The Psychology of Language
Dr. Naveen Kashyap
Department of Humanities of Social Sciences
Indian Institute of Technology-Guwahati

Module No. #01
Lecture No. #04
Doing Research in Language - II

Hello, friends. Welcome back to this fourth lecture on, the course on, the Psychology of Language. In the very beginning of it, I will briefly describe to you, what we did in the first 3 lectures. This recounting is helpful, as we can build a context on which, the lectures are flowing. So, this is lecture number 4. Lecture number 1 and 2, I introduced to you, the concept of, what is language. So, we started off, by looking at, animal communication systems, which are primitive language forms.

We saw in detail, some animal communication system like, the honeybee waggle, the distress call, or vervet monkeys, and some other form of animal communication system. We looked at, why animals communicate, through these channels. And then, we looked at, some principles, or characteristics, of this language system. We added on to this, by explaining, how this system is difficult, and easy at the same time. We described, some characteristics, of this language system. Next, we moved on, to the human language system, which is a more comprehensive system.

We looked at, the nature, and principles of the human language. We looked at, laughter as a model system, and described, how human language progress. We looked at the idea of, how human language progress, from a proto language, looked at the characteristic of human language, and how it is different from animal systems of communication. We described in detail, the language system, that humans use, right from the phonology, which is the speech sound, basic speech sound, to morphemes, to a word, to sentences, and to discourse.

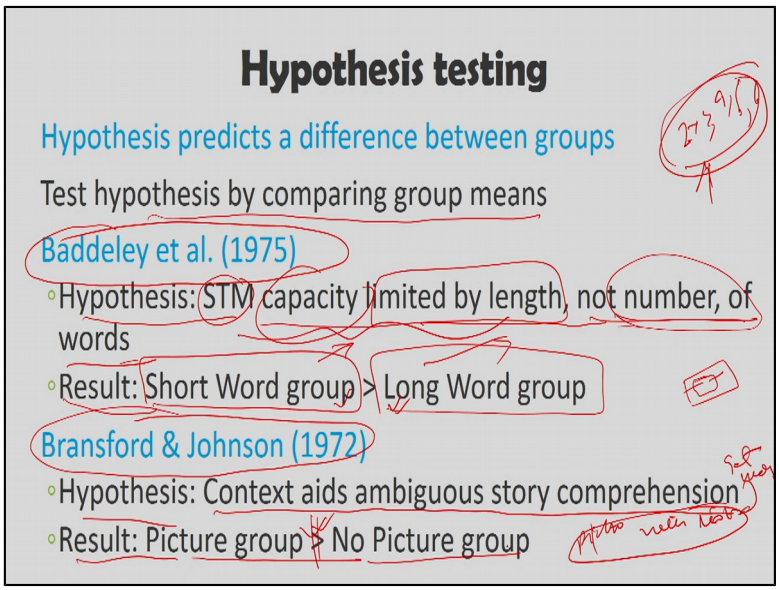
We explained, what is syntactic structures, what is semantics, and what is grammar in language. Then, towards the end, moved up and explained, the evolution of language, how human language evolved. We looked at, the continuity and discontinuity theories of language. One theory saying that, language development is continuous. And, how language develop, follows Darwinian idea, of change across species. We looked at the discontinuity theory, which says that, language developed as one spurt, in one movement of evolution.

We looked at, the idea of Chomsky, where he talks about, language acquisition device. And, this is a brief of, what we did, in the first section. We of course, also looked at, pidgin, which are evidences, of how language would have progressed, from proto language. And so, more evidences towards the, continuity theory of language development, human language development. This was the first two chapters, or first two sections, lectures.

In third lecture, we started off by looking at, how to do research in language. So, we started off, describing a language research. And, the research that we took, the model research that we took, was the development of N400, or that identification of N400, is a ERP marker for semantic incompatibility between language.

We looked at, what is a theory, what is the problem statement, what are variables, and how these variables interact. And, that is the kind of thing, that you are looking at. When we ended off that section, we were at the very core of looking at, what is a problem, what is a hypothesis, and what is an experimental design. The last thing, that we discussed for, in experiments, what is the idea of a, between group, and within group design.

(Refer Slide Time: 04:16)



And so, in today's class, what we are going to do is, continue from, what we have done before, and look at, how do we test hypothesis. So, we described before, what is the hypothesis? Hypothesis, is a tentative solution, to a problem. So, once we set up a problem, any problem, a research problem, this is such problem, so as they talking about, where we left off, in the last lecture, was describing, what are within group, and between group, experimental design.

Now, there we define, in the last lecture, what is the importance of hypothesis. We explained that, hypothesis are answers, tentative answers, to problem statements. Whenever we decide a research, whenever we design a research, we have a problem statement, that we want to test. And, this testing of the problem statement, is done through, testing the hypothesis. So, hypothesis is a solution. So, where does hypothesis actually come from. They come from theory.

So, from the theory, we design some problems. Any theory predicts, some problems. And, they also give, based on evidences, a certain solution. So, what we need to do, is take the hypothesis into the solution, and test it, whether, what the theory is predicting, as answer, is actually the answer to the question, that the theory is providing us. And, how do we do that. By, experimentation. So, in in today's class, these things.

So, what is a hypothesis, then. Hypothesis predicts, a difference between, two groups. So, as we saw earlier, that any hypothesis testing, or experimentation process in research, requires you to have, an experimental group, and a control group. Experimental group is a group in which, the independent variable, the variable of interest, is manipulated. And, because of the manipulation of this independent variable, some change on the dependent variable is noticed. This is the experimental group.

The control group, does not receive the treatment, but then, it does produce a change in the DV. So, with treatment change in DV, is what the experimental group will give me. And, without change in the IV, the results on DV, is what my control group will give me. So, hypothesis is believed to predict, a difference between the groups. How do we test, this hypothesis? Suppose, we make a hypothesis that, N400 markers, Electrophysiological markers, they measure semantic changes, in sentence processing.

For that, we need to group, the experimental group, will have sentences, which are ambiguous in nature. And, the control group, will not have sentences, which are non-ambiguous in nature. And, we will do the ERP's of both the group, on sentence comprehension task. And, when we compare, the mean amplitude, of the ERP waveform, for the experimental group, where which read the ambiguous sentences, and the control group, which have normal sentences, we can say, we are comparing hypothesis. That is what, we do.

So, how do we test hypothesis. The test of hypothesis, is by comparing, group means. So, we run multiple subjects, to the same scenario, and gather, the peak amplitude for waveforms of interest, and what we find is that, for ambiguous sentences, subjects ERP, produces a N400, whereas for non-ambiguous sentences, normal sentences, we do not give the N400 amplitude, in the ERP waveform. So, let us then take, the Baddeley 1975 study, and Bransford and Johnson's study, and see, hypothesis testing is done.

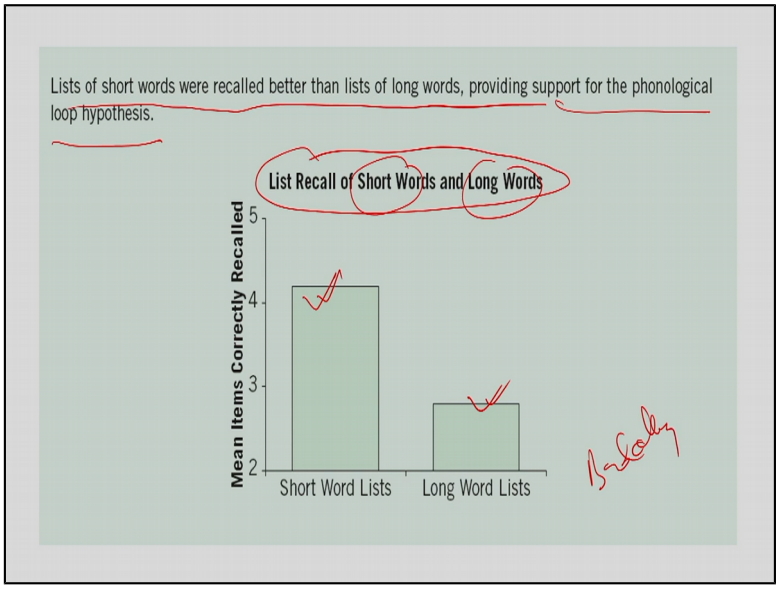
So, the hypothesis of interest in Baddeley study was, STM capacity limited by length, not number of words. And so, this was the hypothesis, that the short term capacity, short term memory capacity, is limited by the length. How long a word is, and not number of words. How many words, which are there? So, the longer a word is, the more space it will take, in short-term memory, rather than, taking a number of words in itself, in camping them together. And, that is not the real reason, being explaining, the capacity of short-term memory.

This is the hypothesis. And, we looked at this research, before. So, when we got our results, in terms of mean, number of words recalled. So, one group received, large varying lengths of words. And, we are looking at the Accuracy, of how many words, can we recall. So, the experimental group was receiving words, which had length of, 2, 3, 4, 5, 6, and so on, and so forth.

And so, the number of words that, they were able to recall, experimental group was able to recall, that was the mean length of word, that can be successfully stored, in short-term memory. And, on the other group was receiving the, number of words. And so, the result was that, short word group, was remembered better, than long word group. So, we had those words, which have small number of letters in it, they were remembered better, than words, which were long.

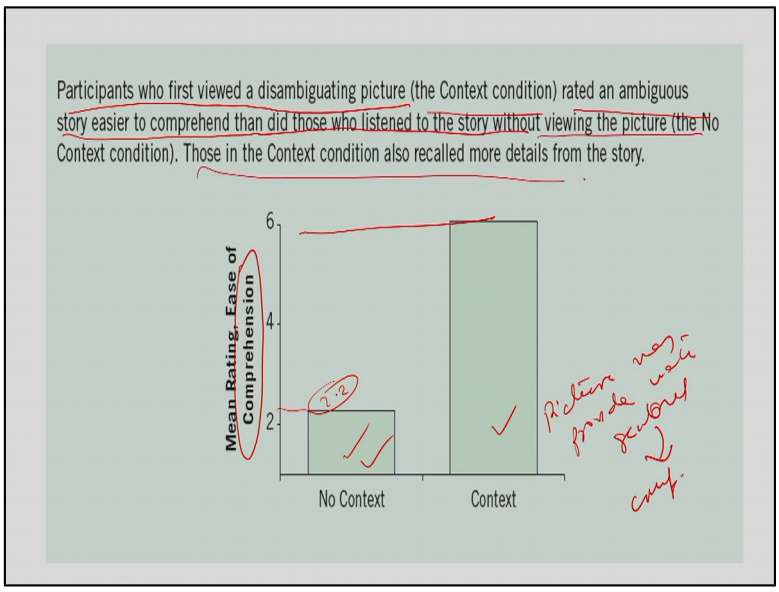
Similarly, the Bransford study in which, the picture, the context, helped us in comprehending, what the text statement it was saying. So, the hypothesis was, context at ambiguous picture comprehension. And, the result was, picture group, was greater than, no picture group. So, when a picture was shown, with text, people were able to get meaning, out of the text more easily, then when, they were shown, no picture.

