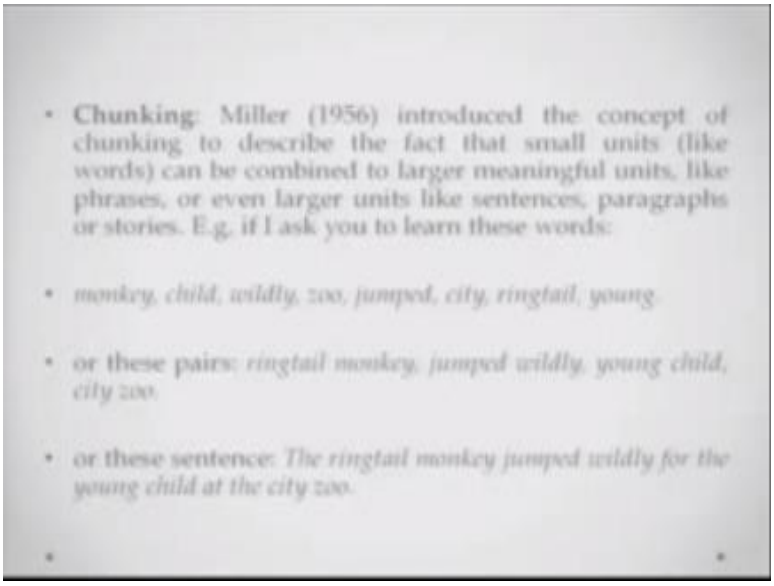

We do it by using a particular phenomenon called Chunking, so Miller in 1956 introduced the concept of what is called chunking to describe the fact that small units like words can be combined to make larger more meaningful units like faces or even larger units like sentences paragraphs or stories say for example if I give you this list of words monkey, child, wildly, zoo jumped city, ringtail, young these are eight online versed if as they ask you to repeat them very quickly.

What let us say if I ask you to repeat them in pairs ringtail monkey, jumped wildly, young child, city zoo maybe this is a slightly easier than the earlier disorganized array of words if I organize it even better the wrinkled monkey jumped wildly for the young child at the zoo is better remembered as compared to the first one, so what is it that is happening in these three examples what is it that is changing, what is changing is the organization of the information in two groups or chunks and what you are doing is you are kind of remembering a chunk as a whole.

So if you see at the last sentence it has exactly the same number of first it has all the words that I said in the first example but now it has a structure to it, it has an organization to it and what you will remember is the gist of what this message was and you can kind of reconstruct from that just

the same taste I will ask you to repeat, if I give you eight or nine separate and unorganized words in the first where in the first level you found it difficult to repeat so that is pretty much what we are doing.

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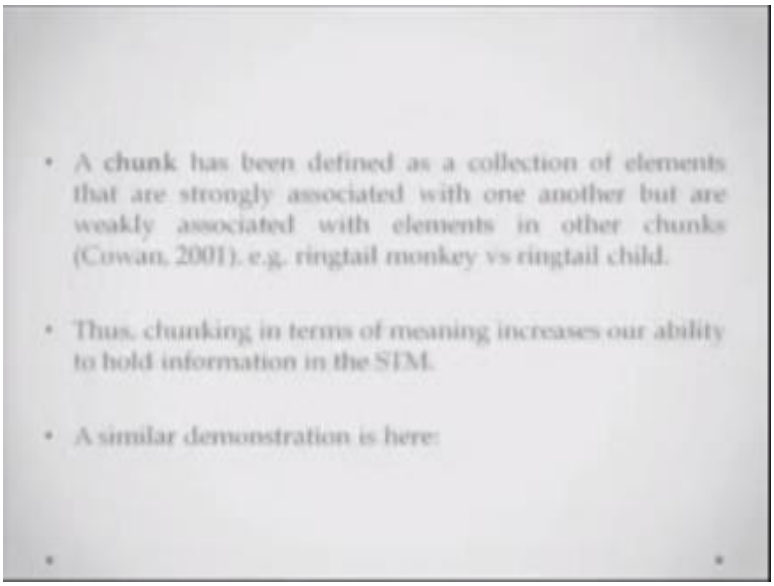

Let me also do some simple demonstration here.

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Say for example I try and recall these letters there is a gap could you recall every one.

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Or say for example now you try and recall this letter which one was easier I have seen in class demonstrations and I hope with you as well that this congregation of letters is easier to remember because these are names or abbreviations so you can actually organize them into CIAFBINBC and CBS so there are only four chunks if you organize them accordingly and that is what chunking is all about.

So let me define chunking for you slightly in a more formal way so chunking has been defined as a collection of elements that are strongly associated with one another but are weakly associated with other elements charged with elements in the other chunks, so you can have units working together and distinctive or distinguishable from other unit so you can have ringtail monkey but if you have a ringtail child that will not make the association very well. So if there is ringtail monkey coming together you will remember it much better.

