Advanced Cognitive Processes
Dr. Ark Verma
Department of Humanities & Social Sciences
Indian Institute of Technology, Kanpur

Lecture - 09
Cognitive Maps

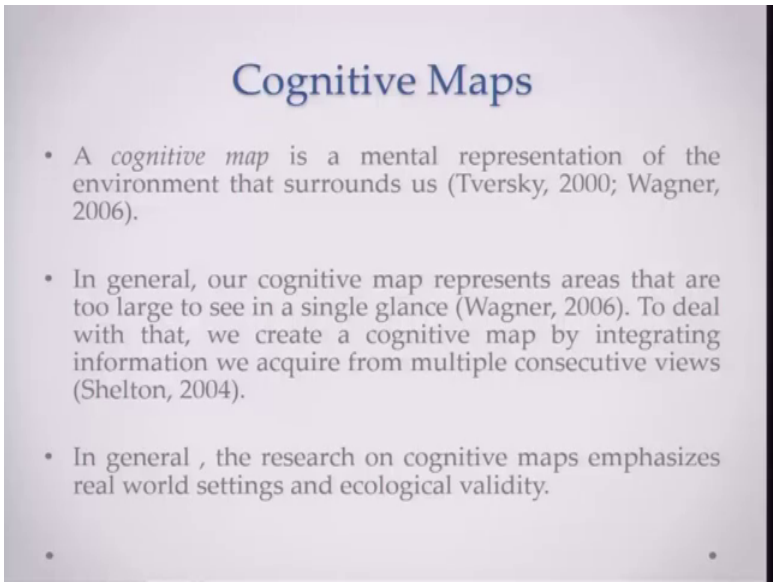
Hello and welcome to the course, Advanced Cognitive Processes. I am Ark Verma from Indian Institute of Technology, Kanpur. This week, we have been talking about mental imagery. We have been focusing a lot upon visual imagery. In the last lecture, we talked about the interrelationships between visual perception and visual imagery; we talked about in the interrelation between auditory perception, auditory imagery and so on and so forth.

Now, the idea is that mental imagery is probably following a very similar process to it that we follow in visual perception. And we have across you know the last lecture across the range of you know experimental studies that we have been following, we have tried to see this evidence experimentally that whether mental imagery or visual perception are actually you know working very closely together or not.

I will try and take you away from the mental imagery debate for a while. And I am going to spend this lecture talking about something called Cognitive Maps. And Cognitive Maps is basically you know the aspect of mental imagery. When you are actually talking more about the distance, we are actually talking more about the navigational properties of the world that you living in, you know what is situated next to what? How far are things from each other? What is the layout of a particular area or the building those are the kind of things we have you know we will be talking about here.

So, what is a Cognitive Map? I am sure all of you at different points in time have been engaging in making these cognitive maps, let me define them for you a little bit.

(Refer Slide Time: 01:50)



A cognitive map is a mental representation of the environment that surrounds us. So, in general, if you know I asked you to make the map of let us say the map of the park near your home or the map of the colony near you know where you are living, all that is a map that takes you from your home to your work place; that is basically you are actually you know plotting a complete layout of those areas; you know what are the shops in the middle, what are the roads that fall, whether you have to take a right turn or a left turn at a particular point, whether there is a curvy road, all of those kind of things need to be specified in this mental representation for this to be called the cognitive map because this is what is going to lead you from place a to place b.

So, in general and it has been seen that our cognitive map represents areas that are too large to see in a single glance. So, if it were small objects you know, apples, bananas those kinds of things you can actually look at them at you know in a single glance; you do not really need to have a map of those things, say for example, you know you go to a departmental store.

If you looking at a very specific aisle, you are looking at a very specific shelf where let us say you know your favourite juice is stored that is still you can have a mental image of that thing and you know when to take you know particular brand of juice or and come back or things like that. But if I ask you to make the mental representation of that entire

departmental store you know an entire large store then what you will need to indulge or what you will need to make is the cognitive map of the place.

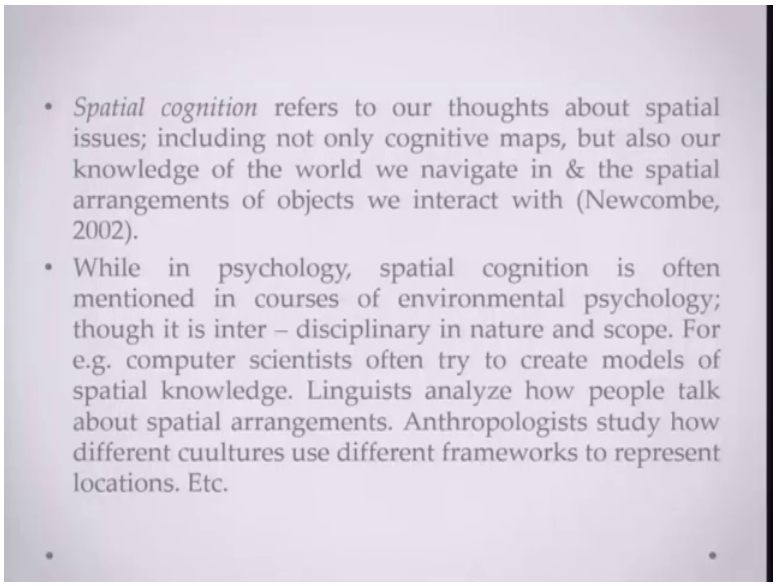
You will need to tell me and you know this is the entrance and from the entrance when you get in on the left side is these trolleys that you take to shop and the right side you will find shells wherein sweets are there the other side there are shells there vegetables are there, the other side at the left corner, you will find say for example grocery like lentils and rice and those kind of things.