(Refer Slide Time: 10:19)



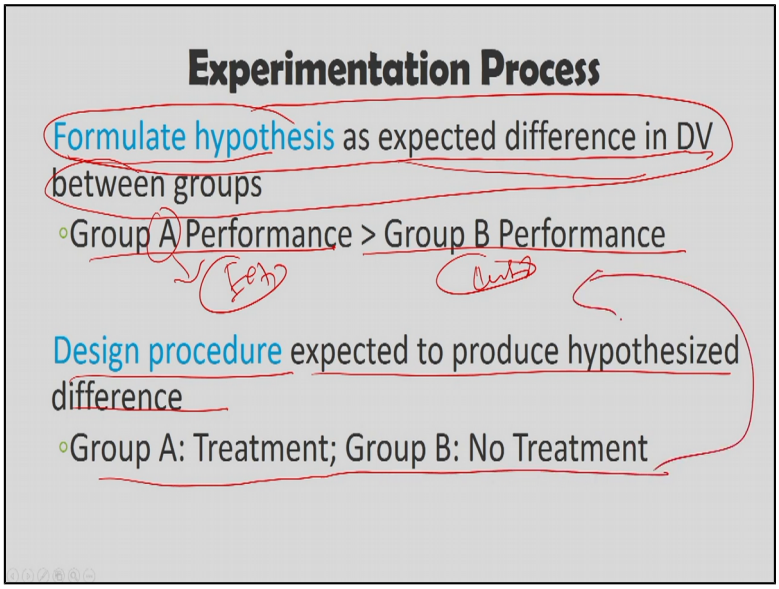
So, list of short words, were recalled better, than list of long words, providing support for the phonological loop hypothesis. Then, there is a phonological loop. So, list of recall of short words, and long words. And, you can see, short words are remembered more, than long words. This is the Baddeley experiment.

(Refer Slide Time: 10:41)



And, this is the context, versus, non-context. So, when picture was provided, with sentence comprehension. So, this is mean rating, ease of comprehension, as you see, it is 6 here, 6 units, and it is 2.2 units, and so on, and so forth. So, participants, who first viewed a disambiguating picture, the context condition, rated an ambiguous story easier, to comprehend, than did those who listen to story, without viewing the picture. Those in the context condition recall, more details from the story.

(Refer Slide Time: 11:22)

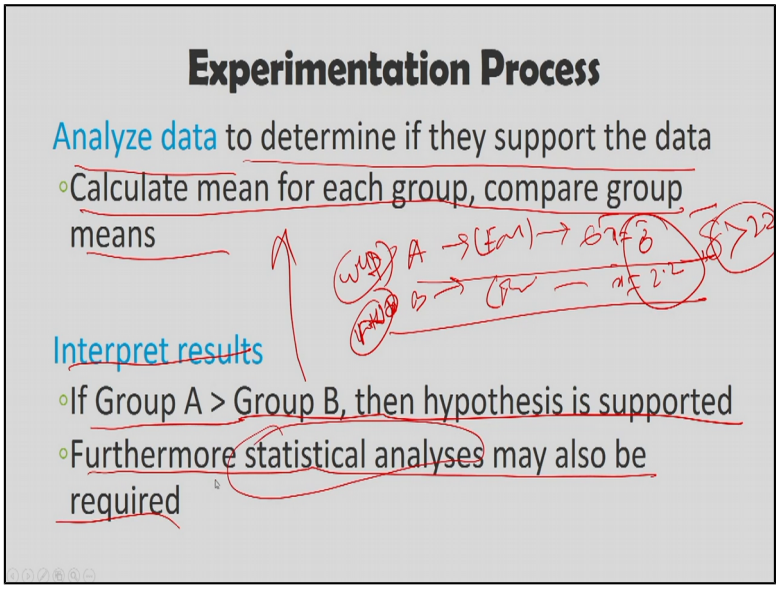


Now, let us look at, how an experimentation is done, the experimental process. So, it starts the experiment, designing an experiment, or the experimentation process, starts by formulating a hypothesis, as expected, differences in DV between groups. So, to start an experiment, we first form a hypothesis. And, this hypothesis suggests that, there is an expected difference between, in the DV, in the DV measure, between groups.

So, in terms of the earlier experiment, the DV measure is, ease of comprehension. And so, as you can see, the hypothesis says that, with context, or hypothesis suggested that, with context was easy, without context was difficult, on terms of DV measure, which is the ease of comprehension. And, that is what, we get. So, group A performance, is greater than, group B performance.

Group A performance is, if you have two groups, A and B. And, let us say that, group A is experimental group, and group B is, let us say, control group. And so, this suggests that, this is what the hypothesis is suggesting, and the results also confirming. Design procedure, expected to produce hypothesized differences. Group A, treatment. Group B, no treatment. As we were, saying the, same thing.

(Refer Slide Time: 12:31)

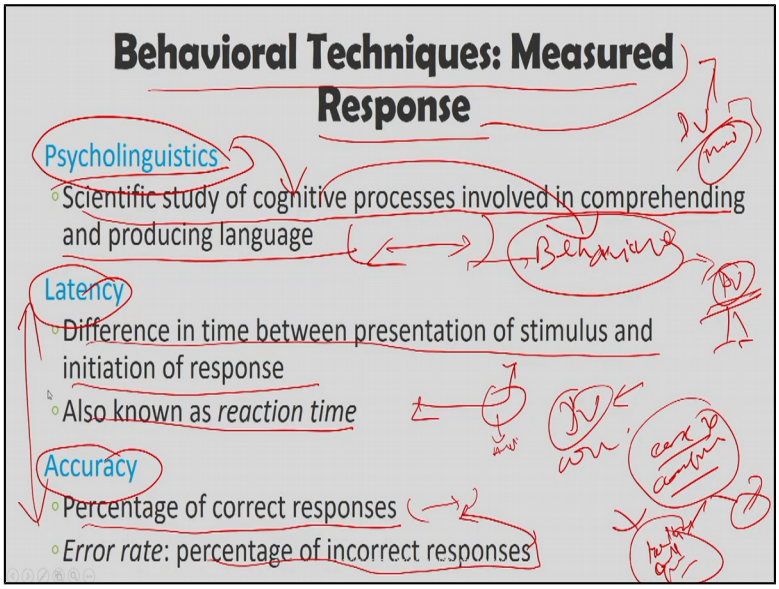


Once you make a group, once we make a design, and once we collect the data, we need to analyse the data. So, how the analysis is done. To determine, if they support the data, calculate mean of each group, compare means. So, let us say, A is the experimental group, B is the control group. And here, ease of comprehension. Ease of comprehension. This is, with picture. This is, without picture. So, picture, and no picture.

And so, ease of comprehension, in terms of DV. So, I get 6, the mean. And here, the mean is 2.2. So, as I compare the mean, the mean for this group is only 2, and the mean for this group is 8. How do we interpret results? If group A is greater than group B, then hypothesis is supported. So, as I said, ease of comprehension 8, is greater than 2.2.

And so, the hypothesis that we have, is supported. The hypothesis says that, with picture, you will be easy, for you to comprehend, ambiguous sentence. Furthermore, statistical analysis may also be required. And so, this is this is very simple, we use mean. But, the more complex a design is, if you are using factorial design, nested designs, nested factorial designs, or any other kind of design, there we might need, more statistical tools, for analysis.

(Refer Slide Time: 13:52)



So, that was the experimentation process of, how we do experiments in research, any behavioral science research, and specific to the language. Now, the behavioral techniques. What are the behavioral techniques, that we use, in doing research in language? In very short form, it is what is the, DV measure. What do we measure in DV's? When we say, an IV is manipulated, so we give picture in one group, and do not give picture in the other group, and look at comprehension, what are we actually measuring.

So, ease of comprehension, has to be defined. An ease of comprehension, can be defined, either in terms of, how many correct, or how many times, you have identified the gist of the story, or it could be in terms of, how quickly you can identify the gist of the story. So basically, in experimental research, there are two measures of DV, that we use. One is called, the Accuracy. The other is called, the Latency.

So, in Psycholinguistics, which is the psychology of languages, scientific study of cognitive processes, involved in producing language. So, psycholinguistic, studies the cognitive processes, which are involved, in comprehending and producing languages. How does it do that? In terms of, behavior. So, it is very difficult, to look at, the cognitive processes, which is involved in language, or production of language, or any language measure. So, what do psycho psycholinguist do. They will give subjects, certain kind of task, and look at the behavioral responses.

And, based on the behavioral responses, then they can think back, predict back, what is the reason, for this kind of a response. And, in doing that, they have to have some kind of a

measure, which is the DV measure, which is, what is the dependent variable, exactly measuring. As I said, there are two measures in experimental psychology. There are two things, that are measured in experimental psychology, whether it is Psycholinguistics, or any other form of Cognitive Psychology. One is Latency, which is also called, the reaction time, how quickly, can you do a particular job.

And then, there is Accuracy. What is Latency? It is the difference in time between, presentation of first stimulus, and initiation of a response. The more-easy a task is, the more automatic a task is, the quicker delinquency. This is also known as, reaction time. So, what are the measure of Cognitive Psychology, or Psycholinguistics, or Experimental Process, is the Latency. The other measure of DV, in a psycholinguistic task, or any cognitive task, is Accuracy. So, Latency will tell me, how quickly, a task is done.

This, quickly can initiate, or can tell us about, several other processes, or a lot about the processes, which are involved. One thing, that Latency point out is that, whether the processes involved, in the question of under investigation, is it automatic or not. Automatic processes, have higher latencies lower latencies. Non-automatic processes will have, higher latencies. If a process is automatic, you should not require time, and show it to me quickly.

