Lecture - 24
Parsing Sentences – 3

Hello and welcome to the course, introduction of the psychology of language. I am Dr. Ark Verma, from IIT Kanpur. And we are in the fifth week of the course, we're talking about sentence processing in this week, last lecture, we were talking about constrained based models of parsing. We talked about, some of the effects that need to be taken into account, while the parsing system, generates all of these multiple structures, we talked about the role of context, verb subcategory, information and also we talked about, say for example, you know the we also talked about, some of the other factors as well. Today we will

continue talking about, the constraint based models of parsing. We will look at some of the other effects that need to be taken into account; one of those is the semantic effect in parsing.

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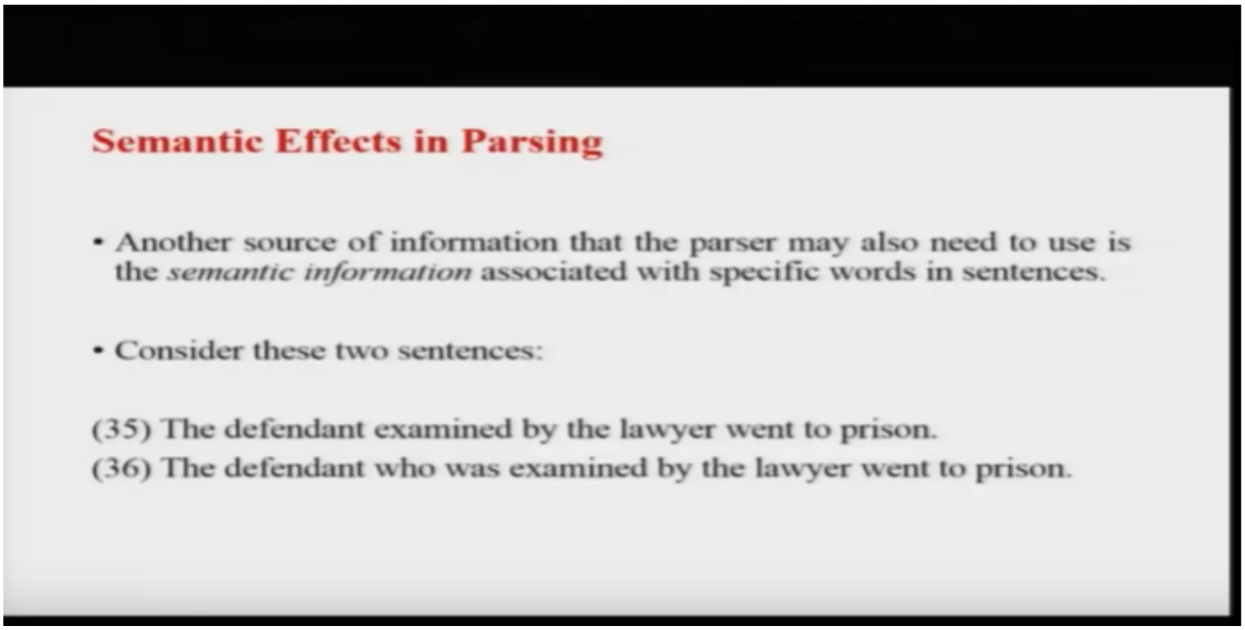

now in, in a general sense, people don't assume that semantics have has to play a lot of part, in syntactical structure, generation or syntactical structure evaluation, however the CBP models basically say that, one of the sources of information that the parser should or does take into account, is the semantic information, associated with the specific words, in the sentences. Now this is almost in a sense, counterintuitive to those coming from the chomskeen school of you know, now you know looking at grammar and syntax and house and how structure should be organized, but the constraint based parsers basically, believe that semantics, is also a very important, source of information that needs to be taken into account, if you are kind of creating multiple possible syntactical, structures and then evaluating those structures against each other. Let us take an example, let us have these two sentences, the defendant examined by the lawyer, went to the present. So, the defendant examined, by the lawyer, went into the present, the defendant who was examined by the lawyer went to the present. So, we have two structures here, two sentences here, the sentence 36 is less because, it is disambiguated by adding, who was examined. Okay? So, 35 is called a,' Reduced Relative', because it contains a reduced relative clause, examined by the lawyer that modifies the meaning of,