So, then what I am drawing out of is my cognitive map of a particular place. So, this is pretty much what a cognitive map is. To deal with this large set of information, we create a cognitive map and wherein we are creating a cognitive map by integrating information that we are acquiring from multiple consecutive views. So, we have been there so many times, each time we have got a snapshot, we noted some information about this place, next time you go again, you again get a snapshot, you again get some more information; you keep adding information you know with your each successful a successive visit to this place.

So, there are so many mental images and you kind of collate all of them together to create a cognitive map of the entire departmental store. That is pretty much what we will be talking about today. Now in general the research on cognitive map emphasizes on the real world settings and ecological validates. It is basically is talking about that cognitive maps again as we saw in the last lecture, basically worked in very similar ways as our actual perception of maps would do.

So, let us try and elaborate these things. Now again, before I go into the experimental part of this, the study of cognitive maps or mental image early on in that sense, basically comes under this broad field of interest called spatial cognition.

(Refer Slide Time: 05:12)



What is a Spatial cognition again I am not going to really get into the details of this, but let me try and define this for you a little bit. So, Spatial cognition basically it refers to our thoughts and our about spatial issues; it not only includes cognitive maps, but also our knowledge of the world that we navigated. You know, what is the distance of place a from place b, things like that the world the spatial arrangement of this place.

So, you know the shop, the coffee shop is situated left to the sweet shop and the sweet shop associated to the left of you know the stationery shop; those kind of arrangements you have to really have all of these details about the spatial layout of the place that you are going to you know make a representation of in your Cognitive Map. Now in psychology, spatial cognition has been it is been rather important.

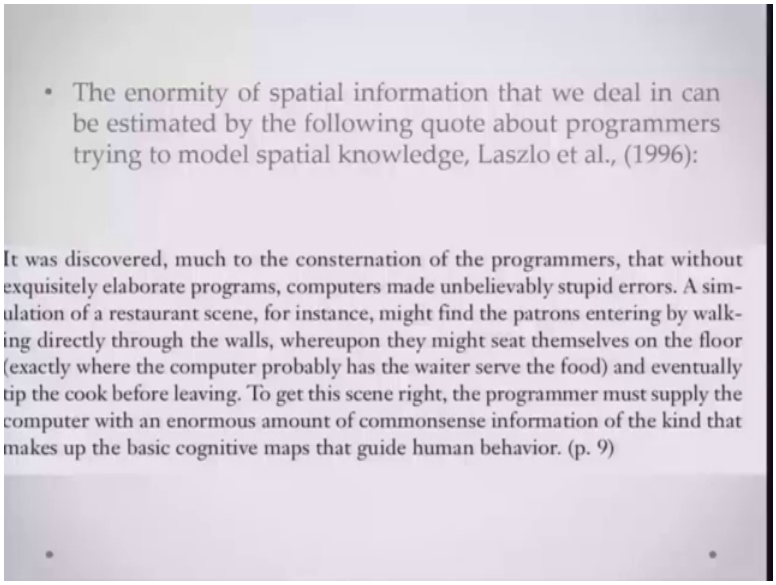
It has found lot of mention in things like you know environmental psychology, but generally spatial cognition is a field of interdisciplinary interest. And how is that happening? There are people computer scientists who have been trying to create models of our spatial knowledge. Suppose if you have to create a robot and you have to actually ask the robot to navigate let us say a particular departmental store and basically buy something that you have asked the robot to buy.

So, again the robot does not really have at it is disposal all of the memory and all of the things that we have. So, the robot you have to feed in every little detail in the robot and it is and people have found that you know it takes a lot of effort to make these artificial

agents perform; even to match the kind of accuracy in the kind of sophisticated performance that human agents would do. Again it just helps you appreciate the lot of minute details; a lot of minute processing that really goes on. Linguists have analyzed how people talk about spatial arrangements again their issues especially cognition. Anthropologists study how different cultures use different frameworks to represent locations.

Say for example, Chinese you know like to talk about space in a more vertical sense as compared to Indians; we talked about the space and left to right kind of sense. Those kind of you know cultural understandings of a spatial cognition or space around us is also there. And there has you will find something about spatial cognition in almost any field of interest; you will really you know you want to explore and you want to read something about spatial cognition in.

(Refer Slide Time: 07:59)

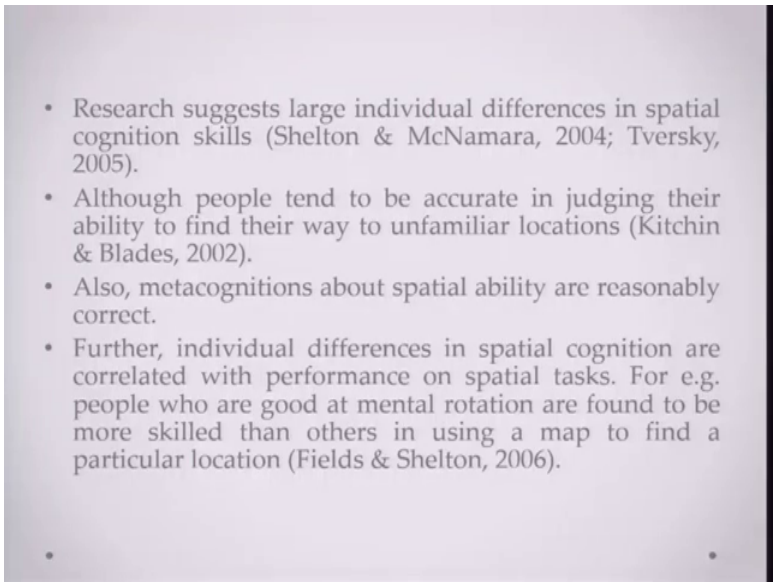


And this enormity of spatial cognition or spatial information that we actually deal with can be estimated by this very nice quote from Laszlo and I am kind of borrowing this from the book of Madeleine, and it says that it was discovered and this is about when robots were basically being taught to you know perform these spatial cognition tasks. So, it was discovered much to the consternation of the programmers that without exquisitely elaborate programs. You know the program will have to have every little detail about every left, right turn the measure robot has to take. Computers made unbelievably stupid

errors you know. They simply do not have the overall knowledge that we have. A simulation of a restaurant scene for instance might find the patrons entering by walking directly through the walls whereupon they might see themselves on the floor.