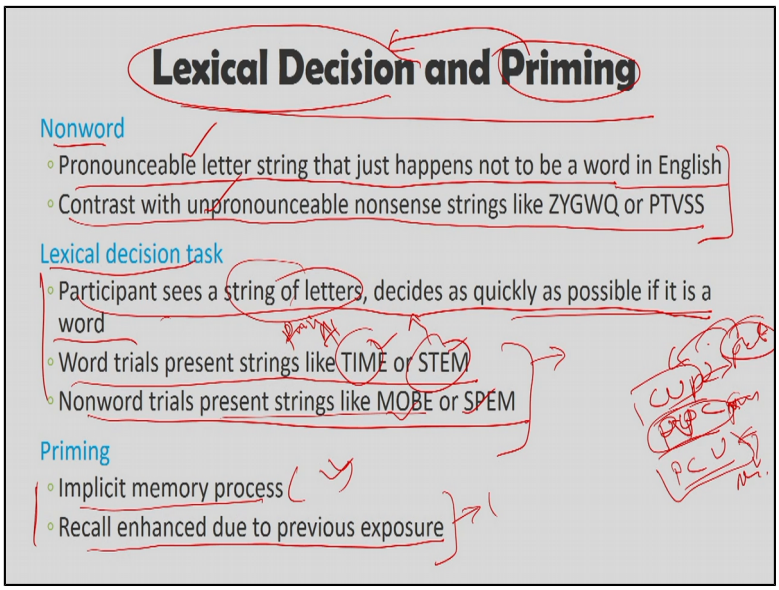
Reflex is an automatic process, and so, Latency will be less. If a process requires you to think, then it should take time. And, that is why, the latency should increase. Another measure, or another DV measure, which is used in Psycholinguistics, or for Cognitive Psychology, that matter, is Accuracy, which is the percentage of correct responses. Now, this will tell me, whether you are able to generate, the correct response or not.

So, it will tell me about the processes, which are involved. The cognitive process involved in in the question and investigation is, in terms of correctness, whether correct response can be, generated or not. And so, it tells me, what are the process, which are involved in, selecting the correct response. Error rate, which is the percentage of incorrect responses. Another interesting thing, which is looked at.

So, the more error, that I am creating, the lower my encoding is, or the worse the process under investigation is. The more error, it is generating, which basically means that, I am not able to get the right answer. And, if I am not able to get the right answer, which means that, there is

some problem with, either the encoding, or something, some cognitive process is not working. And so, that is another measure of Psycholinguistics experimentations.

(Refer Slide Time: 18:36)



The best way to understand, the psycholinguistic process, the easiest experiment to understand, or the model experiment, that that should be Psycholinguistics experiment, that can explain this Latency and reaction time, is the Lexical Decision task and Priming. So, the question is, whether Priming, and what is Priming? Priming is, the help that somebody gets, in perceiving an object, if that object has been shown to him before.

If a partial object, a part of an object is shown to somebody before, will that help him in identifying, the object again, at a quicker speed, that is Priming. So, if I tell you about somebody beforehand, some information about somebody beforehand, it will be easier for you, to identify that person. Somebody goes to meet your friends on an airport. When you are going to welcome some stranger. And so, if we get some information, that he is wearing this dress, he is looking like this, this is called Priming.

The more information you have, the easier it will be for you, to locate that person, in the arrival hall. And, that is basically what is Priming, in very easy words. So, a Priming task. What I am going to explain to you, is a Priming task. And, we look at, whether Lexical Decision-making, is affected by Priming. What is Lexical Decision tasks? Lexical Decision task is, finding out whether a word is, whether a given group of letters, is a word, or non-word.

C, U, P, CUP, is a word. But, U, P, C, is a pronounceable non-word. And, P, C, U, because, you can ah. P, U, C, is a word. But, P, C, U, is a non-pronounceable. Because, I do not know, how you pronounce it, PICU. It requires a I. And so, it is a non-word. This is a word. This this is a pronounceable non-word. And, this is a non-pronounceable non-word. And so, the question in the study, in this particular experiment was, whether showing a word related to this cup, maybe a plate, whether this helps, in identifying, at a letter experiment, whether you can identify a cup or not.

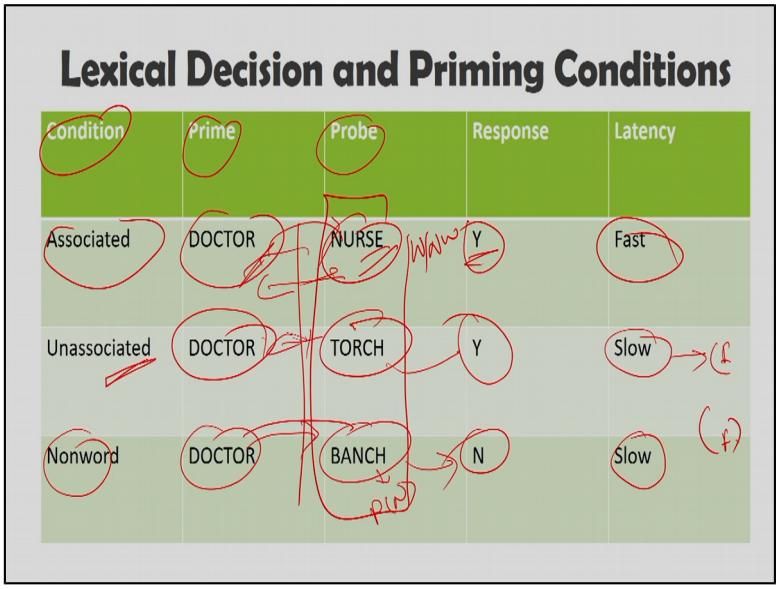
So, subjects were given, some words, to learn. And, later on at their arrival, they were given, an associated word. And, they had to quickly decide, whether this word, was a word, or a non-word. So, non-words, these are pronounceable letter strings, that just happens to, not like to be a word in English. Contrast with unpronounceable nonsense strings, like this. So, you have, non-words are of two types.

One is pronounceable. The other is, unpronounceable nonsense word, non-words. And so, Lexical Decision task. Participant, sees a string of letters, decides how quickly, as quickly as possible, if it is a word, or a non-word. Word trials present strings like, this. Non-word trials present string like, this. And so, when the string is coming here, and the subject has to decide, whether it is a word, or non-word. Just before this, you either see prime, which is a word, and you see a prime, which is a non-word.

And so, let us let us that is how, you actually are supposed to see, whether Priming affects, Lexical decision task or not. So, the Lexical Decision task is an easy task. All you have to do is, participants see a string of letters, and quickly decide, whether it is a word or not. There are two trials. One is the word trial, in which, you see a word, time, or stem.

Or, in the non-word trials you see, words like this, which are pronounceable. What is Priming? It is an implicit memory process, as I said, your own to know, or you are not able to decipher, whether you have been primed or not. And, recall enhanced, due to previous exposure. So, basically Priming, what Priming does is, it enhances your memory, for that particular word.

(Refer Slide Time: 22:39)

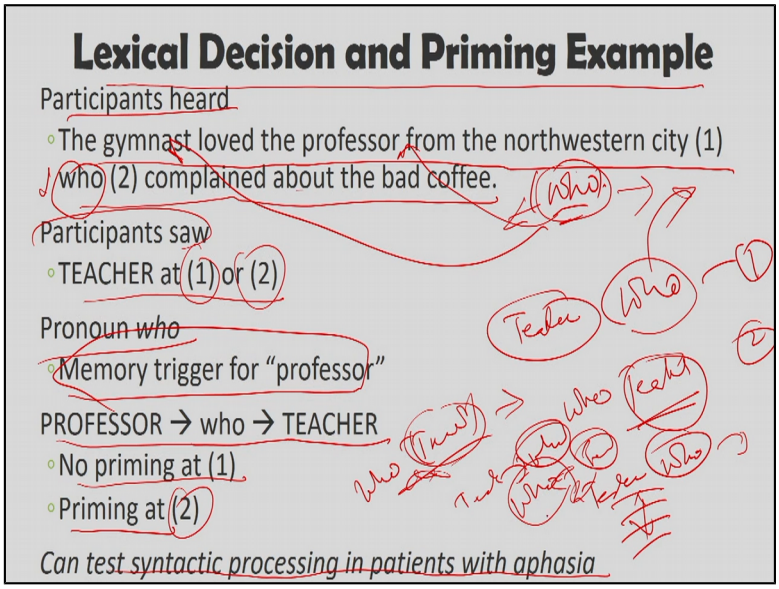


So, this is the chart of, how this experiment was done. In the associated condition, people saw a prime, just before the probe. Just before the nurse was shown, people were shown doctor. And, the response, that people, and the question was, whether it is a word, or non-word. And, people said, it is a word. And, the latency was fast, because they were already primed. Now, when doctors and nurse goes together, and so identifying nurse is a word, when doctor has already been shown to you, was easier.

In un-associated condition, a doctor was matched with a torch. Now, these are not associated words. These are associated words, and non-associated words. So, although people, did identify torch, as a word, but they were slow. Because, this was not Priming. This doctor, was not helping, torch. Doctors and torch, do not go together. But, doctors and nurse, do. Un-associated condition, doctor was matched to banch. The banch is a pronounceable non-word.

And so, in this case, people said, it is not a word, but it was very slow. And so, doctors was not actually Priming it. In this case, the Latency was faster than, this one. And so, what we were trying to find out is, whether the time taken for you to verify, this probe, this word, as a word, or non-word, whether this was faster, when it was preceded by a prime, and whether this works for, words and non-words.

(Refer Slide Time: 24:10)



Another kind of Lexical Decision and Priming example is, participant heard, the gymnast loved the professor, from the north-western city, who complained about bad coffee. Now, the question here was, to look at, how relative pronoun, tell you are. Relative pronoun, as you can see, when I say, who complained about, or the relative pronoun, who, this who, is actually representing the professor, and not the gymnast.

And, we are seeing that, how this is done. How efficient the relative pronoun is, is explaining the professor. So, participants saw. And so, we were testing whether, this who, if it is primed by a word, related word, and a non-related word, whether subjects were able to identify the meaning, so quickly or not. And so, participants or teacher, at 1 or 2, before who. So, they saw teacher, the prime word, teacher, before, who, was presented in one condition. In the second condition, they saw, teacher, presented after, who.