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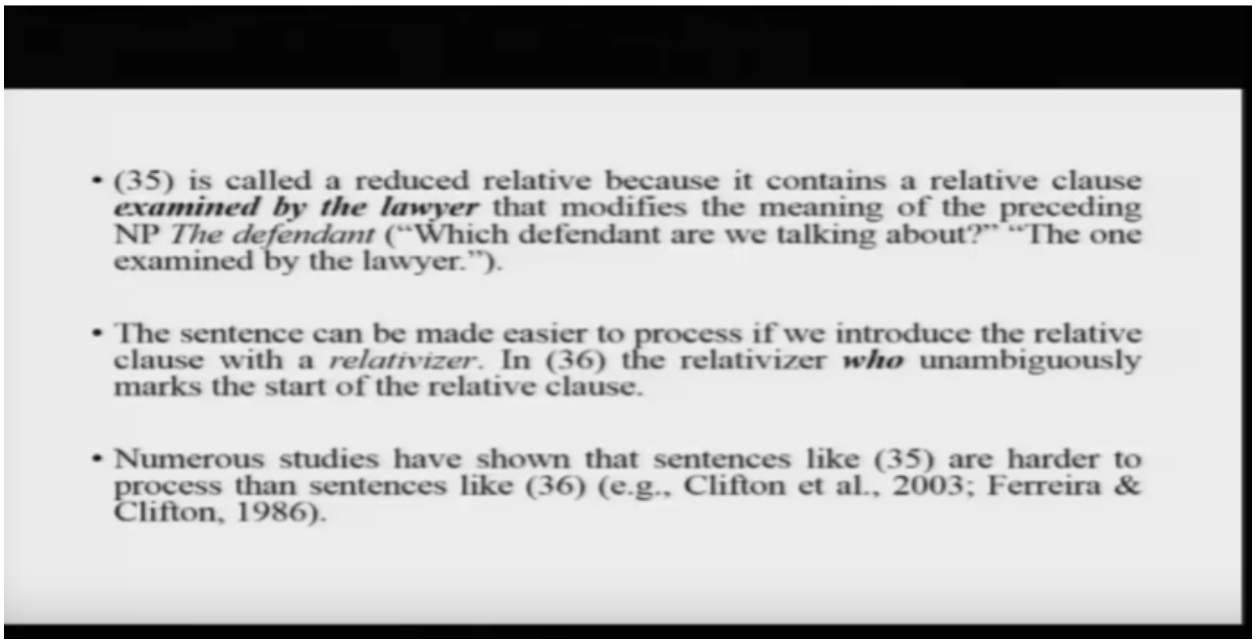

the preceding the defendant. Okay? So, the defendant, who are which defendant are we talking about, the defendant examined by the lawyer, you saw this was disseminated in the next sentence, the defendant who was examined by their. So, that is actually the sentence, but in the reduced relative form you take away, you who, was and you just say the defendant examined by the lawyer went to the prison. Now the sentence can be made easier to process, if we introduce the relative clause with the relativeizer, who was in 36th early divisor obviously, it gets introduced and it um unambiguously makes the start of the relative clause. And it kind of makes things easy. Now numerous studies have shown, the sentences like 35 are hard to process, their sentences like 36, it might seem very easy to understand that, now the defendant examined by the law I went to present the defendant, who was examined by the law I went to present, obviously 36 is easier to understand, let's see why.

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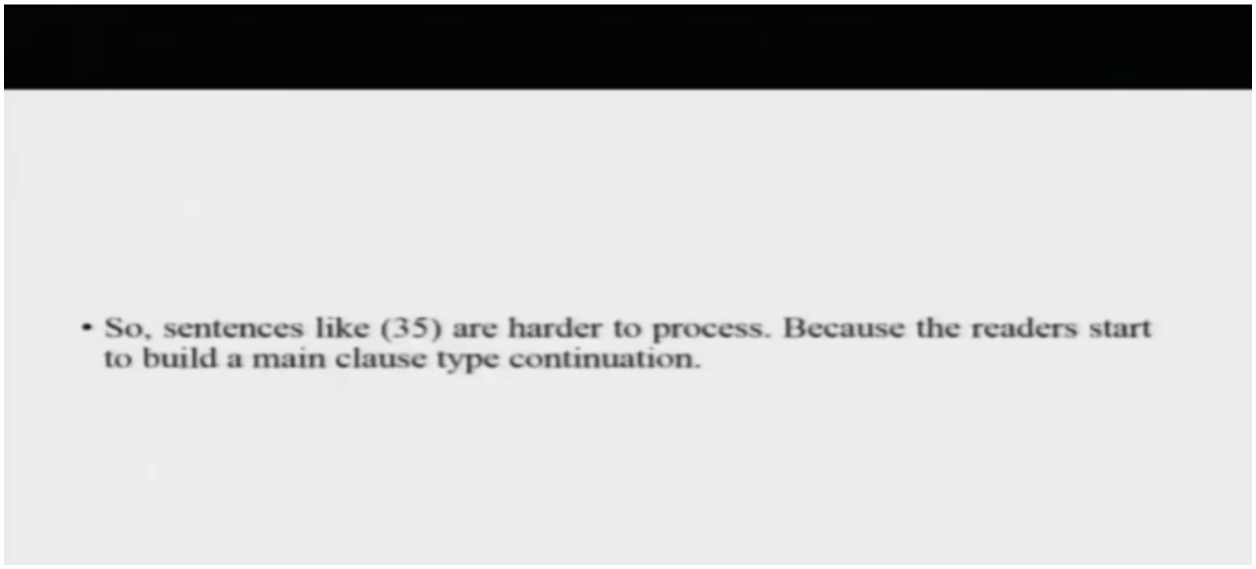

So, sentences like, 35 are hard to process. Alright? Because the readers start to build a main, Clause type continuation. Okay? Let's see what is the main clause type continuation, what is. So, in general reduce relatives are difficult to process, because listeners have a hard time figuring out,