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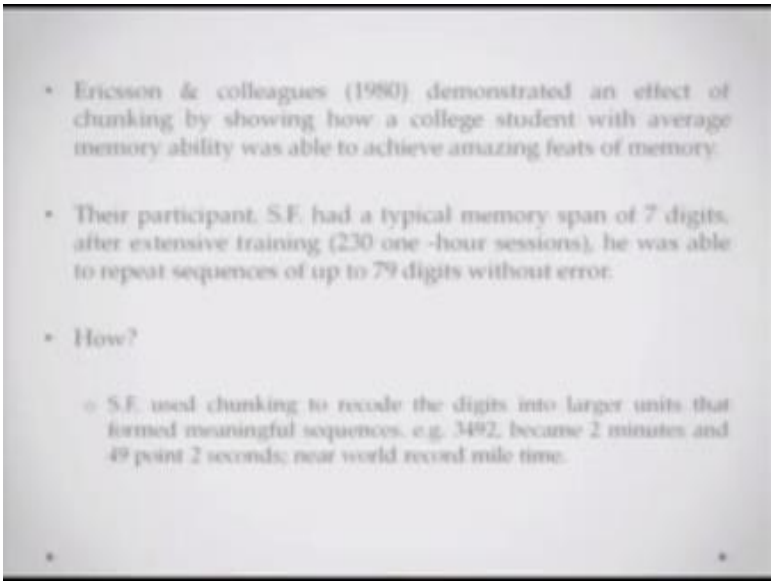

An excellent believes demonstrated an effect of chunking by showing how a college student with average memory ability was able to achieve amazing feats of memory, so they are trained this kid their participant was named SF and he had a typical memory span like all of us of seven digits, but he received extensive training for about 230 one hour sessions and then he was able to repeat sequences up to 79 digits without making an error, how was SF doing that obviously the SF was using chunking to recode the digits into larger units and formed that forms slightly meaningful sequences.

Say for example 3492 became 2 minutes and 49.2 seconds now 2 minutes and 49.2 seconds now this is the way if you kind of remember this kind of can become you know a way or a cue to remember this information in a more meaningful way and in that sense this can be basically used to enhance your memory, so a very simple tip will be for people who want to improve their memory having done a course on cognitive psychology.

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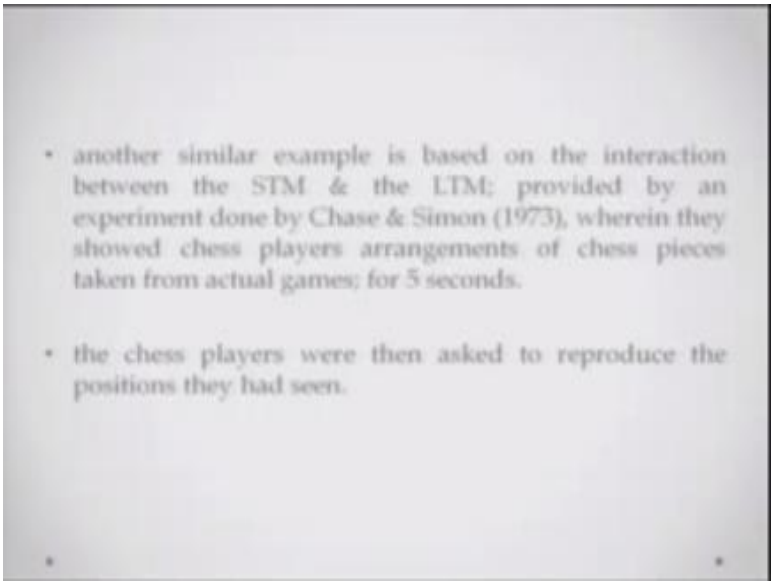

And read something about memory so start organizing information better start storing information in ways that are meaningful to you and so that those meaningful ways can be queued with very little effort. Now coming back another similar example is based on the interaction between the short-term memory and the long-term memory and it was provided by an experiment than Chase and Simon in 1973 where in what they did was they showed chess players arrangements of chess pieces taken from actual games for five seconds.

So chess players and a novice person who had never played chess they were shown arrangements of 24 pieces or 24 chess pieces on a particular board and then they were later asked to recall which were the pieces, so the chess players basically whereas would reproduce their positions and the position that they had seen.

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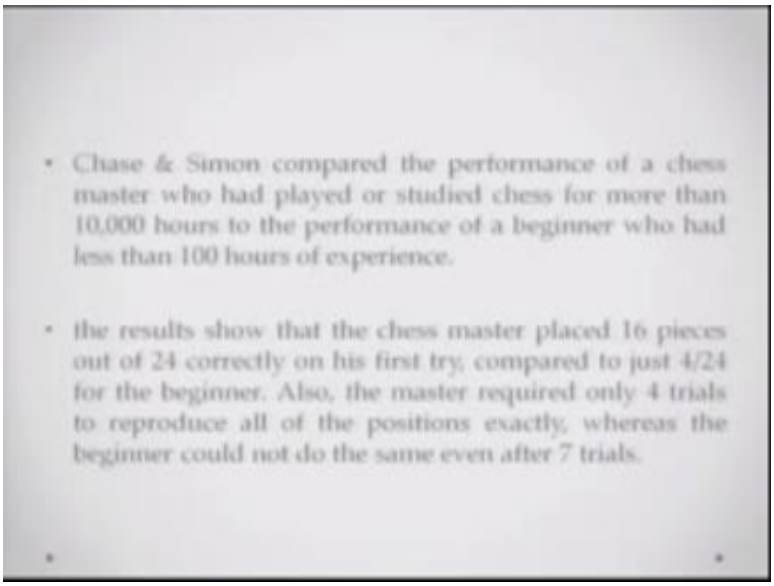