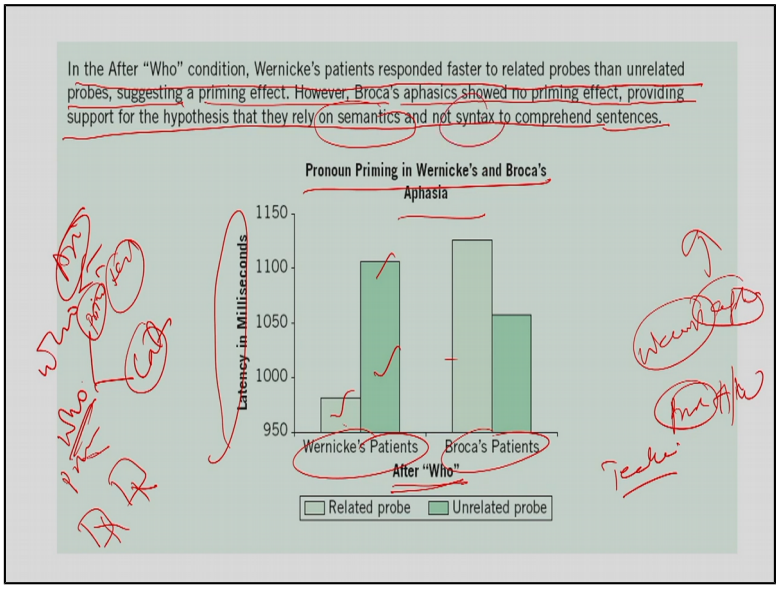
The noun, who, it triggers the memory from the processor professor. And so, that is what, we are trying to look at, whether this relative pronoun was, how quickly they were, when this, who was there, how quickly this, who was able to identify them, every for the professor. Professor, who, teacher, this is the relation. So, no Priming at 1. So, when teacher was presented before the word, who, people were not, people took more time to verify, what, who is specifying.

But, in terms, when, who, was followed by teacher, and they were asked the questions about, what, who is specifying, they were faster in telling that, it was specifying the professor, and not the gymnast. So, we can test syntactic processing in, participants with aphasia. So, this is

important for aphasics. Or, this kind of experiment is important for aphasics. Aphasics are those people, who are not able to comprehend sentences.

And so, here we saw that, when the prime word, which is teacher, was presented before the relative pronoun, it had no effect, whatsoever, on how quickly, the trace for, memory trace for professor is generated. But, if it is, the teacher, the prime word was presented, just after the relative pronoun, it was producing, or people were able to verify, professor, memory for professor faster.

(Refer Slide Time: 26:43)



As you can see, in the after "who" condition, Wernicke's patients responded faster, to relative probes than unrelated probes, suggesting a Priming effect. However, Broca's aphasics, showed no Priming effect, providing support for the hypothesis, that they rely on semantics, and not syntax, comprehension. And so, Wernicke's people, people who had Wernicke's aphasia, those people can produce sentences, a lot of sentences, but they cannot understand the meaning of it, in terms of, what the sentence is saying.

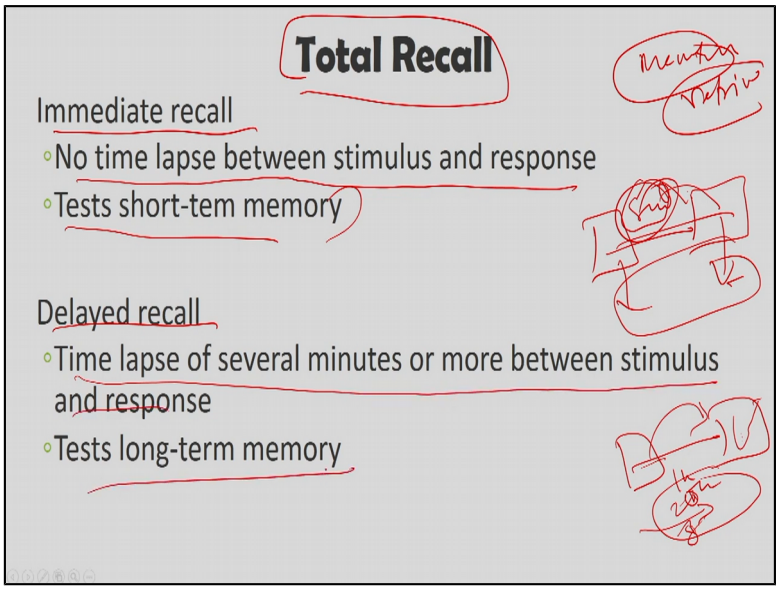
Broca's aphasia, on the other hand, people with Broca's aphasia, are not able to produce. They can understand the meaning, but they will not be able to produce, the sentence itself. And so, that is what, what the test was, where the Priming was affecting people from, Broca's aphasia, or Wernicke's aphasia. And so, Pronoun Priming in Wernicke and Broca's aphasia, as you can see, Latency in milliseconds. Wernicke patients. Broca patients.

As, Wernicke's patient, after who condition, a related probe, versus, the unrelated probe, so if teacher was presented. So, first we found out that, after who, the thing is working. The prime is working, only after, who. And so, what we did was, in one case, I presented people with. So, in people with Wernicke's aphasia and, both with Broca's aphasia. In one case, I gave a related prime to, who. So, the who, was actually the, professor. And so, I presented, teacher here.

In the other case, I presented cat. And so, I wanted to know, whether cat, led to faster identification of the memory of, professor, a faster identifying, the word, professor, as represented by, who, then, when cat was doing it. And, I tested it, in Broca's and Wernicke's aphasia. And, what I found, it is Wernicke aphasia. After who, for related probes, people took faster, people were faster.

But, for unrelated probes, they were less. In, Broca's aphasia, it was the other way around. Which means that, Wernicke's aphasia people, are able to not process the meaning. But, Broca's aphasia people, are able to process the meaning, but they are not able to, process the sentence itself, produce the sentence itself. Broca, rely on semantics, and not on the syntax, to comprehend sentences.

(Refer Slide Time: 28:59)

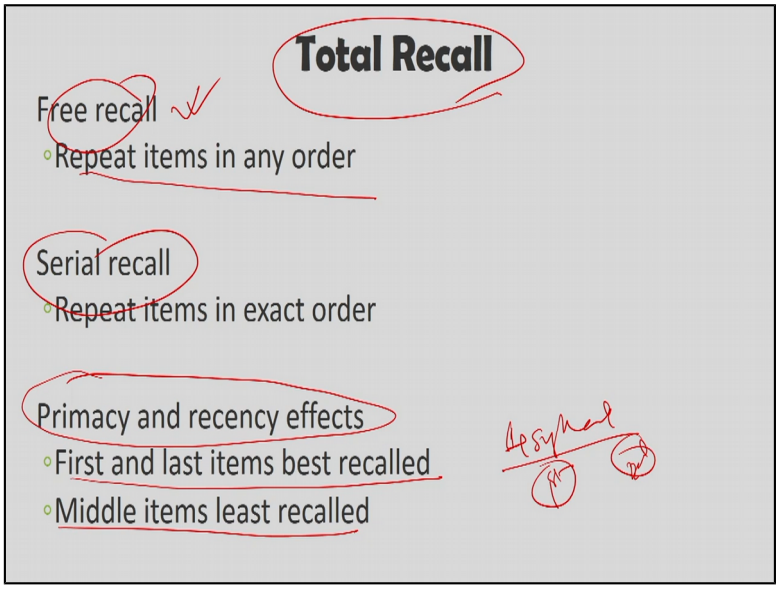


There are certain other things, that we measure. Certain the ways, that we measure. Memory in linguistics, in Psycholinguistics. One way of measuring responses, or memory responses, for sentences, or for structure, sentence structure, in Psycholinguistics, is in terms of, memory. So, there are two types of memory retrieval, that we use in Psycholinguistics. One is called, the Immediate Recall. The other is called, the Delayed Recall.

So, if I give a subject, a sentence to learn, and if I ask them to retrieve back the sentence, this is called, Immediate Recall. But, if I give a subject, a sentence to learn, and after a delay of sometime, let us say, 1 hour, or 2, 20 hours, or maybe 5 days, and they come back, and do the retrieval, this is called, Delayed Recall. So, no time lapse between, stimuli and response. So, if people are processing sentences, based on semantics, on syntax rather, then these people will have, better memory here.

But, if people are using, semantics for processing sentences, then they will have, even after 20 hours, or 2 days, the sentence will be easily processed, and the gist will be easily recalled back. So, Immediate Recall, no time lapse between, stimulus and response. And, the tests are, short-term memory. On the other hand, in Delayed Recall, time lapse of several minutes, or between stimulus and response. And, it tests, long-term memory.

(Refer Slide Time: 30:33)



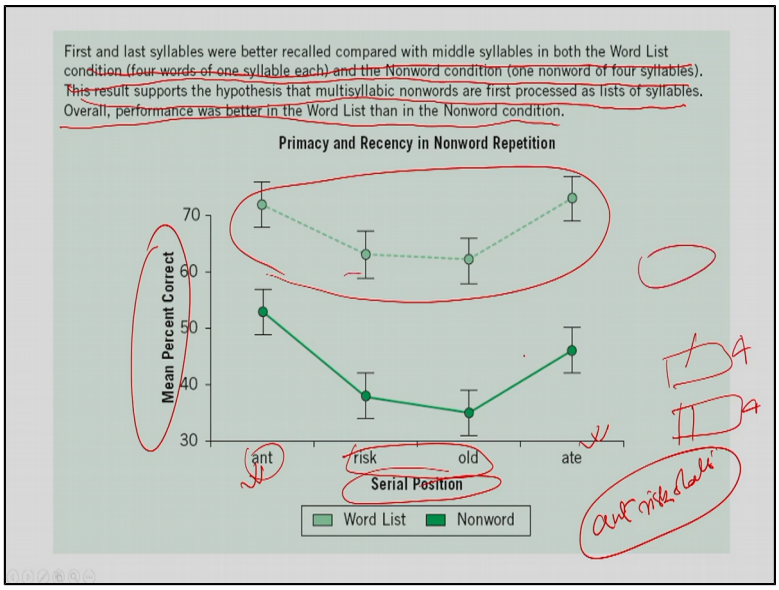
This recall, can be of, three types. We can have, Free Recall, repeat items in any order. So, I give you a list of words, to remember. And, if I at recall, at retrieval, I asked you to produce the words back, in any order you want, in any random order you want, it is called Free Recall. This is a Serial Recall. Here, when you recall back the words, you have to follow a particular order of recall. As you learned it, you have to recall it back. And, there are something called, Primacy and Recency effects, that you see in, words.

First and last items are better recalled, then middle items. Which basically means that, if I have a word with 3 or 4 syllables, the first. So, if I have, a 4 syllable word. The first syllable, and the

last syllables, are remembered better. And, this is called Recency Primacy effect. You are sitting in lectures, by professors. So, when you are in that lecture, the professor is speaking to you, and suddenly bla, bla, bla, bla, bla, and some new words, comes in. It is a, 8 or 10 syllable word, or maybe 4 or 5 syllables, 6 syllables word.