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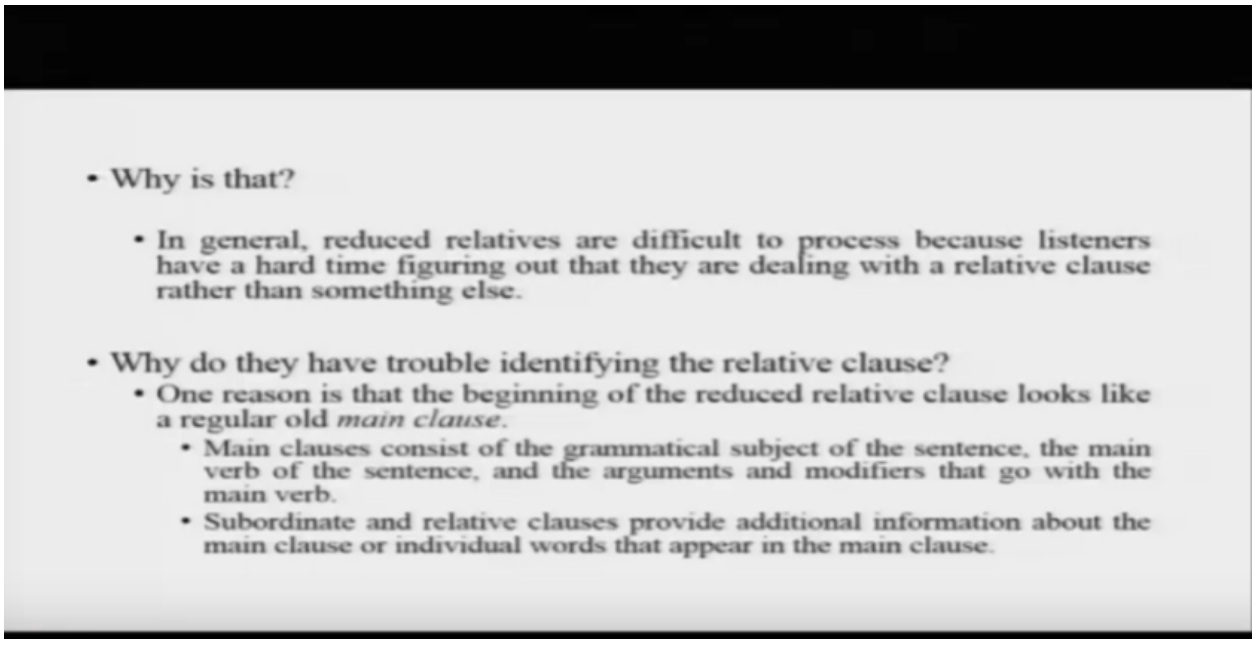

that they are dealing with a relative clause, rather than a main clause. Okay? So, they kind of start with looking at that as main Clause, main sentence, whereas that is actually a reduced relative that kind of gets attached, to this one itself. So, why do they have trouble in identifying the relative clause, one reason, is that the beginning of the reduced relative clause, looks like a regular old main clause, main clauses

consists of grammatical subjects of the sentence, the main verbs of the sentence and the arguments and modifiers that go in the sentence. So, typically it has everything that a main Clause needs, subordinate and relative clauses, provide additional. So, that's the main clause, basically main clauses, have all of this subordinate and relative clauses. Right? Additional information, about the main clause or individual words that appear in the main clause. So, they do not have all of this information.

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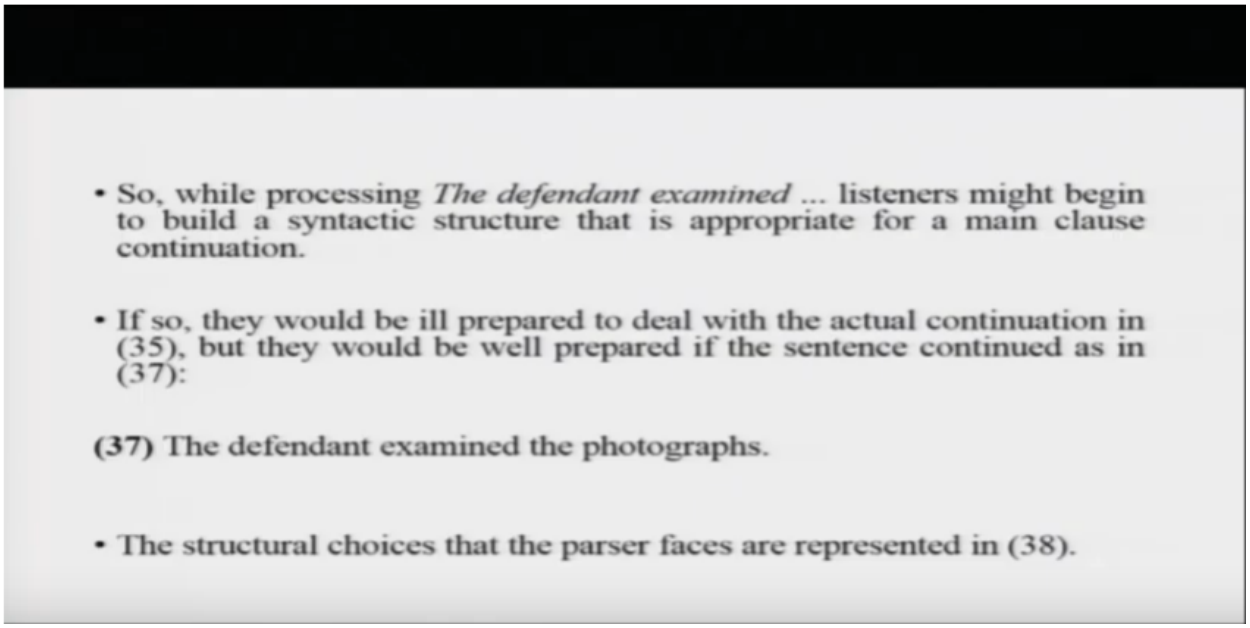

So, while processing the defendant examined by the lawyer went to prison, listeners might begin to build, a syntactic structure that is appropriate for a main Clause continuation, rather than treating that as a relative clause. So, if so, they would be ill-prepared to deal with the actual continuation, in 35 and then basically, it could be easier if the actual condition was more like this, the defendant examined the photographs. Okay? The structural choices parser faces, kind of can see here.