You know things like that and eventually tip the cook before leaving, to get the scene right the programmer must supply the computer with an enormous amount of common sense information of the kind that makes you know that makes up the basic cognitive map of a particular place. So, for example, if you are trying to teach the robot how to go in a restaurant and behave how do you come through the you know entrance, where do you see it yourself, where do you know position yourself, whatever different aspects you perform and it is these very sophisticated dealings that you have to teach the robot to really perform.

(Refer Slide Time: 09:29)

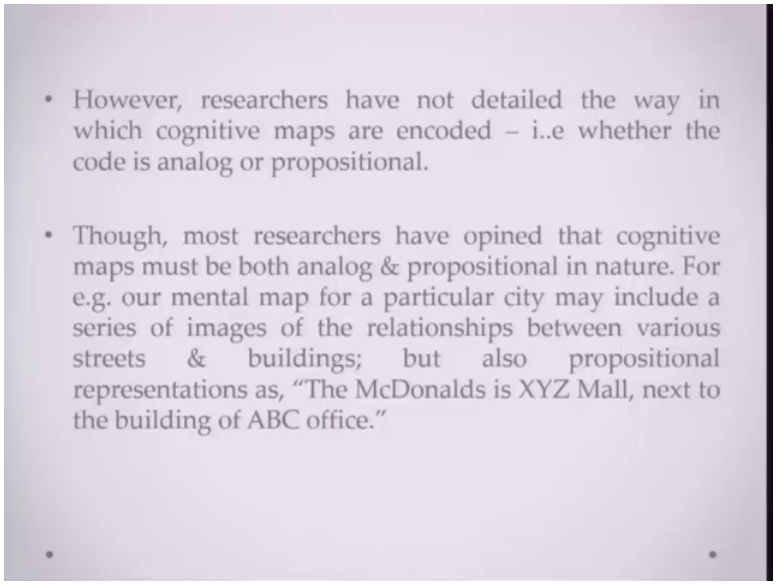


So, yeah this is fairly complex and there is a lot of research in this area and yeah. So, we will be talking broadly about some of those kind of research in today's lecture. Even before I get into this, let me also again pin up one of the basic topics here that I wanted to talk about; there has been a lot of talk about individual differences in various aspects of cognition and those kind of things have been there, people have been found to be different in their spatial cognition skills, the difference there has been some difference in their spatial abilities.

So, although people would be you know they would tend to be accurate in judging their ability to find their way to unfamiliar locations. Also people have used things like metacognition about spatial ability which have been found to be reasonably accurate, reasonably correct.

Also individual differences in spatial cognition have been found to be correlated with performance on a variety of spatial tasks; for example, if you remember the earlier tasks we talked we are talking about in the last class as well, for example, people who were found good at the mental rotation task were found to be more skilled than the others in using a map to you know navigate somewhere to go to a foreign country and use a map. So, people who have better mental imagery who have been consistently performing better on tasks involving fresh ability, have also shown better ability in reading things like these maps.

(Refer Slide Time: 10:53)



However, researchers have not really detailed them if not really understood the way in which cognitive maps are encoded; that is sort of unclear, that is whether this code is propositional or analog.

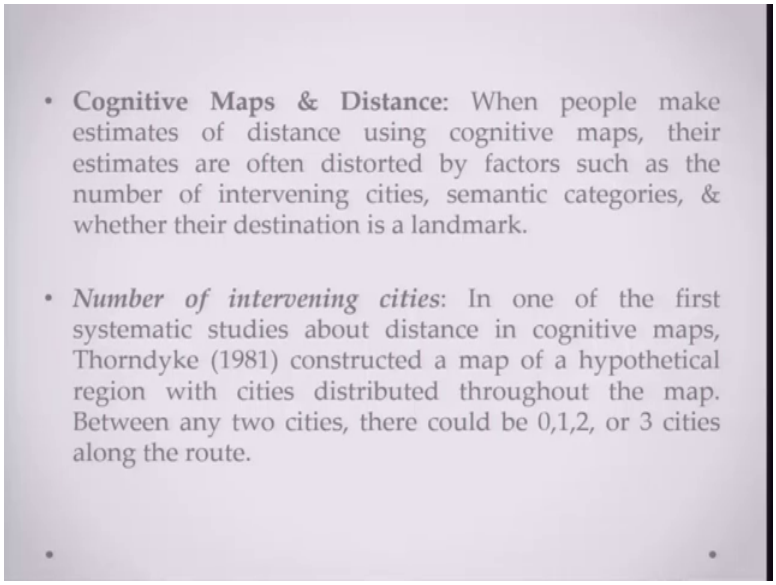
Now, though most of the researchers have opened you know that cognitive maps must be both analog and propositional in nature. For example, our mental map if you are talking about a mental map of the city, now that we have mental map of the city, we will have the spatial layout which is your spatial ability, but it will also have things this and

descriptions like I was talking about earlier you know the McDonalds in X is in XYZ mall which is next to this ABC office building.