And it was like the chest and the chase and Simon compared this performance of a chess master who had played or studied chess for around 10,000 hours to this performance of a beginner who had only had around less than hundred hours of experience. Now the results of this particular experiment showed that the chess master had placed sixteen pieces out of 24 pieces correctly on his first try itself compared to 4 out of 24 pieces that the beginner person could do.

Also the master required only four trials to reproduce all of the 24 pieces correctly as compared to the beginner who could not even do the same even after seven trials, so you see there is something here now is it that the chess player is an expert.

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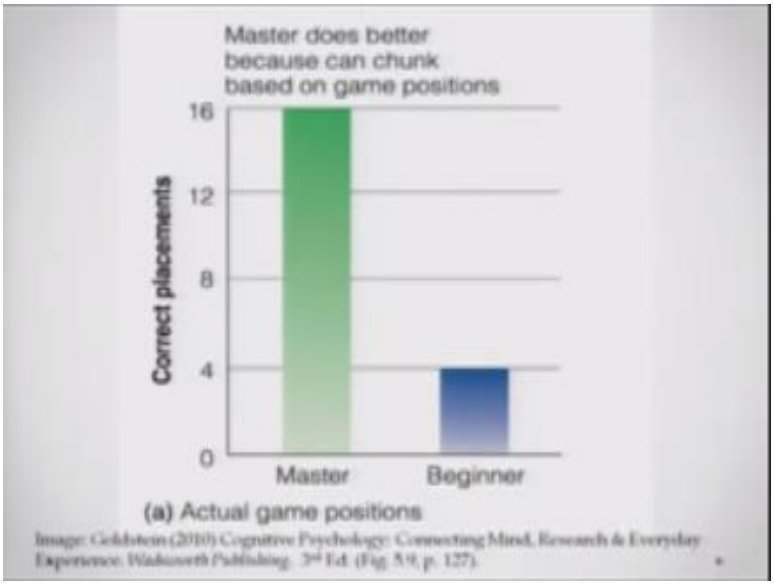

So here is the data so the master around you know does this correct placement sixteen correct places on the first trial itself beginner does only four.

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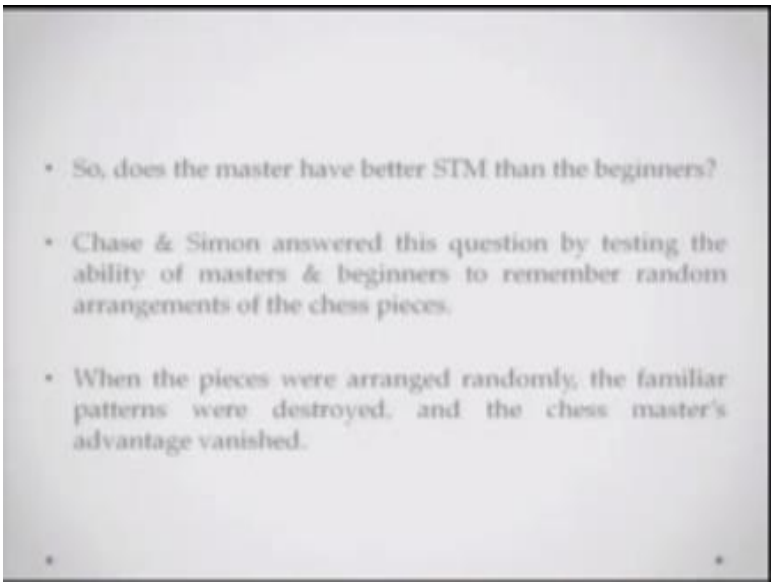

So then does the master have better short-term memory than the beginner or does he have you know better knowledge of chess is that helping him in some way or the other that was the question that was asked, Simon and Chase they answered this question by testing the ability of the Masters and the beginners to remember random arrangement of chess pieces, so if you have a play chess if you are you know a familiar with chess if you arrange something in a particular way you will know that there are specific positions and there is a you know a specific name for each position so if you are a chess master you can recall those positions by experience and you can say that.

But when you are actually looking at randomly arranging pieces there is no name for those kind of positions and then let us see what happened, when the pieces were arranged randomly the familiar patterns were destroyed and the chess masters advantage completely vanished, so it was not that it is short-term memory was better it was that he knew those familiar positions from obviously a lot of practice and skill that is required over 10,000 hours of chess training and that was what was helping him organize those positions better there were names of those positions and that he could have used to organize that.