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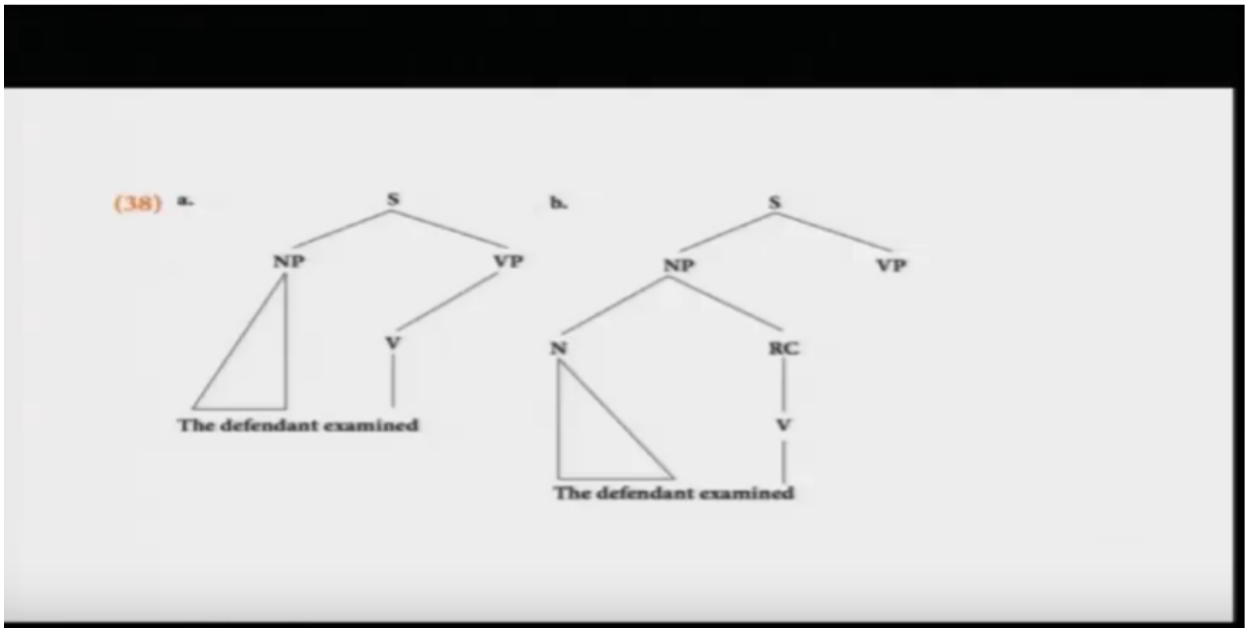

So, the defendant examined and then by the lawyer and the defendant examined kind of comes in the same thing, by a lawyer went into the prison. So, that's the difference so, these are the two structural choices 38 a and 38b.

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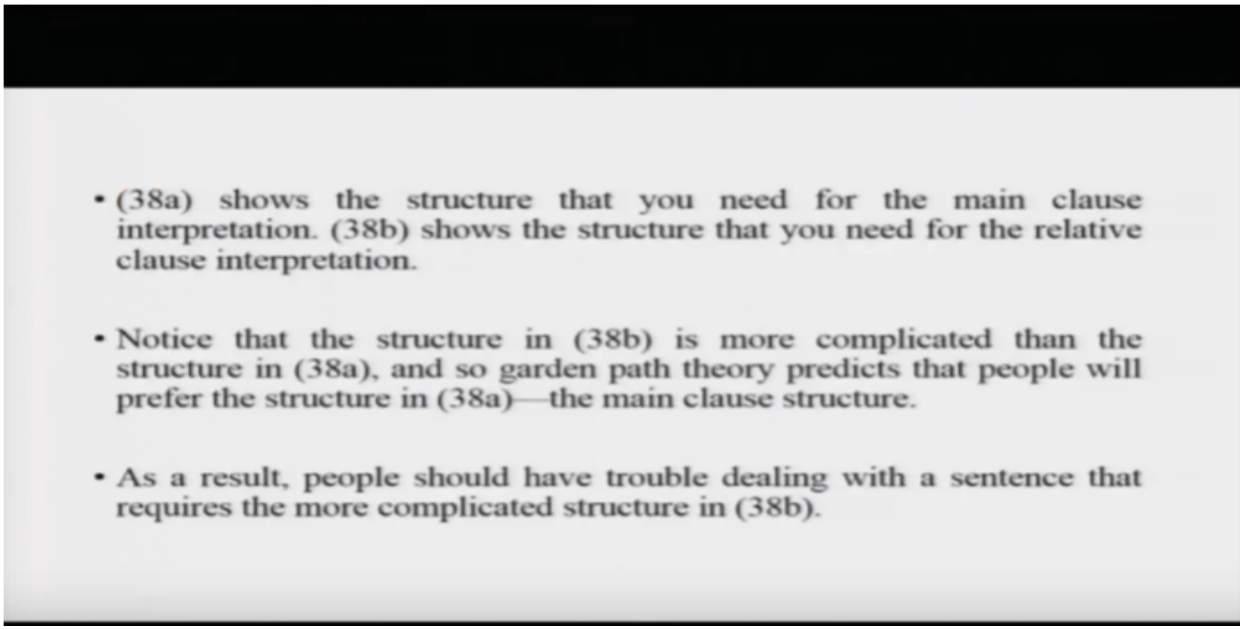