So, although you have the spatial arrangement right there in front of you, you would also have these discriptional notes attached to it. So that once you really want to find your way to that particular mall, you can use all of these verbal linguistic cues to make you know to basically ease your tasks through it. So, again that there has been a lot of debate about whether imagery is analog or propositional, there seems to be a sense that Cognitive Maps. Basically involve both kind of representations they basically are taking a more information from both of these places.

Now, I will just try and review some of the basic research related to cognitive maps and then we will see you know what we find here. So, there has been a lot of research with respect to how people traverse distances in these cognitive maps.

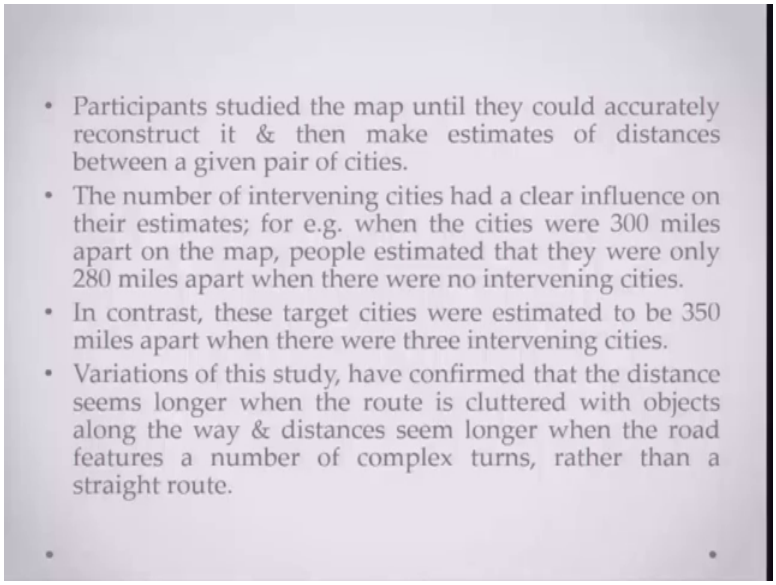
(Refer Slide Time: 12:20)



So, when people are making their estimates of distance using cognitive maps, their estimates have been often found to be distorted by factors such as the number of intervening cities between 2 places, the semantic categories the 2 things belong to or also whether the particular destination they are traveling to is a very important landmark destination or it is a kind of a mundane, non landmark. We will talk about this now. So, number of intervening studies in one of the first systematic studies about distance traversing in cognitive maps;

Thorndyke back in 1981 constructed a map of a hypothetical place, hypothetical region where in the cities were distributed throughout the map. And what Thorndyke asked Sportsmans to do was basically estimate the time that would be taken to travel from point a to point b. And the distance between the 2 cities could be filled up by 1 cities, 2 cities or 3 series or almost there will be no cities as in some cases.

(Refer Slide Time: 13:20)



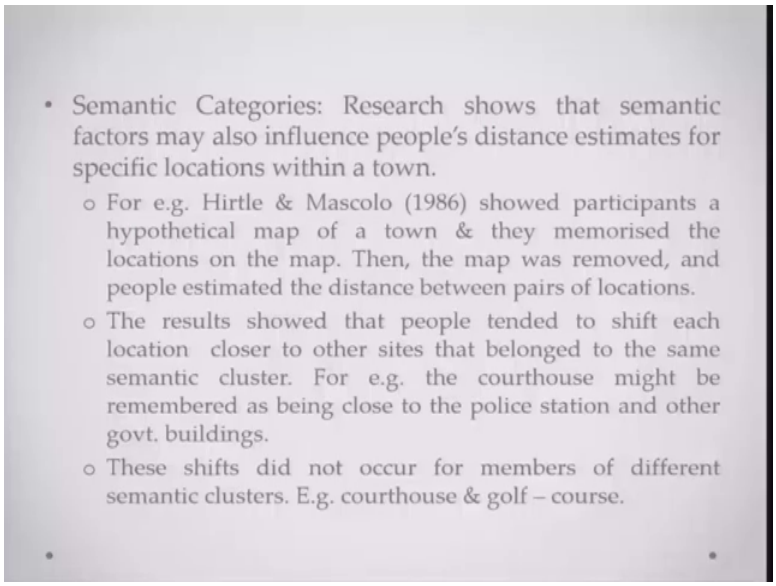
Participants they studied this map, they you know till they could accurately reconstruct it almost. So, they have completely memorized it and then they were making these estimates of the distances between a given pair of cities. The number of intervening cities had clearly an influence on their estimates of distance say; for example, when a particular pair of cities was 300 miles apart on the map, people estimated that they were just 280 miles apart because there were no intervening cities between these shootings.

So, their estimate is getting shrunk because there is no intervening cities between the 2 cities that are in question. In contrast when the 2 target cities are separated by 1 or 2 or 3 of intervening cities, their judgment actually shot up to 350 miles. So, the idea is their judgment is kind of getting inflated by then when there are more number of intervening cities. Variations have also been conducted of the study and where people have confirmed that a distance seems longer when the route is calculated and the route is cluttered with. So, many objects if there are too many landmarks in the middle, there are too many important things in the middle, the distance estimation kind of you know goes

awry also when the road features a number of complex turns rather than a straight route ok.

So, again this was about distance the other aspect is about semantic categories.