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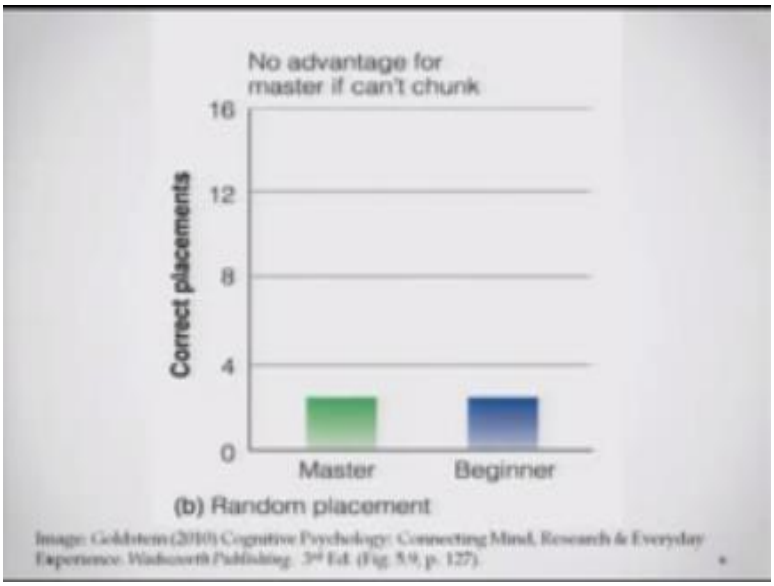

So you see here there is no advantage for the master if you cannot chunk on the basis of previous knowledge, that is pretty much what we all do if we are fed in new information.

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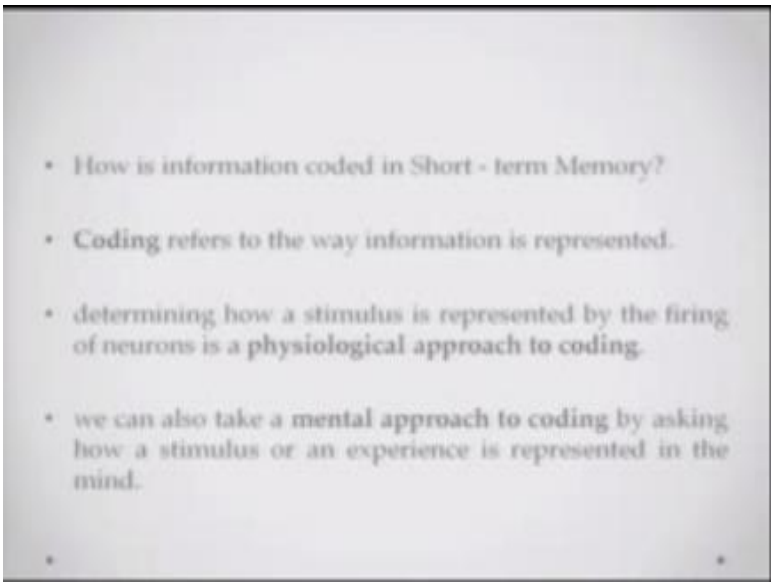

Now how do you feed in new information in short-term memory that is the third question one can ask you feed a new information into the short-term memory by a process called coding or a process called encoding? Now determining how stimulus is represented in the brain by firing a such ignorance as was a seen by you by Umbel and Wiesel as I mentioned in one of the earlier lectures is called the physiological approach to coding, that is one way to do it.

The other way to do it all is following the mental approach to coding, what is the mental approach to coding the mental approach to coding is by asking how stimulus or an experience is represented in the mind say for example if you go you know go somewhere and you meet some new person and you just have a short conversation with him you come back and you are trying to recall that person maybe there is something similar something salient about that person maybe that he belong to a city where you had done your previous schooling if you remember that person according to that knowledge it might help you recall better.

Now similar things you would use in chunking as well so there could be a variety of ways in which one can encode information.

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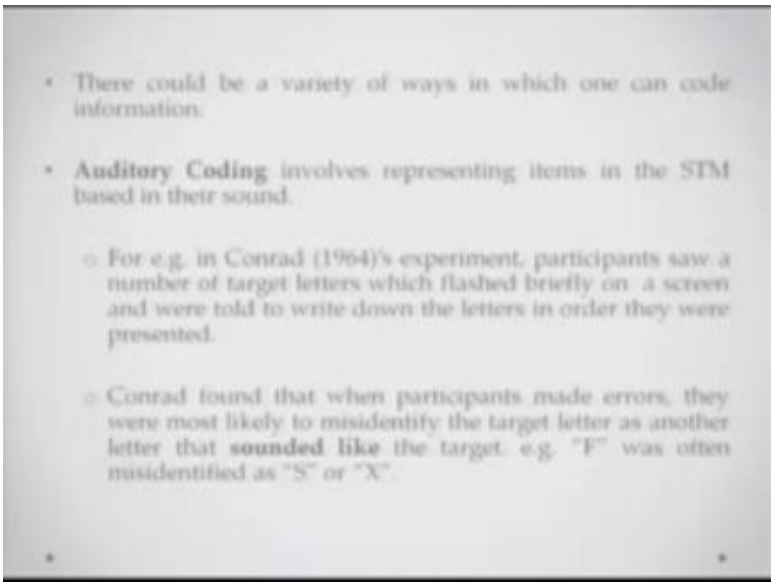

The first kind of ways auditory encoding the auditory encoding involves representing items in the short-term memory based on this sound, so what Conrad did in 1964 experiment he showed participants a number of target letters which flashed very briefly on a screen and then the participants were told to write down the letters in the order in the exact order they were present a coordinate found that when participants made errors they did make some errors though when persons made errors they were most likely to miss identify the target letters as another letter if they sounded very similar.