38 a shows the structure that you need for the main Clause interpretation, whereas 38 B shows the structure that you need for the relative clause interpretation. Notice that in structure 38 b is obviously a

little bit more complicated, than the structure in 38 a. So, by the garden bar theory obviously 38 b will be predicted to be harder, as a result people should have, trouble dealing with 38 B, because it has a more complicated structure.

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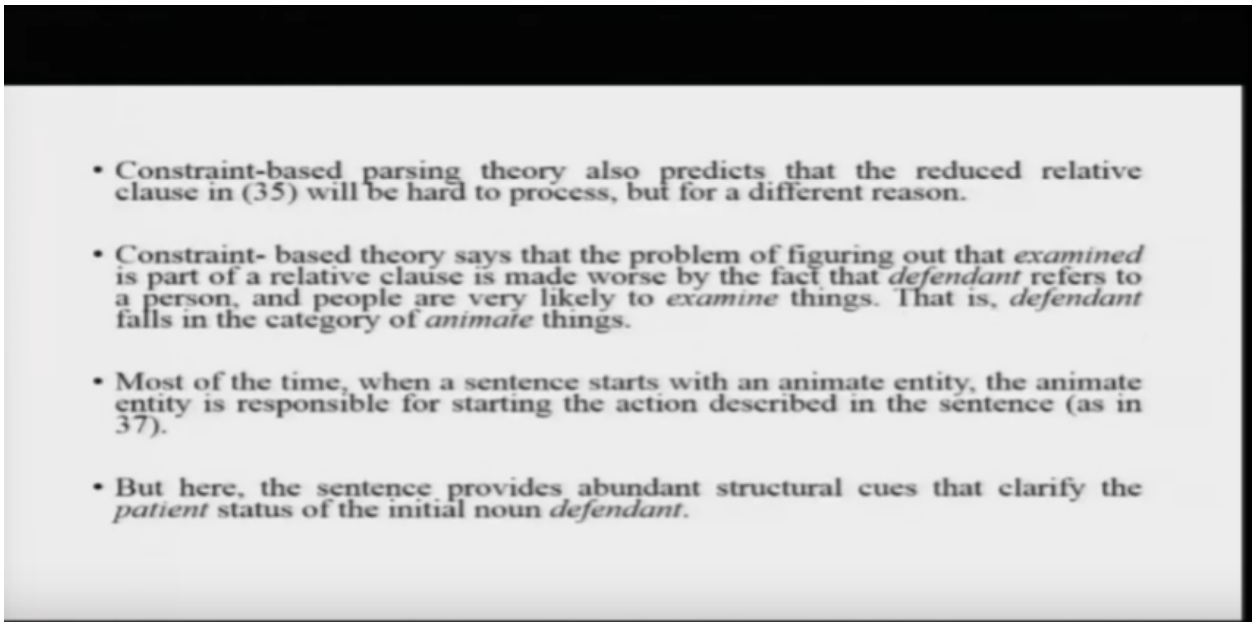

The CBP Theory also produces at 38 b, 35 will be a harder to process or 38 B will be harder to process. But it says for a different reason, how C V B says that the problem of figuring out that examined, is a part of a relative clause, is made worse by the fact defendant refers to a person, but people are very likely to examine things. Now so, for example the defendant is a person. Okay? Generally you do not examine persons, I do not examine X Y or Z person, I usually examine the pen, I would be examining the vegetables, I would be examining the fruits or the scene or something like. So, usually people examine things, but not actual real people. So, because the defendant examined, is there so, you kind of you know want to take it to a you're looking for a different subject almost. Okay? So, defendant falls into the category of animate things, most of the time, when a sentence starts, with an animate in entity the animate entities the Smurfs were the action described by the sender's because, the defendant examined so, defendant it kind of leads, to a new action, you know it kind of leads to a possible, new action being generated. But here the sentence provides abundance structural, cues that clarify the patient status, of the noun, defendant. Okay? So, we know that the defendant is the one being examined and defendant is actually not doing anything .Okay? So, here that way and that should create a little bit of a problem. So, again looking at the theories, the CBP parsing theory would say,