As soon as, he produces the word, you tend to ask your friend, what did he say, that word. And so, what the friend says, he says, and something-something, a bleah, or bleah. It basically means that, you understood the first word, and the last. First syllable, and the last syllable, in between, you could not hear. And, that is how, what is Recency Primacy. Recency is, remembering, recently produced syllables, which is still undergoing. And, Primacy is, remembering those syllables, which have been produced, at the beginning of a sentence, beginning of a word. And so, this is Primacy and Recency.

(Refer Slide Time: 32:17)

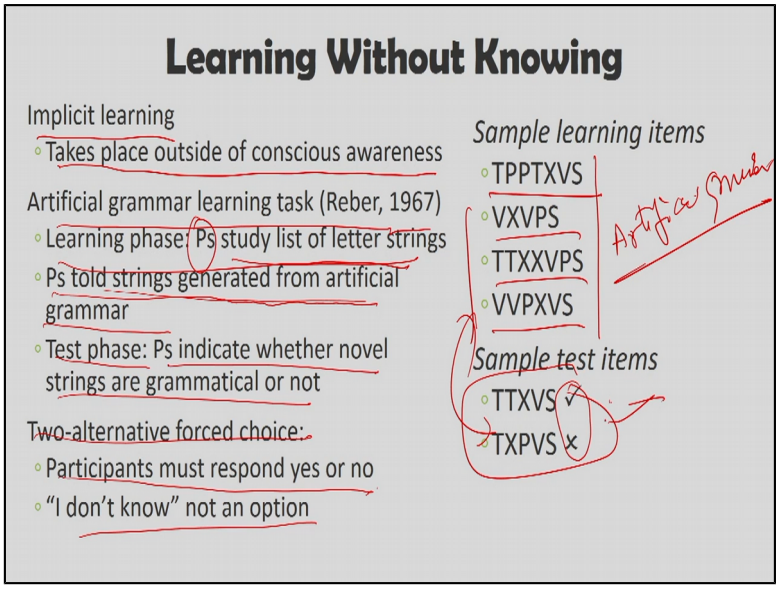


So, first and last syllables, were better recalled, compared to middle syllables, in both the word list. Condition, 4 words of 1 syllable each. And, the non-word condition, 1 non-word of 4 syllables, were given to people. This is the result, which supports the hypothesis, that multi-syllable words are first processed, as lists of syllables. Overall performance is better than, wordless, than non-word condition. So here, what happened is, word and a non-word was used. And, 4 syllable word in, non-word.

And so, it was found out that, Primacy and Recency, happens in, a word and a non-word repetition. As, you can see, this is the Mean Percentage Correct, this is the Serial Position. So, the word here is, ant, risk, old, ate. Ant, risk, old, ate, is the word. And so, when this was

presented to people, people were able to remember, ant and ate, faster. Then, risk and old. And when, it is a non-word, what represented a non-word, the whole word was repeated. And so. As you can see, the Primacy and Recency happens, both in the word and the non-word.

(Refer Slide Time: 33:24)



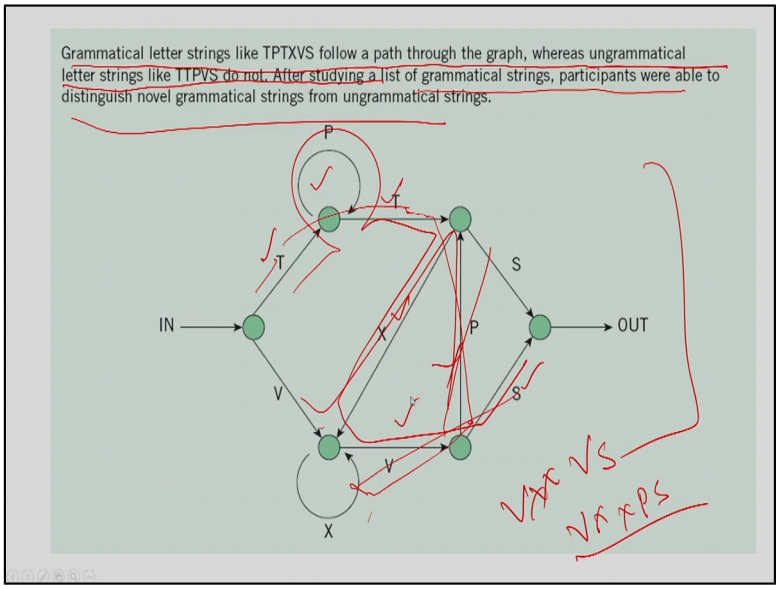
Now, sometimes, people also learn implicitly. For example, grammar is something, that we learn, implicitly. When the wrong sentence is produced, before us, we can immediately say that, something is wrong with the sentence. But, we are not able to pinpoint, what is wrong with the sentence. So, what is it. That is because, we learn grammar, implicitly. What is implicit learning. Takes place, outside the conscious awareness.

And so, what Reber did was, he created an artificial grammar. So, he produced certain sentences, or group of words, following an artificial grammar. And then, he gave these subjects, these words, to remember. He also said that, an artificial grammar is being used, to form these sentences. So first, he formed some words, with an artificial grammar. So, sample items, like this. And, he showed people, these words. And, he said that, these are produced, out of an artificial grammar.

Later on, at tests, he showed people, these words. And, he asked whether, these words are following, the same grammar, as these words are following. What he found out is that, people were able to decipher, the artificial grammar. So, Artificial grammar learning task, Reber, 1967. Learning phase, subject study list of letter strings. Sub the p the Ps told subjects, the participants were told, string generated from artificial grammar.

So, this is participants. They studied, the list of letter strings. Then, they were told that, the strings are generated from an artificial grammar. In the test phase, the participants indicate, whether novel strings are grammatical or not. Two-alternative forced choice response task was there. Participant must respond, yes and no, cannot say, I do not know. So, they have to either say it is, this this or this.

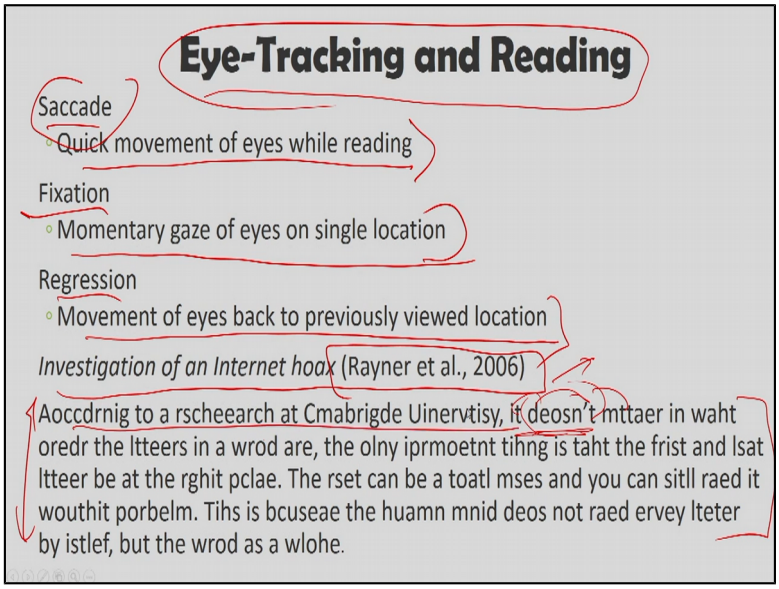
(Refer Slide Time: 35:18)



And so, this is the task. So, the Grammatical letter string tasks, follow a path through which, the graph, whereas ungrammatical letter string like, T T P V S do not. So, as you can see, T P. So, T P T X V S is allowed because, this is the forward arrow. This is, how much intense is following. But, if I say, T N T P V S, this is not allowed. T V S, this is not allowed. So, after studying a grammar string, participants were able to distinguish, grammatical from non-grammatical.

So, people were able to generate this grammar that, T and 2 P's or V. And, X and X, N number of text. So, V X X or X X V S is can be generated. But, V X X P S, cannot be generated. Because, this string is not allowed. Right. And so, that is what the task, was all about. And so, from that Reber was able to understand that, people were able to decipher implicitly, the grammar of a sentence.

(Refer Slide Time: 36:44)



These are, some of the ways, or some of the techniques of doing research, in Psycholinguistics. Another interesting thing is, Eye Tracking and Reading. And so, how does the eye move around. So, when you read something, how does your eye reads. So, the eye does two moments. One is called the circa the Saccade, the other is called the Fixation. So, whenever it is reading, what it does is, it fixates from the first word and the last word, and keeps on jumping between words.

The brain fills the, between words. So, it does not read the word, completely. It reads the first word, or the first letter, and the last letter of a word, and the brain completes it, the whole word for the eye. That is how, eyes do. So, I um make something called, Saccade. These are quick movements of eyes, while reading. And then, there is fixation, momentary gazes of eye, on single location.

So, if something of interest, if the first word and last word, is read through a saccade of the eye, and if the word is a non-word, or if the word does not match the context, the eye does longer fixation. And, that is how, the eye reads. It does not read, the whole word. What it reads, is part of words. The first and the last sentence, and keeps on jumping, across from one word to next word, across the sentence. And, that is how, it reads.

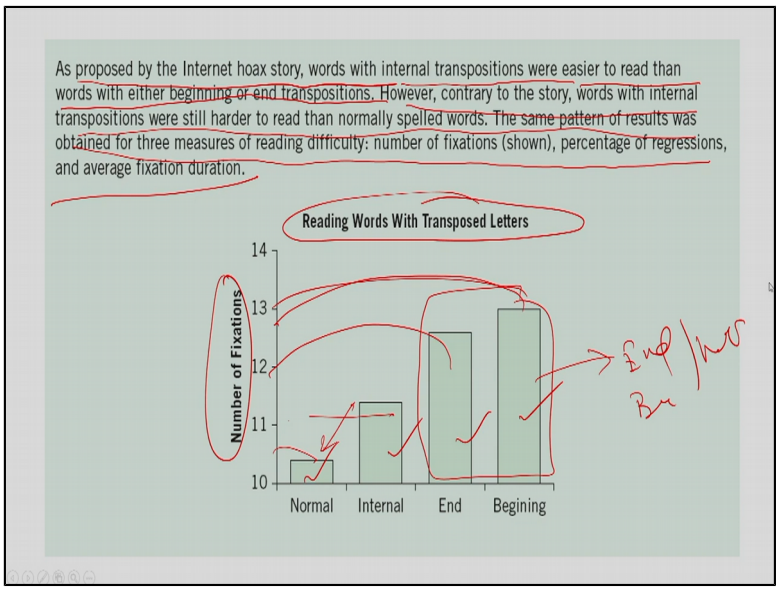
Because, had that not been the process, that would have taken, or it would take forever, to read a text. Now, so the two processes, one is called Saccade, the other is called fixation. And Regression is, the movement of the eye, back to the previously viewed location. Is something wrong, is with the word, the eye will move back, to the previous location, to correct it. This is

how, the eye fixations actually work. And, to prove, that eyes do not read the whole word, I have here.