So if they sounded very similar there was a scope of confusing them say for example a lot of participants were you know misidentified F as S because they sound so similar to each other.

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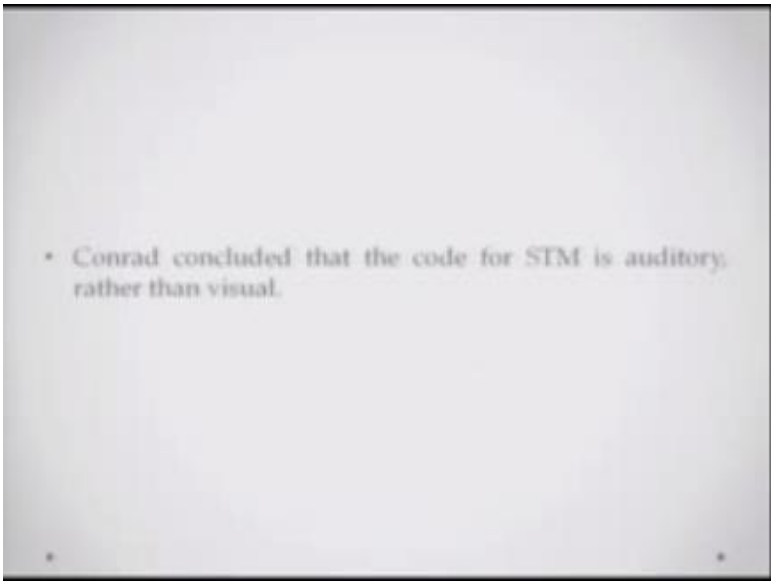

Conrad concluded on the basis of this these results that the code for STM is or the preferred encode method for SCM or short-term memory is auditory rather than visual.

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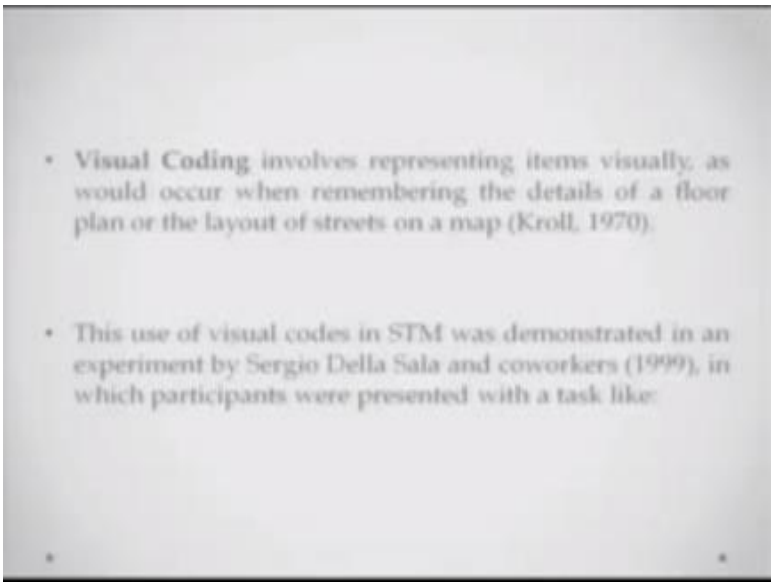

Now it is not that we do not encode visual information it is not that we do not encode information in a visual manner we also do encode items and information in a visual manner and visual encoding basically involves representing items visually as say for example would occur if you are trying to remember the details of a floor plan or a blue print of a particular you know building something like that or the layout of a streets on a map, if you are dealing with specific visual information that does not is not really easily encoded in the verbal thing you will use it visually as it.

Now this use of visual quotes in the short-term memory was demonstrated in an experiment by Sergio Della Scala and their colleagues in 1999 in which the participants were presented the tasks like this one here.