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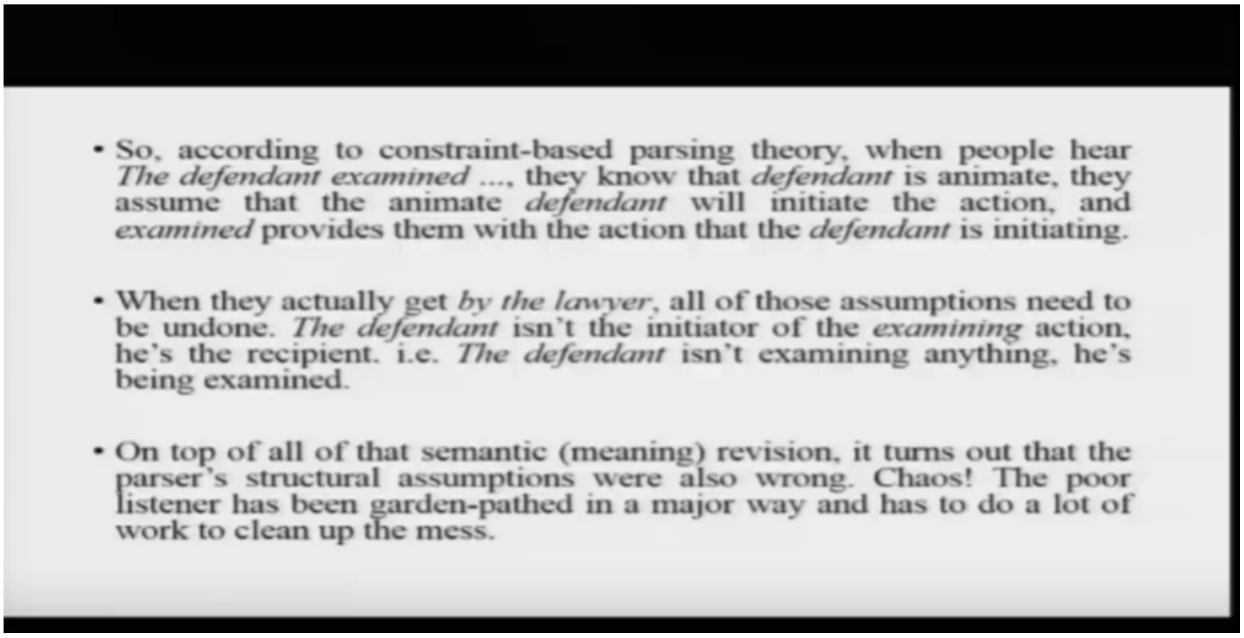

when people hear the defendant examined, by the lawyer window person, they would know that the defendant is an inmate; you would assume that the animate defendant will initiate, some action. Okay? And examine provides them, with the action that the defendant is initiating. So, they will kind of that is why be led on to, expect a main Clause type continuation, when they actually get, to by the lawyer all of those assumptions need to be, re-examined, need to be undone, the defendant is not the initiator of the examiner in action, instead it is being examined. So, that's a sort of a revised, revision that needs to happen, on top of all that semantic revision, it turns out that the parser structural, assumptions are also wrong, it cannot be a main clauses has to be a relative clause, this leads to, errors on both accounts semantics and syntax, leads to pure chaos. So, the poor listener has been garden paths, in a major way and has to do a lot of work to clean up this mess so, let's see.

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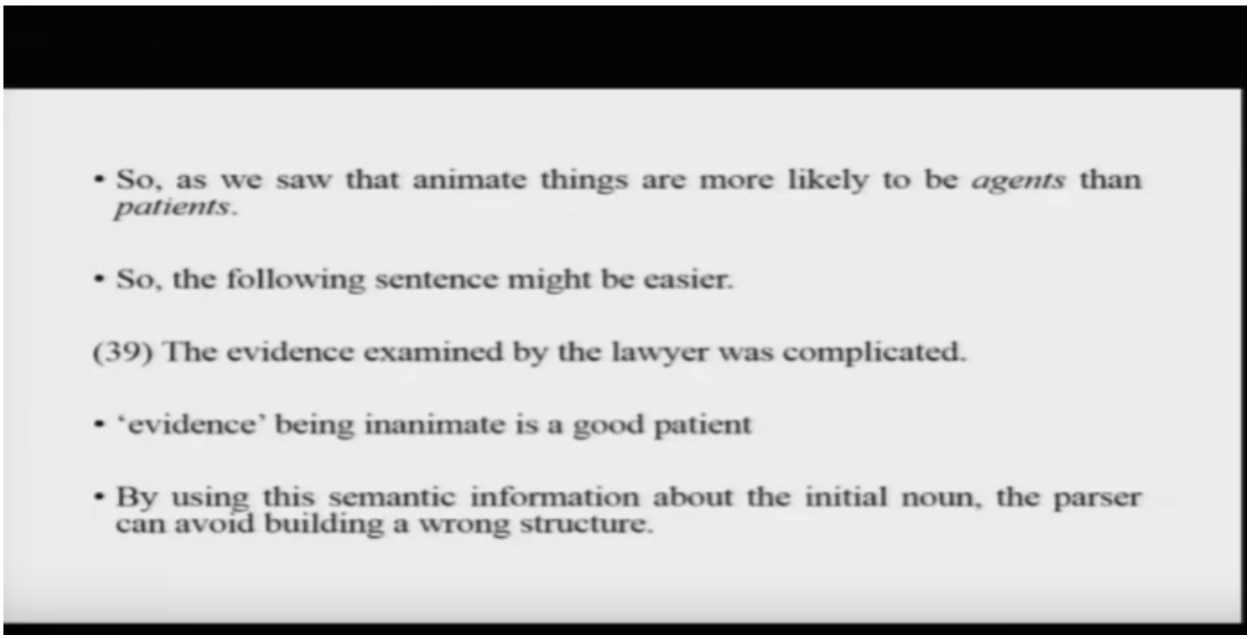

Now looking at this again, as we saw that animate things are more likely to be agents rather than patients. So, the following sentence, in that sense might be easier to read, the evidence examined by the lawyer was complicated. Now evidence is inanimate and it can be examined this is easier. So, the in the sense evidence, being inanimate is a good patient, of examined, by using this semantic information about, the initial noun the evidence, the parser can avoid building a wrong structure, as soon as the sender starts the evidence, examined by the lawyer, you know that this is inanimate thing it can be subject, to examination, you will not create a wrong structure. Okay? But in the defendant examined, you thought that this is an animate, thing it will initiate action rather, than being the object, of the action that is what will create problems. So, this is basically, something that one has to really understand that the knowledge about, you know what each of these words mean, the knowledge about the semantics, is kind of important to take into account, when passing has to move ahead. Now another effect that we can take into account when you're talking about constraint based parsing models.