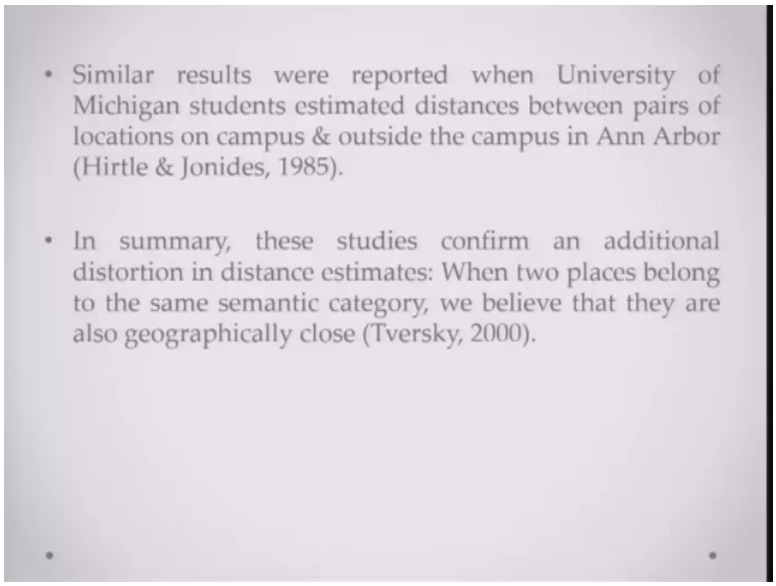
(Refer Slide Time: 14:43)



So, research has shown that semantic factors also influence people's estimates of distance when they are talking about or when they are traversing a cognitive map. So, things like Hirtle and Mascolo in 1986, they actually did this experiment. They showed participants a hypothetical map of a town most like the earlier study and they you know asked these participants to memorize the locations on this map. The map then the map was removed and the people were asked to estimate the distance between 2 locations, any 2 locations on the map.

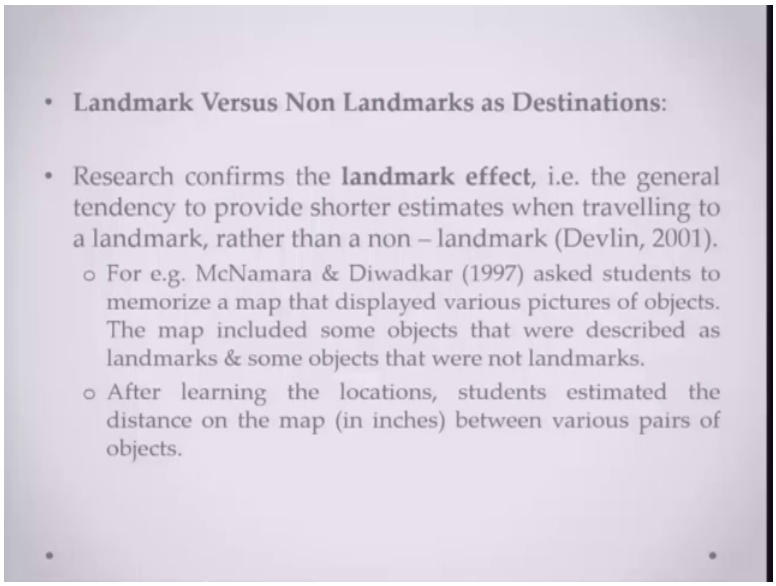
The results showed that people tended to shift location to other sites that belongs to a locations close to other sites that belong in the same semantic cluster say; for example, a coatroom was estimated to be much closer to a police station because semantically they form the same group. In contrast they did not move the courtroom closer to a golf course because again these 2 are very different things. So, again this research says that, if 2 things semantically close together in your head, your estimate of distance about them is also probably kind of getting shrunk.

(Refer Slide Time: 15:47)



Similar results were also reported when the students of University of Michigan estimated distances between pairs of locations on the campus or outside the campus. In summary, these studies confirm an additional distortion in distance estimates: that is when 2 places belong to the same semantic category, we might judge them to be closer together. Again these are sort of findings again experimentally. You can see where all you are using them in your daily lives etcetera. Another very interesting citizen this is why I was referring to you know you are not linking this with your daily life. You might have come across a situation where you know when you are actually going into a very coveted place; you know you are going to vary this famous mall or this particular tourist town.

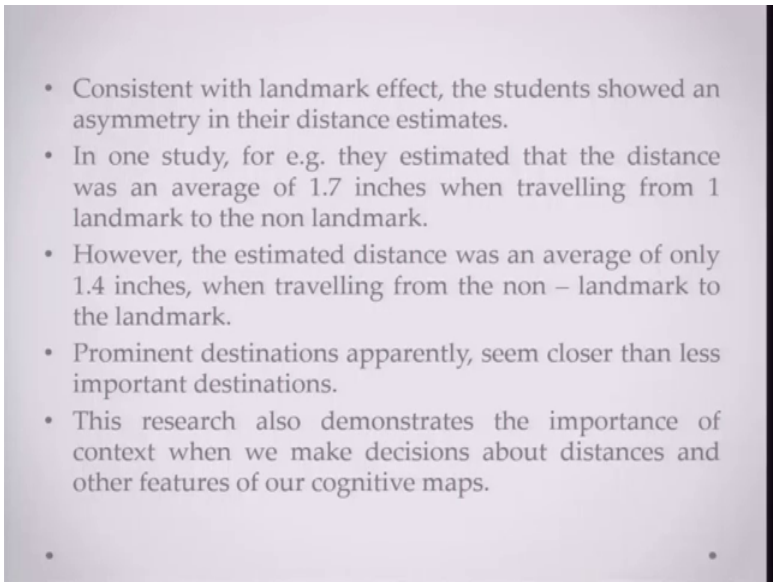
(Refer Slide Time: 16:29)



The distance will traveling towards the tourist town always seems to be lesser as compared to when you are traveling from this important location to a slightly non-important location.

This is pretty much what is referred to as the landmark effect that is, the general tendency to provide shorter estimates of time when traveling towards a landmark rather than towards a non-landmark. This is the classic landmark effect and McNamara and a Diwadkar basically do the studies in 9 this they study in 1997. They are students to me you know again memorize a map with various pictures of objects, that map included some objects that were designated as landmarks, some other objects that were designated as non-landmarks. After learning the locations the students were to estimate the distances of these things on a map between various pairs of objects.