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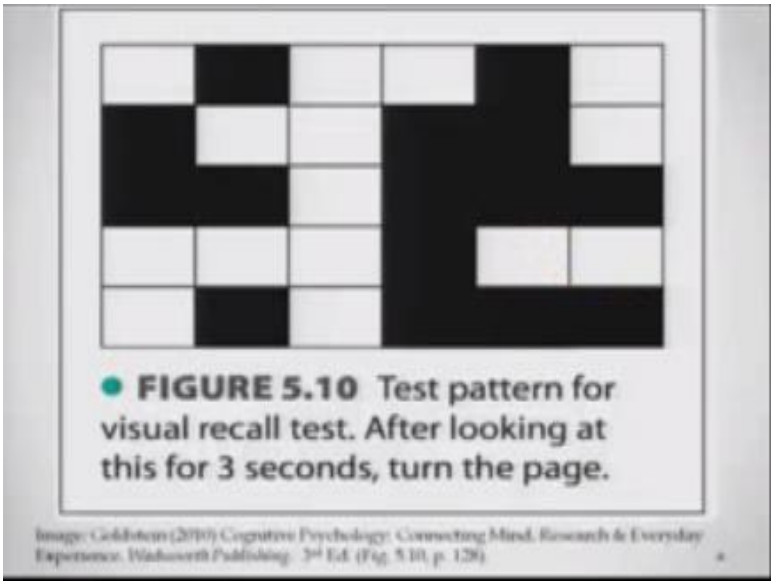

So I will show you this array of squares some of them are black and then I will ask you to fill exactly.

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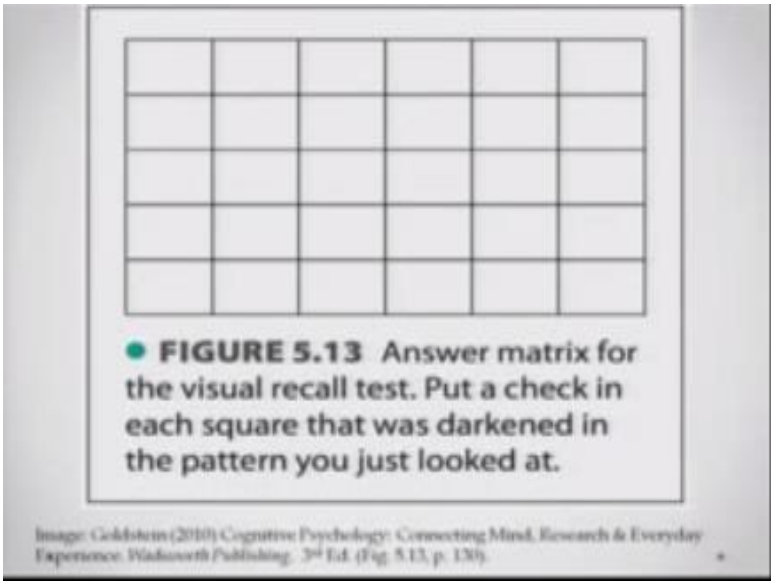

Which squares are black in this particular experiment now both of these demonstrations are drawn from Goldstein's book and psychology.

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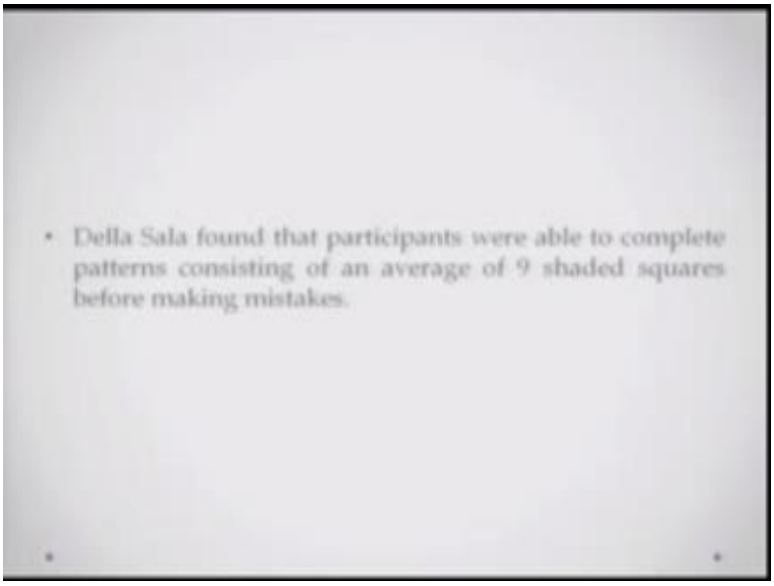

Now, Della Sala in this experiment found that participants were able to complete patterns consisting of an average of around 9 shaded squares before they started making mistakes. So up till nine squares we go to correctly remember but they started making mistakes if the number of squares was more than nine.

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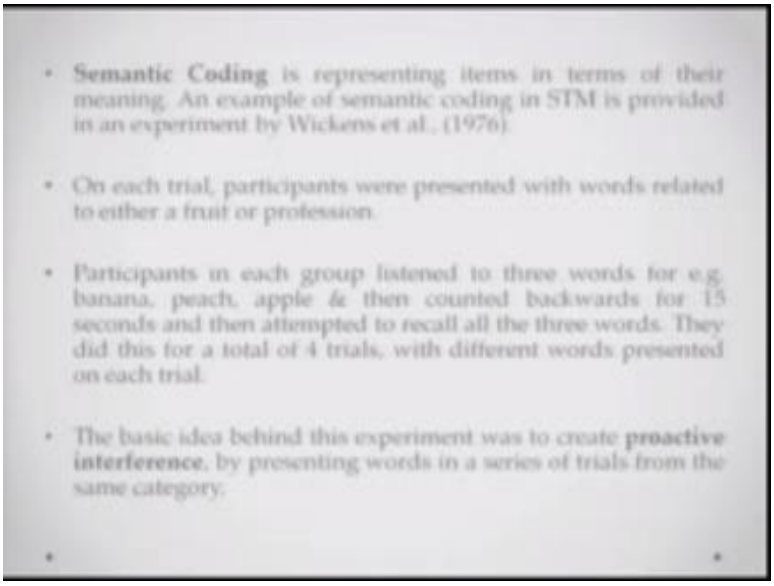