So, Investigation of an internet hoax, Rayner, 2006. If I ask you to read this, most people will be able to. And, this is because, the eye is not treating, each word. And so, it is very easy for us, to reshow. According to research, at Cambridge University, it does not matter, in what order, the letters of a word are. The only important thing is that, the first and the last letter, be at the right place. The rest can be, a total mess. And, you can still read it, without problem. This is because, the human mind, does not read, every letter by itself, at the word as a whole.

As you can see, I am perfectly able to read this. But, this is not according, neither this spells research, neither this spells Cambridge, neither this spells university, neither this spells does not, so on and so forth. So, how am I rea able to read it because, the eye is jumping, between these letters, making saccades and fixations, and so. Since, does not fits with, the context of it, and matter, and from what I am reading, it is easier for us to read. Do it for yourself, and you will see that, it is easier.

(Refer Slide Time: 39:40)

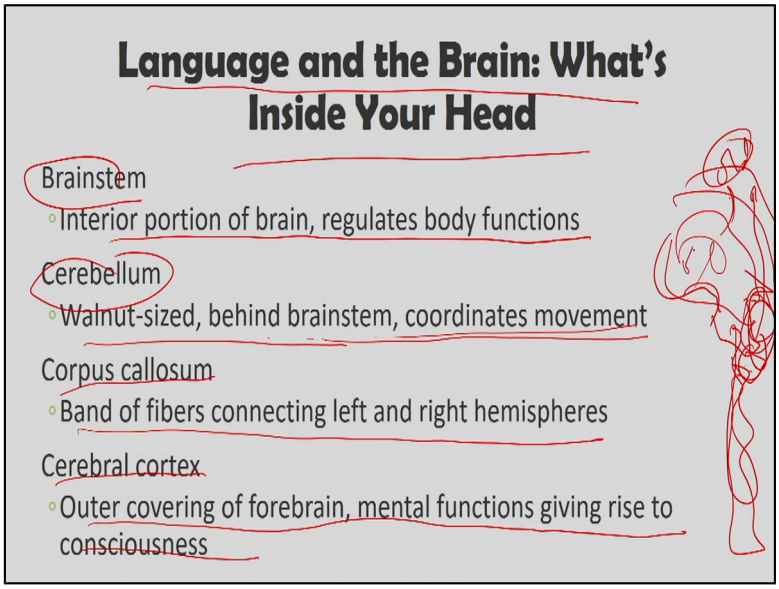


So, as proposed by the, Internet hoax story, words with internal transpositions, were easier to be read, than words with, either beginning or end transpositions. So, if I replace, the first word, and last word, the first letter, and last letter of a word, then people will not be able to read, the word, correctly. But, if I replace in between items, people will still be able to read, words correctly. And, that is what, the internet hoax was about. And, that is what, tis they showed.

So however, contrary to the story, words with internal transpositions, were still harder to read the normally spelled words. The same pattern of result was obtained, for three measures of reading difficulty, number of fixations shown, percentage of regressions, and average fixation duration. So, these number of fixations, reading words with transposed letters, normal, internals, end, and beginning. So, with the beginning, number of fixations were more. With the end transposition, it was less, still less, but normal.

And, this is internal. So, with internal, the number of fixation did not increase, but not to this level. So, if you make transpositions, from the end and beginning, letter of a word, then fixations are harder, or regressions will be more. Why regression? Which means, that the eye has to look back, at the word. Why it will be there? Because, it is doing Saccade. It is jumping. And so, I have to spend, more time onto it. This is another interesting research, in Psycholinguistics, and using the Experimental Methodology.

(Refer Slide Time: 41:10)



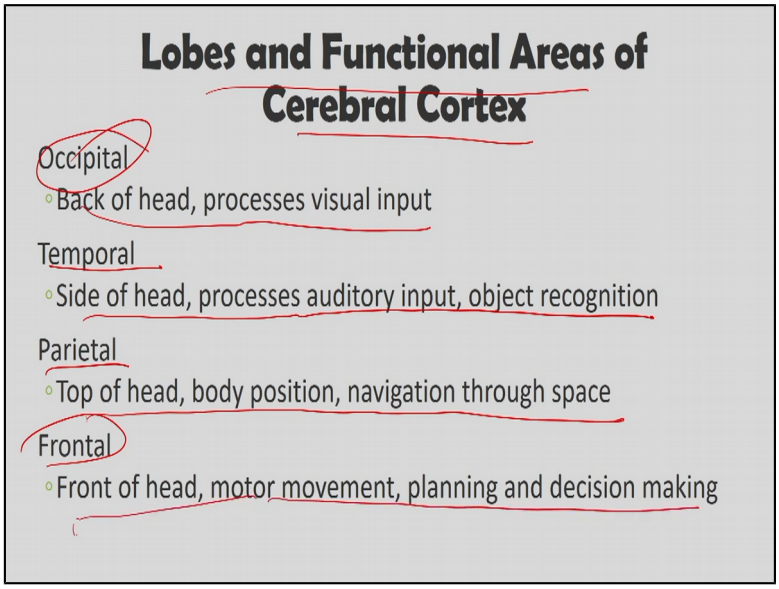
So, then lastly, we have to look at, what is, or what role, the brain has to play with, Psycholinguistics, or language processing. So, within the brain, you have something called, the Brainstem, which is the interior portion of the brain, which regulates the body function. You have something called the, Cerebellum, which is a walnut-sized, behind Brainstem, coordinates movement.

So, tis this is what, my brain looks like. And, this is my spinal cord. This region here, this is what, my brain generally looks like. And, so this dis region, which is hanging here, which is called the Old Brain, common in Animals, Birds, and Humans, is called the Cerebellum. It

coordinates movements, and it is just behind the Brainstem. This is where, my brainstem is. This is where, my spinal cord, gets connected, to the Brainstem.

Corpus callosum, a set of fibers, which run between the two hemispheres. So, band of fibers, connecting the left, in the right hemisphere. And, the Cerebral cortex, which is the outer covering of the forebrain, mental functioning gives rise to consciousness. And so, Cerebral cortex is the outer part of the brain. This is more of, white matter. And, inside the brain, it is grey matter.

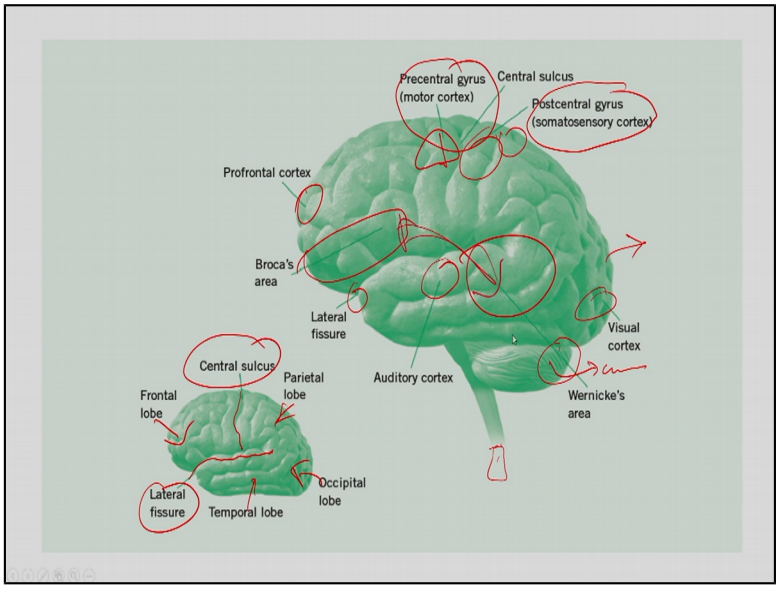
(Refer Slide Time: 42:19)



So, Lobes, and functional areas of the Cerebral cortex, we have the Occipital lobe, which is the, right at the back of the brain. This is the back of the head, processes visual input. So, all visual input, goes here. We have the Temporal lobe, which is the side of the head, process auditory input, and object recognition. So, this is my temporal lobe. Right. And so, it processes auditory input, because it is connected directly to ear, and object recognition.

Ah the Parietal lobe, which is the top of the head. This is my Parietal lobe. And, body position, navigation through space, and that kind of thing. And, this Frontal lobe, which is my front here, of the head, in motor movement, planning and decision-making, and so on, and so forth. So, quick recap of, what the brain looks like, or what are the parts of the brain.

(Refer Slide Time: 42:57)

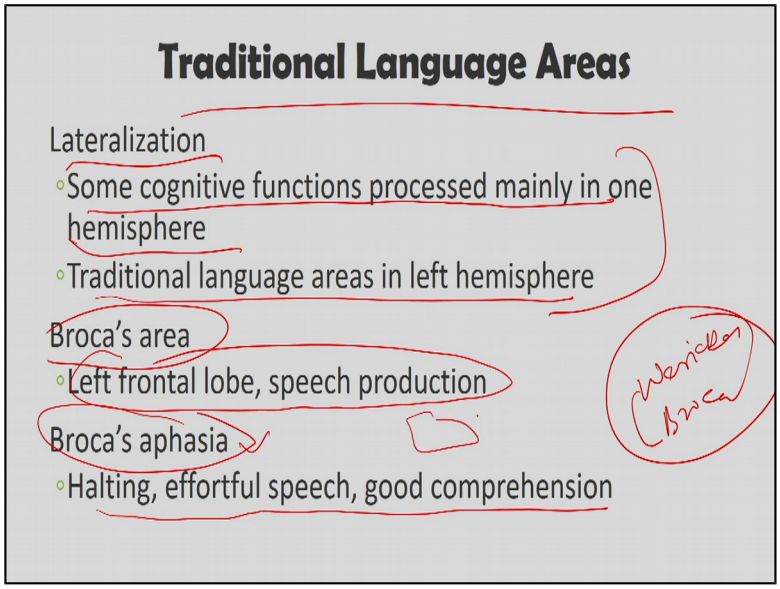


So, if you look into here, this is my Central sulcus, so, two divisions of the brain. It is divided, this way. And, it is divided, this way. Two divisions of the brain. This is the Lateral fissure, Central sulcus. This is my Frontal lobe. This is my Parietal lobe. This is my Occipital lobe. And, this is my Temporal lobe. Similarly, if you look at the brain, in this way, this is the Cerebellum, Cerebrum, or Neocortex. This is my Brainstem. And, this is where, my Spinal cord gets attached.