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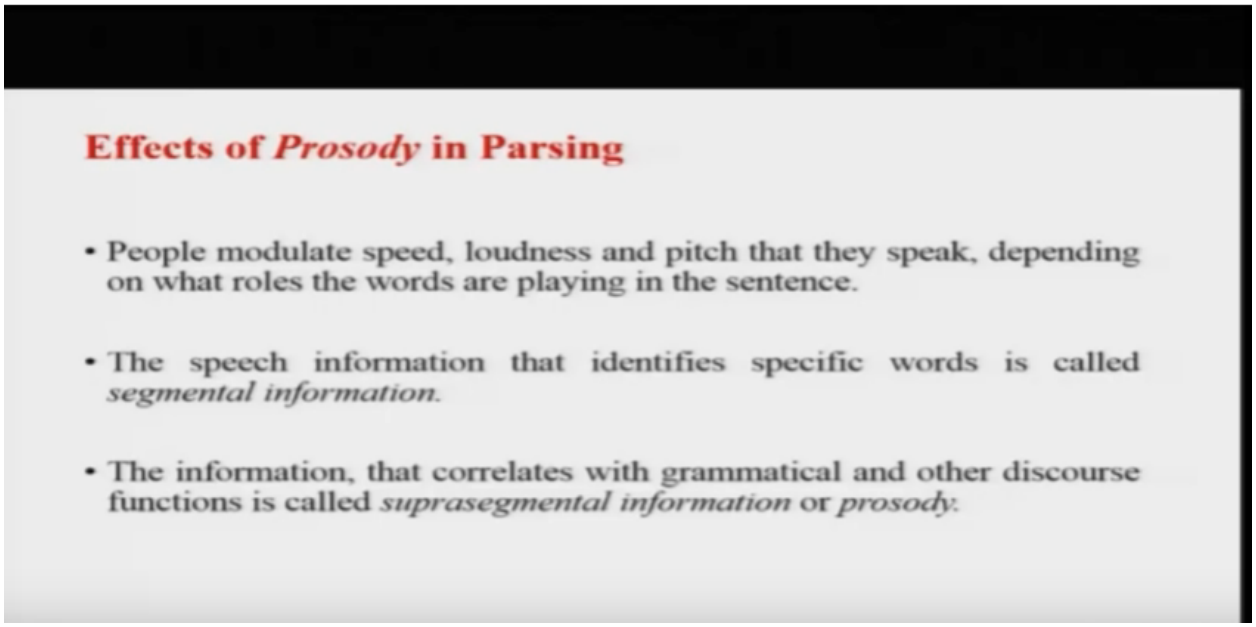

Is the effect of prosody, now we've talked a lot about prosody, in this course, starting from, you know the developmental part in other, sections say for example in word, meanings and stuff as well in speech processing as well. So, what is cross-city prosody is you know loudness, relative loudness pitch, speed of speaking and all of this you know that people kind of modulate while they are speaking. Okay? This speech information that identify specific, words is called,' Segmental Information'. And in this information that correlates with the grammatical and other discourse function is called,' Suppressing Mental Information or Prosody'. So, this information, which is also kind of correlating with you know the, other syntactic features is called,' Suprasegmentals Information'. So, there are two kinds of information, again, let me repeat this the speech, information that identifies specific words is called,' Segmental Information'. So, pauses and other things, the information that correlates with a grammatical and other discourse function, with respect to you know here, I have to pay emphasis here, I have to not it's called,' Suprasegmentals Information or Prosody', neural generated loudness speech and those kind of things. Now there can be two kinds of accounts of prosody, first is non linguistic crossly, what is that? It consists of those parts of speech that provide cues, to the speaker's,