(Refer Slide Time: 16:15)

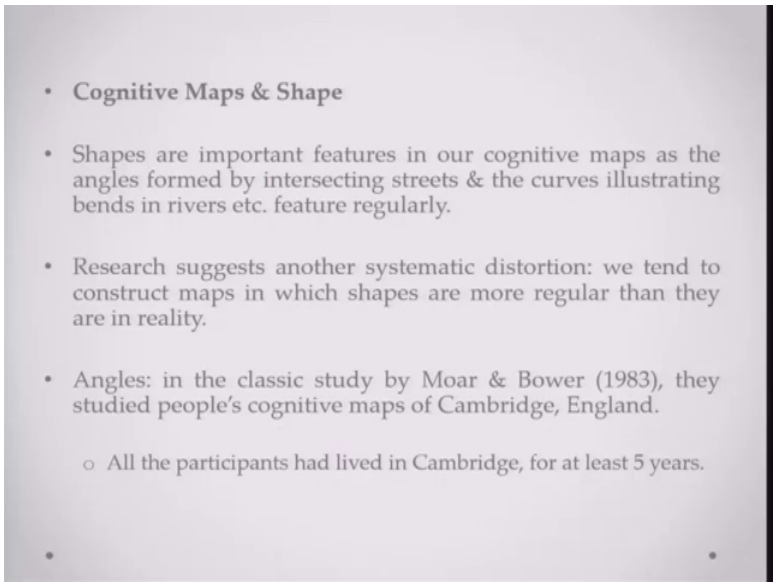


Consistent with the landmark effect the students showed a symmetry in their distance estimates; for example, if you are traveling towards a particular landmark, the estimate of distance was only about 1.4 inches.

And when travelling from the non-landmark to landmark yeah, so when they are traveling towards the landmark, the distance was shortened. It was made up to 1.4 inches. When they are traveling away from that landmark to something else, the distance was stretched to 1.7 inches. So, there overestimating the distance when they are traveling away from the landmark to some other non-landmark place and they are shortening the distance estimate when they are actually traveling towards a particular landmark.

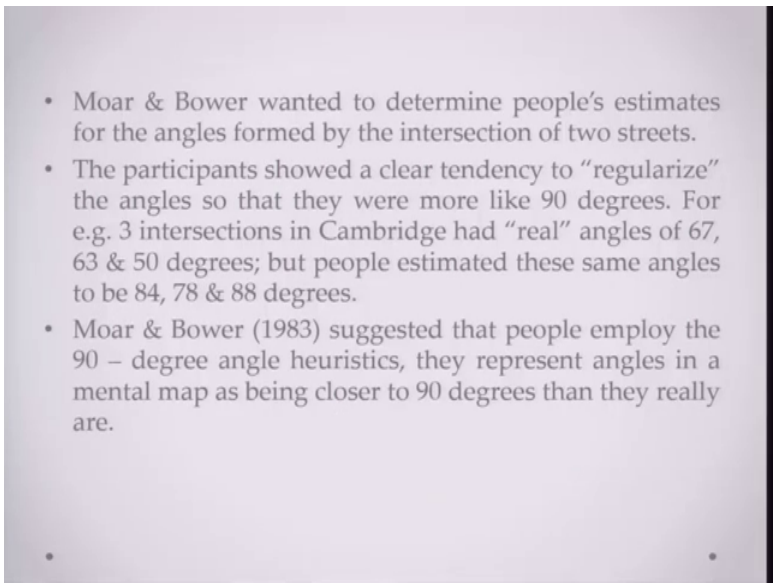
Again this could be affected by so many different factors by expectations, by overall motivation to go to that place and those kind of things. But we see that this is kind of entering your estimate of distance, entering how you navigate with your cognitive map. So, this is again one aspect of research. There is also been some research regarding cognitive maps and shape. So, shapes again shapes are very important features in Cognitive Maps.

(Refer Slide Time: 18:15)



As the angles performed by these intersecting streets and the curves, the illustrate these bending's of reverse and those kind of things are also there. They are the very important information you would like to maintain. Now research suggests that, there is also another systematic distortion we tend to construct maps in which shapes are much more regular than they actually are. And you know say for example, angles in a classic study by Moar and Bower in 1983, they were they wanted to study the cognitive maps of people for the place Cambridge in England.

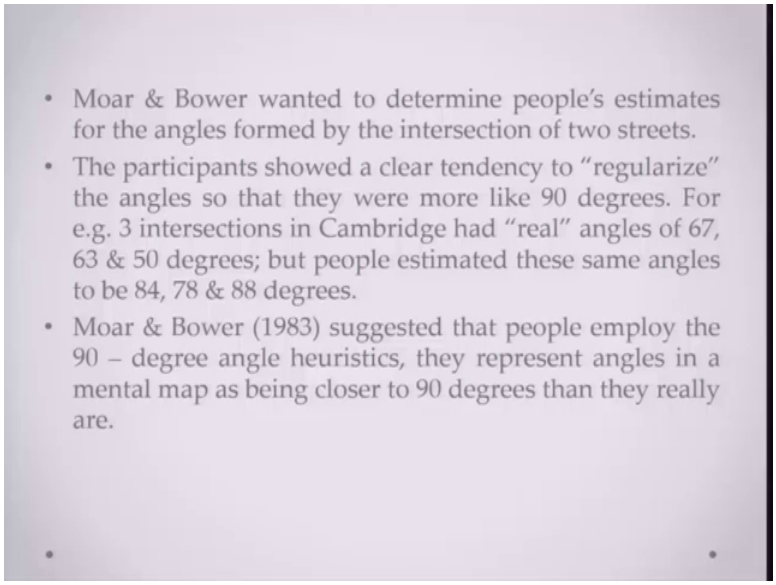
(Refer Slide Time: 18:52)



So, all the participants had lived in Cambridge for at least 5 years and they wanted to determine people's estimates for the angles formed by the intersection of particular 2 streets. They found out that the participants were showing a clear tendency to regularize the angles so that they are more like to it, they are more similar to the 90 degree angles; for example, for 3 intersections in Cambridge, there where the real angles were around 67, 63 and 50 degrees. Participants brakes basically gave the estimates of 84, 87 and 88 degrees, 84, 78 and 88 degrees. The idea is there kind of pushing these estimates more towards the 90 degrees, because 90 degrees almost the perfect intersection.