This portion is called, the Auditory cortex. This is the Lateral fissure. This is the region of, the Broca's area, semantics related. Prefrontal cortex. Precentral gyrus, or Motor cortex. This is the, Postcentral gyrus, so Somatosensory cortex. So, movement, here. Sensory in items, here. Visual cortex. And, this is where, my Wernicke area is all about. So, there is a difference between, the Wernicke area, and the Broca area.

(Refer Slide Time: 43:51)

Traditional language areas. So, what are the areas of the brain, which has been traditionally



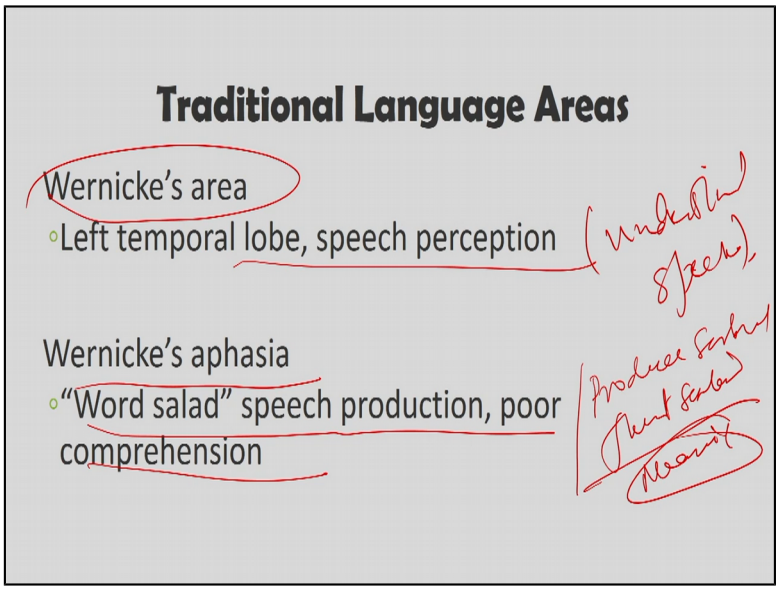
mapped, or traditionally identified. Generally, two areas have been identified. One is the Wernicke's, and the other is the, Broca area of the brain. So, lateralization. Some cognitive functions, processed mainly in one hemisphere. Traditionally, language is basically a left hemisphere, or dependent thing.

So, some specifics to you. Language generally is processed, only the left hemisphere of the brain. Having said that, it is not only dedicated, to the left hemisphere, if there is a damage to the left hemisphere, the right hemisphere takes on, processing of language. So, there is a certain language processing areas. Both, the Wernicke, and the Broca's area, is situated, in to the left hemisphere of the brain.

But, if it receives a damage, if the left hemisphere has a damage, this information is conveyed, to the right hemisphere, and the right hemisphere can then process, language. Spatial navigation, or manual dexterity, motor works, are which are done by the right hemisphere. So, it is more special in nature. This is more linguistic in nature. Broca's area, it is a left frontal lobe, speech production area. So, speech is produced, by this area.

And, what is Broca's aphasia? Is halting effortful speech, good comprehension. So, people can understand words, but they are not able to produce word, and produce sentences. And, that is called, Broca's aphasia. So, Broca's aphasia as I said, Broca's area is, in the front of the brain. So, that is what, my Broca area is. And, this is a left frontal lobe, and it is involved for speech production.

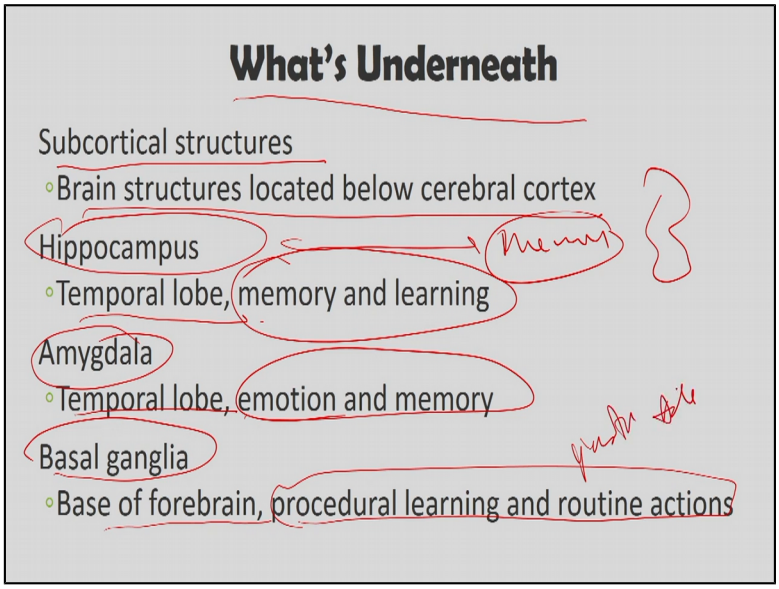
(Refer Slide Time: 45:29)



I have something called, the Wernicke area also, or the brain has something called, the Wernicke area also. This is, in the left temporal lobe. And, it is for, speech perception. So, understanding speech. Wernicke's aphasia, damage to the Wernicke area. What happens? Word salad, speech production, poor comprehension. So, people will be able to produce, sentences, and fluent sentences, but with no meaning.

And so, damage to our Wernicke area, will have sentences, with no meaning at all. Damage to Broca area, will have no sentence at all. Although, subjects will be able to comprehend meaning, but not able to produce sentence. Wernicke area damage, people will be producing sentences, like anything. But, these sentences will have, no meaning at all.

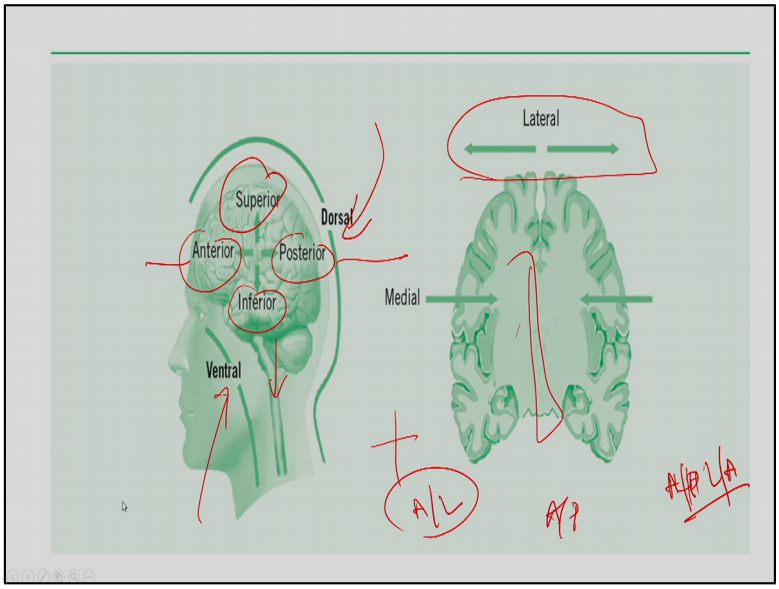
(Refer Slide Time: 46:20)



So, what is underneath the brain. The subcortical structures. Brain structures located below the Cerebral cortex. One of it is, Hippocampus. This is for, especially for memory. It is a C-shaped structure, which is bilaterally present in your brain. It is in the Temporal lobe, this area. And, it is used for, memory, and learning.

You have the Amygdala, a small peanut-shaped, or Kidney shaped region, somewhere here in the Frontal lobe. So, in the Frontal Temporal lobe, I would say, more of a Temporal lobe. And, this is for, emotional memory. Then, you have something called a, Basal ganglia, which is the base of the forebrain. And, it is for, procedural learning, and routine actions, so mostly, motor action.

(Refer Slide Time: 47:09)

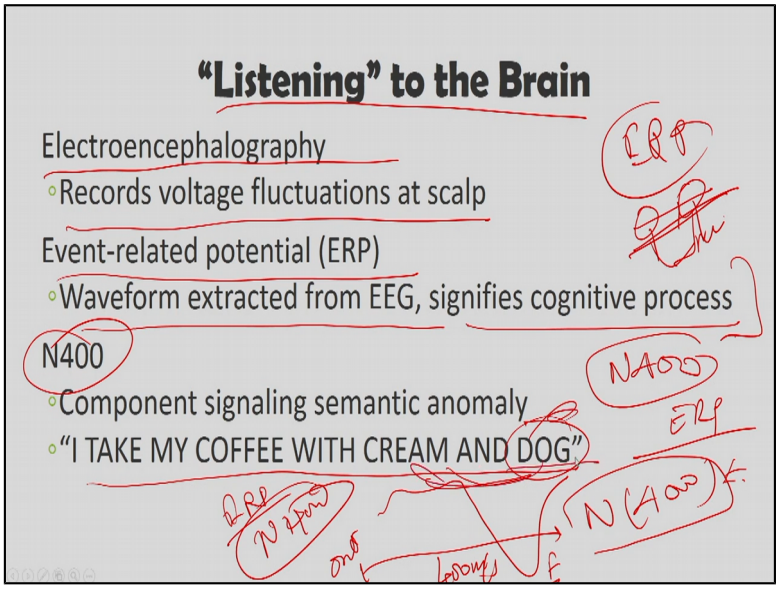


Now mostly, when we talk about the brain, if you go to a doctor, and he writes an x-ray, he generally writes something like, anterior, posterior, or and left anterior, this is the kind of things, that he writes before an x-ray. So, what are these things, then. There are several navigation systems, in the human body. A several ways to study, the human body. And, one of these navigation systems, or how to express a particular structure, is based on something called, Dorsal, and Ventral.

So, Dorsal is, this side, towards the top. And, Ventral is, towards the bottom. Towards the top, if it is up, then it is called, Dorsal superior. Towards the top, it is towards the back of the brain, it is called Dorsal posterior. If it is, towards the front of the brain, towards the top, it is called, Anterior. And, if it is towards the bottom, it is called Ventral inferior. So, Ventral is towards the leg side, and towards the head side, the Dorsal, front is Anterior, back is Posterior, up is Superior, and down is Inferior.

Similarly, if something is towards the side, we call it Lateral, but if something is towards the middle, we call it Medial. So, there are several ways of division. For example, we have the Sagittal plane. Several planes in which, the human body can be cut. So, AP is basically, Anterior posterior, or AL is Anterior lateral, and so on so forth. So, this is how, we actually divide, a particular area of the brain.