Another way of coding information other than auditory and other than visual is basically starting to code information on the basis of semantics on the basis of their meaning and their relationship to you know whatever knowledge you already have something that I was telling, now semantic coding is representing items in terms of their meaning. An example of semantic coding in SEM is provided in an experiment and I have Dickinson colleagues and in this experiment what happened was that on each trial participants we represented with words related to either a fruit or prophet so there were two groups they were presented items say the names of fruits and the other group was presented names of professions.

So participants in each group they were listening to three words for is banana, peach and apple and then started counting backwards for 15 seconds and then attempt to toe recalled all the three words, now they did this for a total of four times and with different words presented on eisha so every trial they will say for example see some names of fruits then we will start counting backwards and they will be told another three fruits and they will start counting and they'll continue counting backwards but do you remember all of this.

Now the basic idea behind this experiment was to create what is called proactive interference by presenting words in a series of trials from the same category, so if you are repeating the same kind of words trial by trial these new trials will actually interfere with the older trials I will show you a demonstration.

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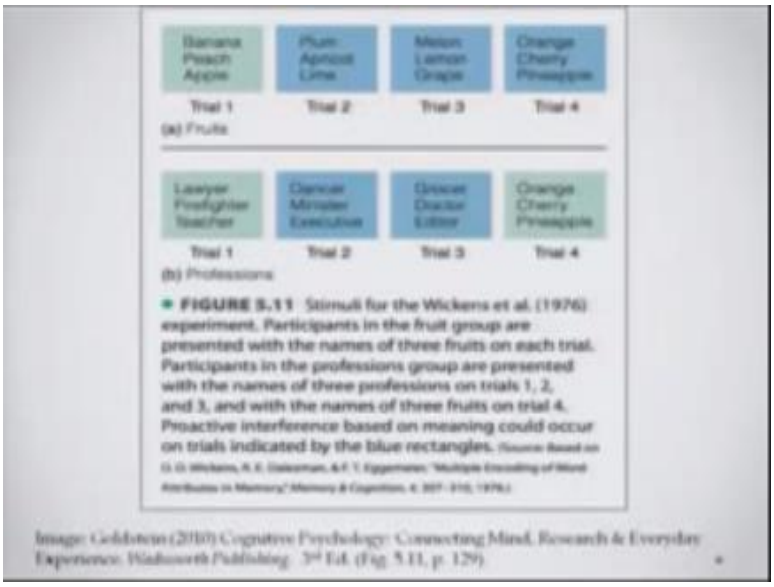

Say for example you can see in trial in the fruits group the first trial is banana, peach and apple the second trial is plum, apricot and lime the third trial is melon, lemon and grape the four trial is orange, cherry and pineapple so the fruits group is basically getting all of these fruit names. The second group is the professions group and they are also being said these profession names only on the fourth try they are not told a professions name they are actually told a fruits name and three names of food.

So first I will is lawyer, firefighter a teacher second is dancer a minister executive doctor, the fourth one is the name of three fruits, now what do you think happened here.

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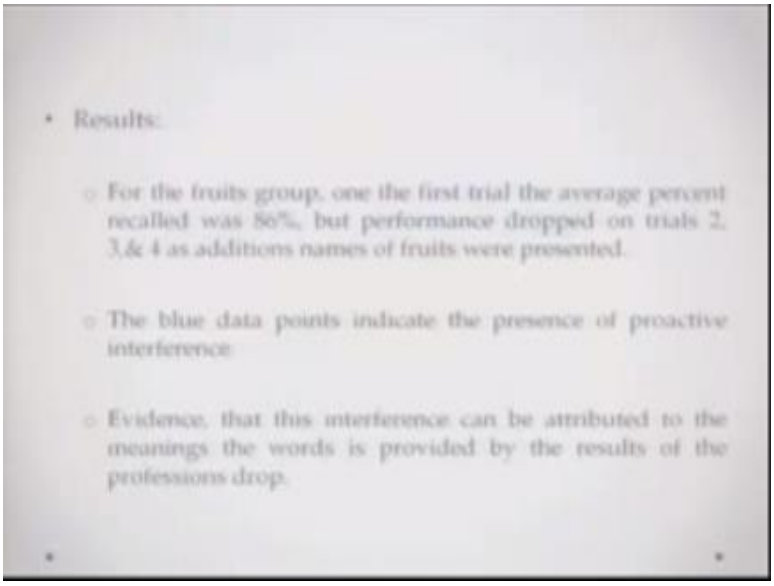

Now it was found that for the fruits group on the first trial the average percentage recall was as high as 86% but performance drops gradually and steadily on trials two three and four as additional names of fruits were being presented, now this additional information forms the part of the same category of the first trial and in that sense there is proactive interference starting from the second trial, third trial and the fourth trial.