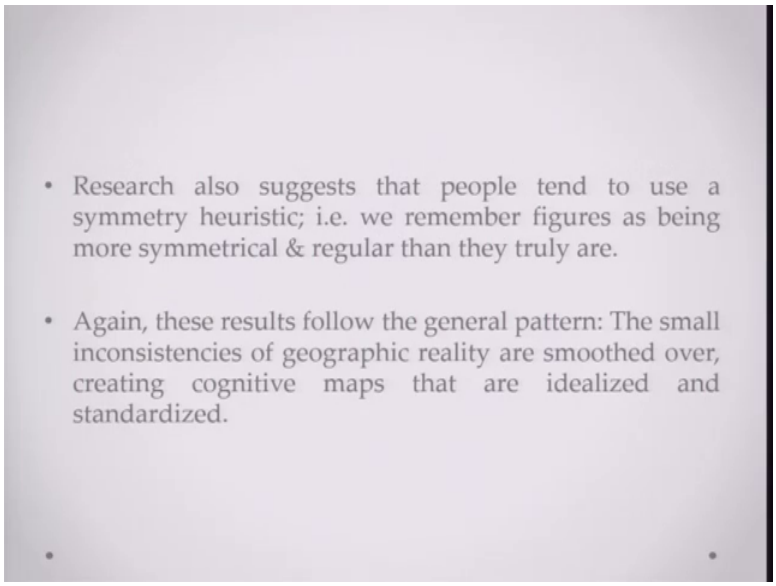
So, the idea is there kind of regularizing and standardizing whatever you are seeing. See in the ideal world everything is not so perfectly geometrical, but we are seeing this, this is one of the biases that we have when you ask somebody to describe you know a particular turn, a particular intersection they are actually doing this almost unknowingly in some sense.

(Refer Slide Time: 19:52)



So, more and more suggests is that people are employing what is called the 90 degree angle heuristics, that is they represent angles in a mental map as me as close to 90 degrees than they really are.

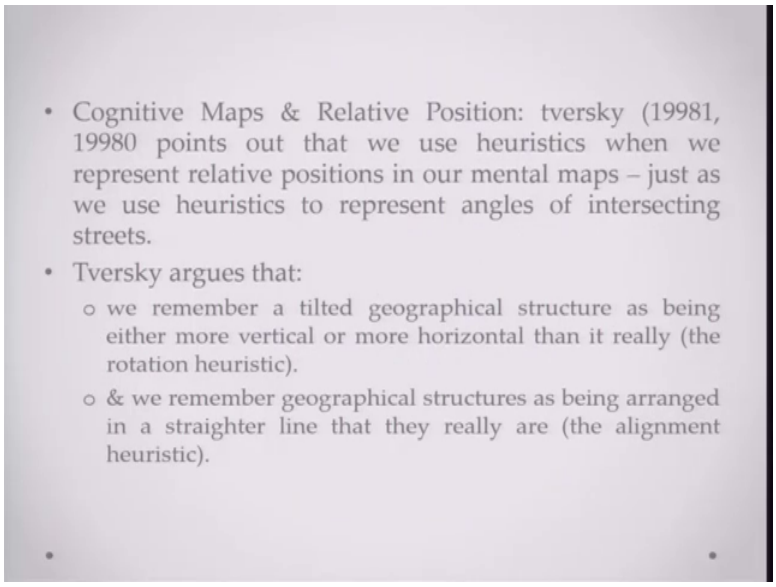
(Refer Slide Time: 20:01)



Other research let us talk about other research. Research also suggests that people can do what is called a symmetry heuristic that is they remember figures as being more symmetrical than they actually are.

So, these results follow the general pattern. The small inconsistencies of geographical reality are smooth over creating cognitive maps that are much more ideal and much more standardized.

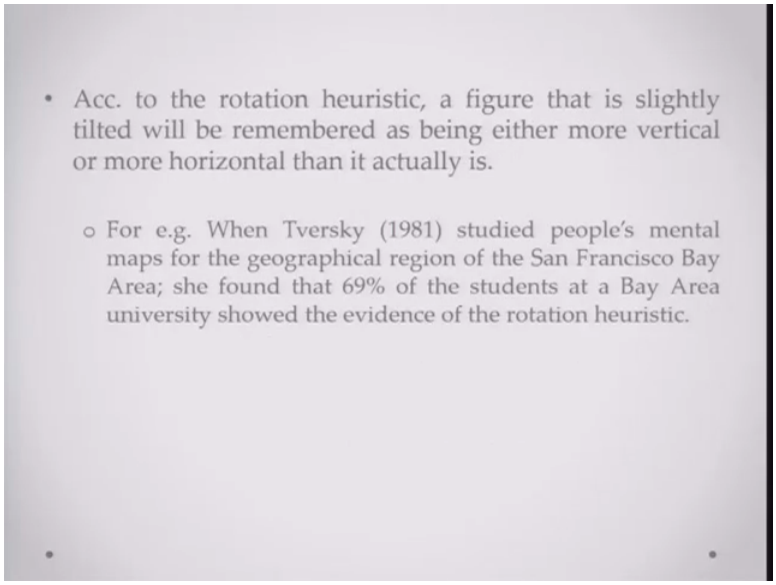
(Refer Slide Time: 20:21)



Let me take an example. So, they did the study wherein they were supposed to estimate shapes of particular place and they actually imagined those shapes to be very regular eyes and very standard. Also there has been research about cognitive maps and relative positions. So, for example, Tversky did this research and it points out that you know, we are using these heuristics when we are also representing relative positions of objects in our cognitive map.