(Refer Slide Time: 48:35)

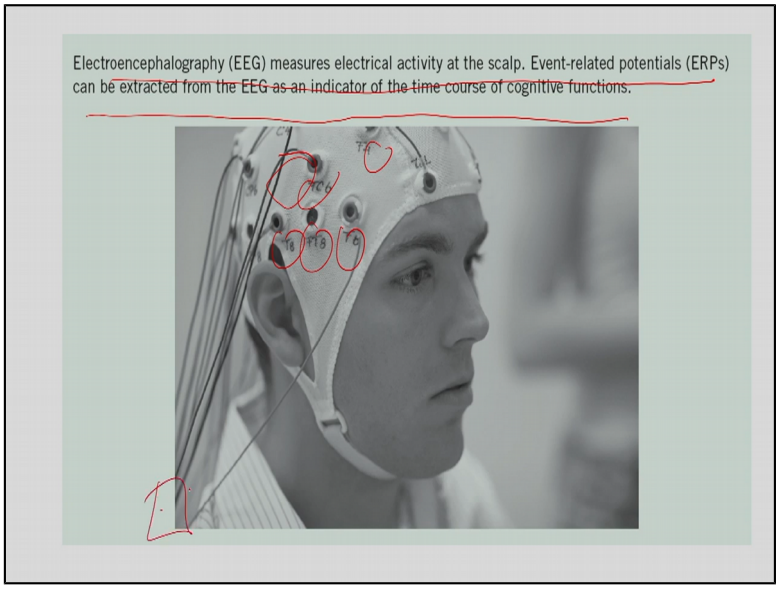


Listening to the brain. So, how do we study, the brain? There are various methods, of studying to the brain. One of the ways, of studying to the brain, is the Electroencephalography. So, what is it? The brain itself, produces, neural currents. And, this is what is measured. So, some event takes place, these currents are generated by the brain. And, a measurement of this current, using a reductionist technique, will be able to generate, or will be able to pinpoint, that one-change in the neuronal current, that a stimulus of interest is doing. And, that is what, an ERP is all about.

So, if everything being same, a word is presented, and a non-word is presented, the change that the word is bringing, in the neuronal current, in comparison to the non-word, that is called an ERP. So, in Electroencephalography, it records its voltage fluctuations at the scalp. Event-related potential. These are waveform, extracted from the EEG, signifies, cognitive processes. For example, the N400. As we looked at, the N400 is an ERP, which is generated, a negative going potential, a negative going peak.

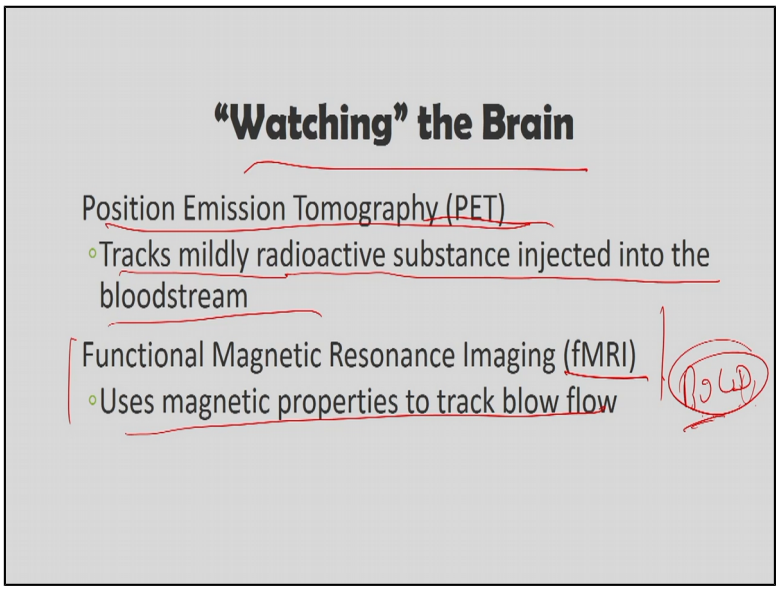
So, if this is my ERP, 400 milliseconds, past the onset of the stimulus, I find a negative going peak. This is my, N400. And, why does this happen? It happens because, the subject sees a, meaning difficulty. He sees a sentence, where the meaning is the problem. For example, I take my coffee, with cream and dog. Dog is a problem. Because, it does not match here. And so, this sentence will generate an ERP, because of N400. Why? Because, the subject, does not expect, a dog here. And, dog is not fitting. So, he is comprehending the sentence. And, once he comprehends in sentence, dog should not be there.

(Refer Slide Time: 50:22)



So, this is the Electroencephalograph, measures electrical activity at the scalp. Event related potentials, can be extracted from the EEG, as an indicator of the time course of cognitive functions. As you can see, this is what, the cap looks like. These are, Temporal 6, Temporo occipital 6, Frontotemporal 8. These are the regions, these are the sensors, which are there. And so, these are attached to a common box. And, ERP's are collected from it.

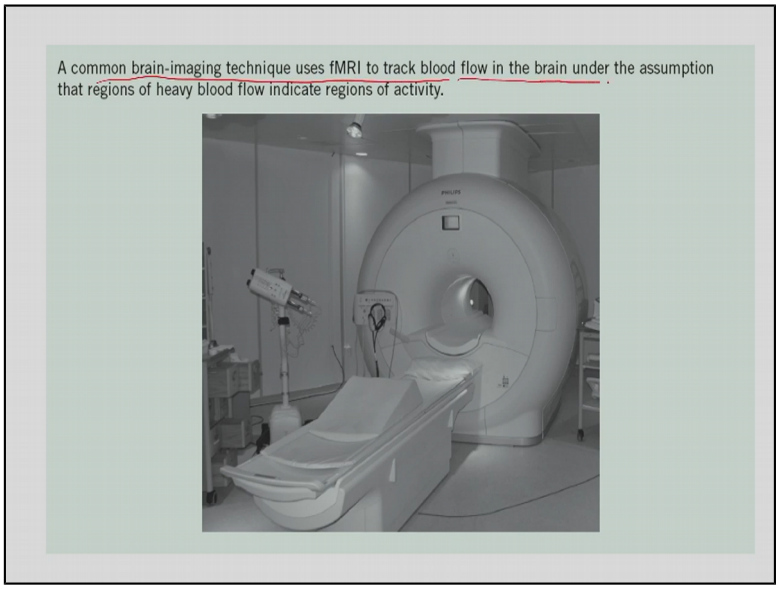
(Refer Slide Time: 50:44)



I can also, see the brain, in action. And, that I do with, something called, either the PET, or the FMRI. In, Positive Emission Tomography, what happens is, tracks mildly radioactive substance, injected into the bloodstream. So, mildly radioactive substance, inject in the bloodstream, and then the experiment is done. And, I track in real-time, what is happening, in the brain, when a particular stimulus, or wat when a particular word, or non-word, is presented to the subject.

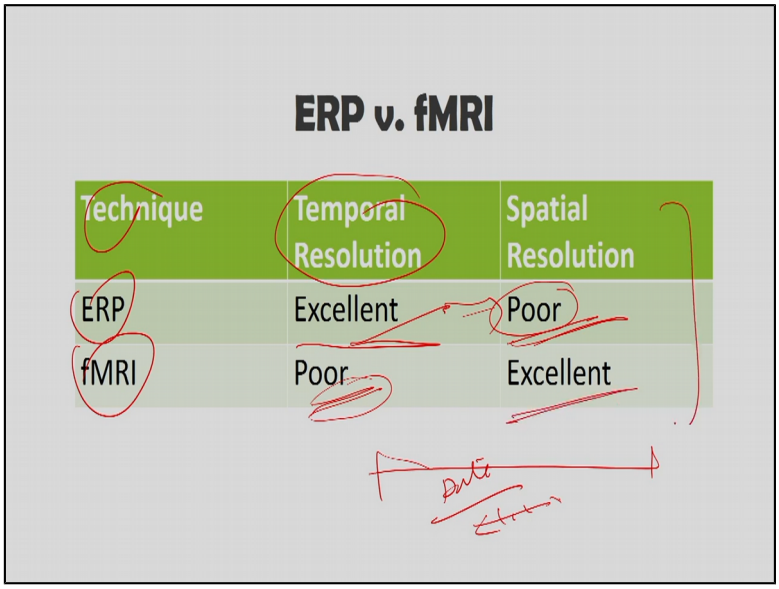
I can also use something called the, Functional Magnetic Resonance Imaging, to use something called the BOLD technique, which is the Blood Oxygen Level Detection, uses magnetic properties, to track blood flows. It can track the amount of blood, that a particular region of the brain, a particular neuronal group of the brain is taking, when a stimulus of interest, and a stimulus on all interests, were presented to the subject.

(Refer Slide Time: 51:35)



And, this is what, my FMRI looks like. So, common brain imaging technique uses, FMRI to track blood flow, in the brain under the assumption, that regions of heavy blood flow, indicate regions of activity.

(Refer Slide Time: 51:47)



And so, this is a comparison of, the ERP, and the FMRI. The technique here is, EEG. The technique here is, MRI. The Temporal Resolution, as in recent time. So, how accurate, data can

it give me, on the time axis, on how an event is happening. So, ERP excellent, but FMRI poor. In terms of structure, it looks where, exactly the changes are happening. ERP has a poor spatial resolution.

Although, it can tell me, when an event has happened, when an electrical change has happened, but it cannot tell me, where the electrical change is coming from. And, FMRI cannot tell me, when an electrical changes happen, but it can tell me, where it is happening. And so, this is the comparison between, the FMRI and MRI. So, basically, what we did today is, we looked at, what is the hypothesis?

And, from there, we progressed into, looking at the experimental process, how experiments are done? We looked at, some model experiments. And, we defined, these model experiments, and how, these model experiments, actually carried out. So, we looked at a number of studies, right from, the picture and no picture, ambiguous sentence, comprehension, to Baddeley's study, and some other study, as well.

Then, after we did, define, how Experimentation Process is done, we looked at a model experiment, and expanded the model experiment. And then, what we did was, we looked at the Experimentation Process. And, we looked at, Lexical Priming Decision task, which explains the lexica the experiment process in detail. We looked at, how memory is used as a technique, or as a measure, for psycholinguistic tests. We looked at, implicit learning, an implicit learning test. We looked at, eye tracking, as a measure of psycholinguistic phenomena.

And then, we looked at language, and the brain of how, various brain regions, are relate to its various language properties, or various language phenomena. And, towards the end, we looked at, how FMRI, and MRI, can be used, for measuring psycholinguistic phenomena, or psycholinguistic problems. When we meet next, we look at, how speech is produced, in the human brain. And, what are the various issues, related to the production of speech. So, until we do that, it is thank you, and goodbye, from here.