The blue data points I will show you now indicate that the presence of proactive interference is there if you see in this figure here. On the fourth on the professional group what happened was that because the fourth trial had names of fruits instead of professions there is no proactive interference there what is called release from proactive interference that is why the performance of recall on the four trials is also very good.

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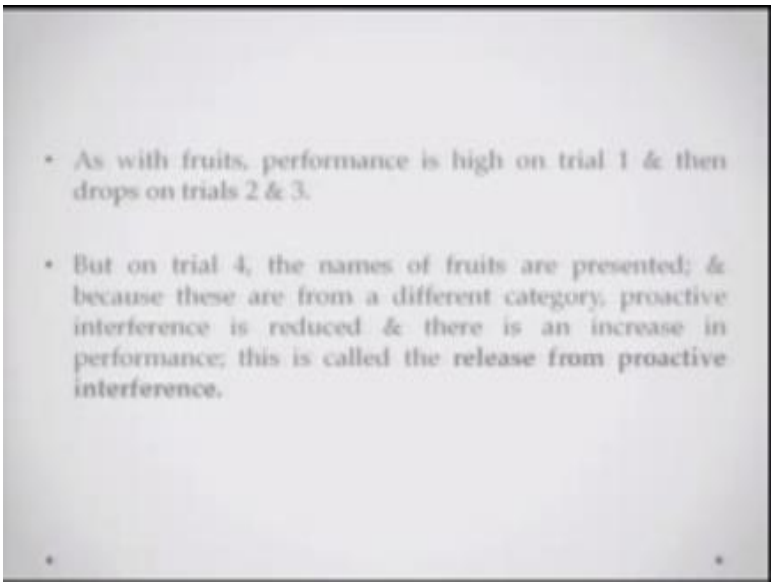

So you can see here in this particular result.

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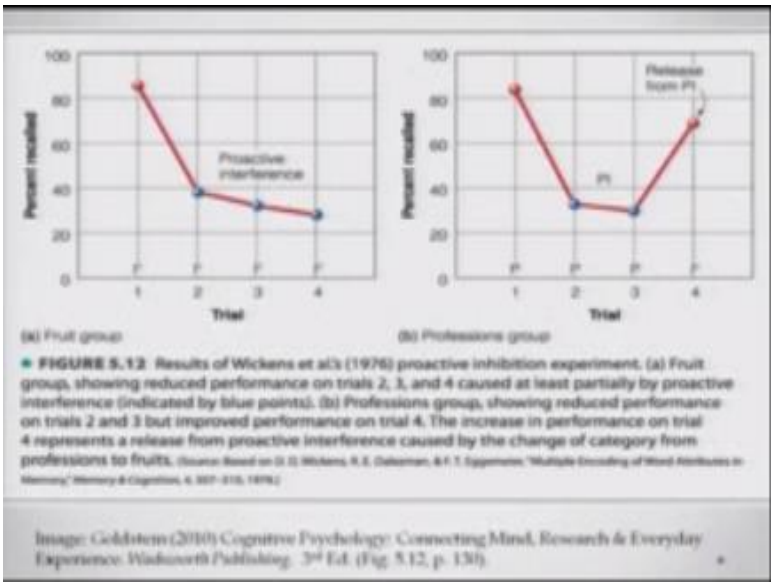

FIGURE 5.12 Results of Wickens et al's (1976) proactive inhibition experiment. (a) Fruit group, showing reduced performance on trials 2, 3, and 4 caused at least partially by proactive interference (indicated by blue points). (b) Professions group, showing reduced performance on trials 2 and 3 but improved performance on trial 4. The increase in performance on trial 4 represents a release from proactive interference caused by the change of category from professions to fruits.

Image: Goldstein (2010) Cognitive Psychology: Connecting Mind, Research & Everyday Experience: Wadsworth Publishing. 3rd Ed. (Fig. 5.12, p. 136).

That in the fruits group you see that the performance is steadily and gradually declining from trial one to trial two three and four. In the profession slope you will see that the performance is very good on the first trial it comes down on the second trials goes further down on the third trial but on the four trial there is already release the partisans performance already kicks up and this is and why is this happening is because the things presented the names presented on the fourth trial were different from all the names presented in trials one two and three. So this phenomena is basically referred to as release from proactive interference, because the four trial had names from a different category participants had no trouble in recalling this new information and their performance increased and it became better.

Now these were some aspects about short-term memory that we studied today we talked about the duration of short-term memory we talked about capacity of short-term memory and we also talked about different ways in which information can be encoded into short-term memory. I hope this session on short-term memory would help you understand more about memory as a mental function in the next chapter we talked about other aspects of memory that were proposed by Atkinson and Shiffrin, thank you so much.

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