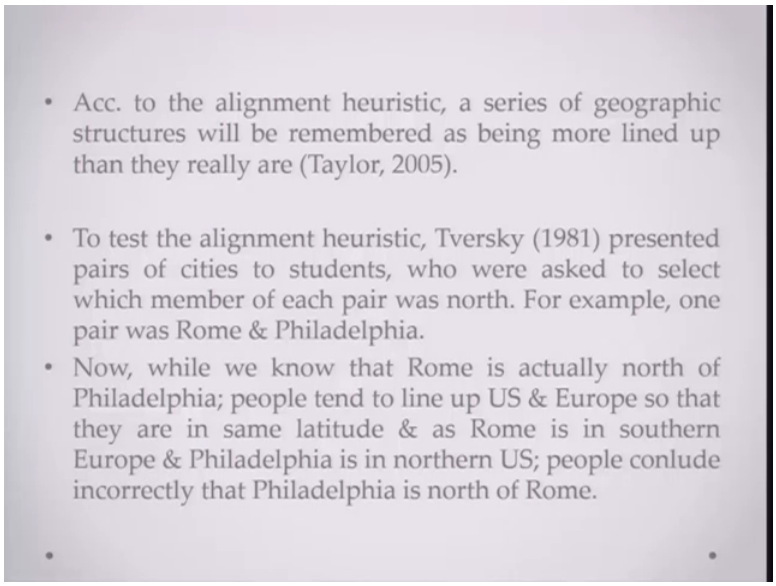
Things like just as we are using heuristics about 90 degree angle or symmetrical heuristic, they are using all of these heuristics to also understand relative position of objects. Tversky argues that we remember a tilted geographical structure, something that is slanted as being either more vertical or more horizontal; this is called a rotation heuristic. Also he says, let me remember geographical structures as being arranged in much straighter line than they actually are. Let us take some examples about this.

(Refer Slide Time: 21:14)



So, according to the rotation heuristic, a figure that is slightly tilted will be remembered as either more vertical or more horizontal. So, when Tversky in 1991, they study a studied peoples mental maps was the geographical region of San Franciscos Bay Area; she found it almost 69 percent of the students at a Bay Area university showed the evidence for the rotation heuristic.

(Refer Slide Time: 21:38)

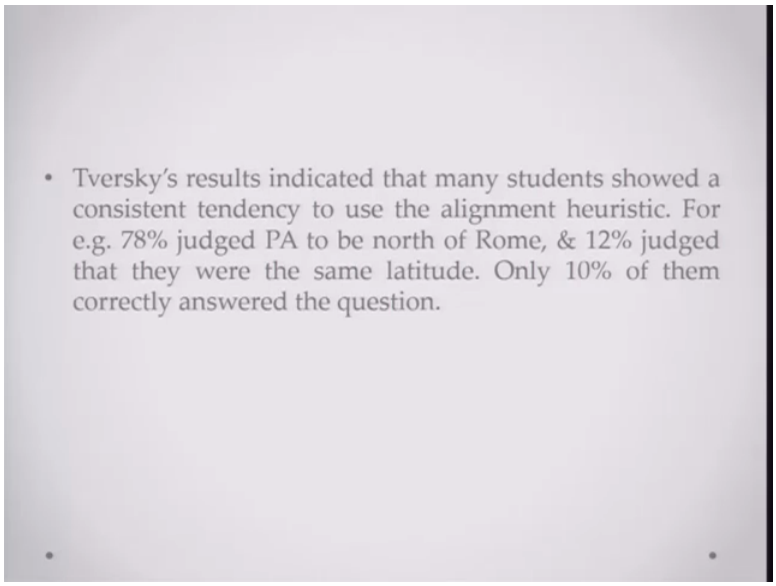


According to the alignment heuristic, a series of geographical structures should be remembered as being much more lined up with each other as you know than they really are.

So, they did this experiment Tversky 1981, represented pairs of cities to students who are asked to actually tell which of their is more towards the north. So, they gave for example, Rome and Philadelphia. Now, the problem with Rome and Philadelphia is north of Europe, Philadelphia in the south of the United States; only actually Rome is in the southern part of Europe and Philadelphia is not part of Europe. Now what people do is they try and align Europe and US in such a way that they are lying on the same latitude. And what results is that, in this kind of description, people conclude incorrectly that Philadelphia is in north of Rome because Rome is in the southern part of Europe, you have Philadelphia in the northern part of US.

So, if you are imagining them as aligned to each other, you will think that Philadelphia is northern and Rome as southern where in actuality you can see the figure here, Rome is actually slightly towards the north as compared to Philadelphia. Again this is an evidence for people aligning the 2 locations close to each other.

(Refer Slide Time: 22:58)



So, Tversky's results indicated that many students are showing this consists in tendency to use the alignment heuristic. For example, 78 percent judged PA to be northern of much north of Rome as compared to only 12 percent judging them at the same, only 10 percent of these people actually gave the correct decision. So, this is all from me about Cognitive Maps. I hope you understood a lot of facts about this and let us meet in the next session.