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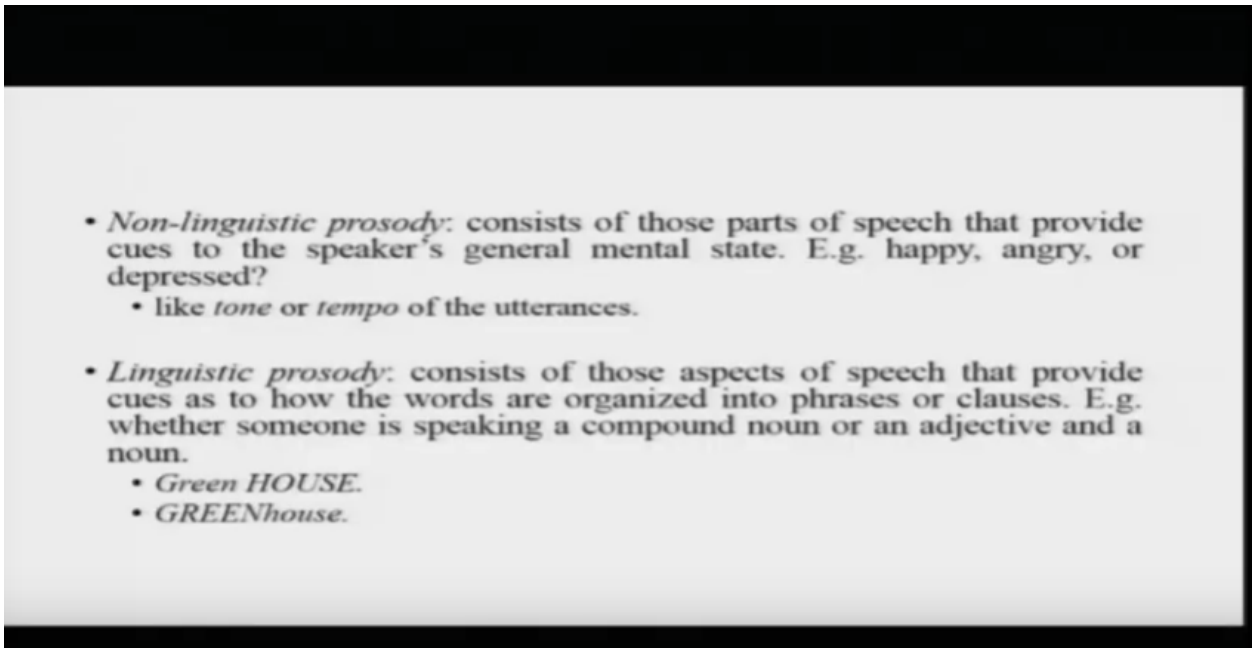

general mental state so, whether you're happy or angry or depressed. So, say for something like, the tempo or the tone of the utterances, the excitement in the utterance that is the non linguistic prosody, it is just the superficial feature, is the cosmetic feature it's telling us about, what this is thinking about? What is it general emotional state? The second kind is the linguistic prosody, which has some linguistic function, to fulfill, what is that? It consists of those aspects of speech that provide cues as to, how the words are organized into phrases; you know about troche and iambic were. So, green house, green house, green house. Okay? So, green house versus green house the kind of the difference in stress, can tell you whether I'm talking about a house that is green or I'm talking about that glass structure, which you can grow fruits or vegetables in you know, in you know if that kind of thing. So, nitrates or nitrates, you know those kind of things.

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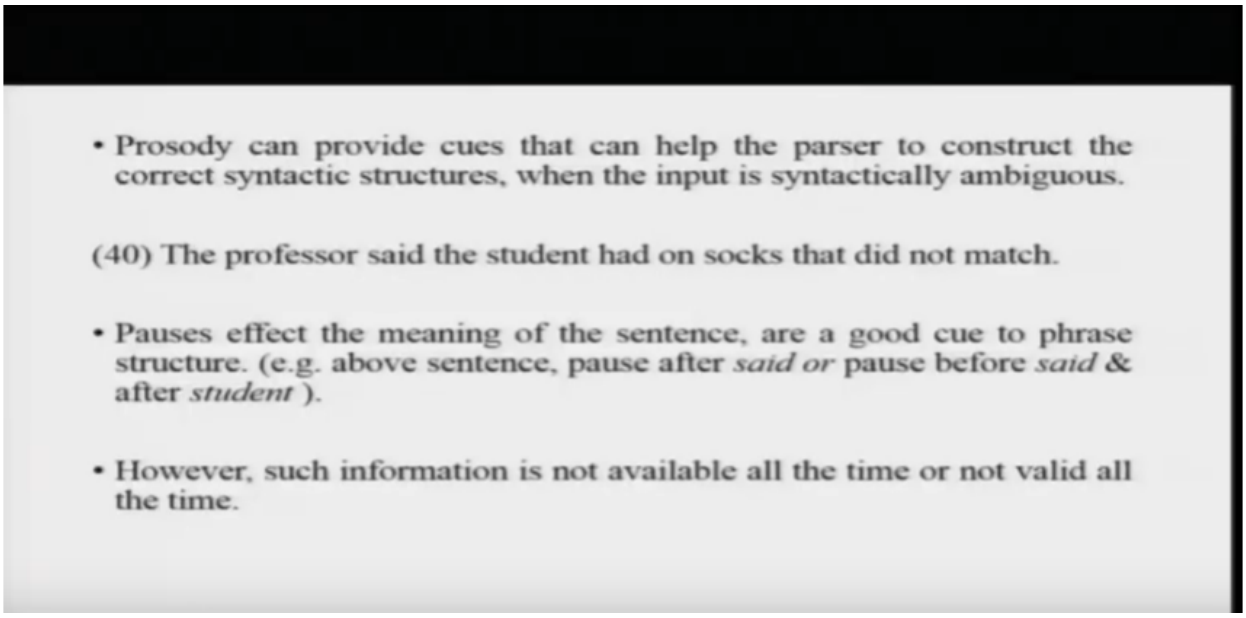

Now prosody can also provide ask use that help the parse to construct correct syntactic structures. So, say for example, in case the input is syntactically ambiguous and you don't really know how to you know organize, this the CVP model kind of says that people can take cue, from the parse from the prosody as well. Let us take this example the professor said the student, had on socks that did not match. Okay? Or the professor said the student, had on socks that did not match or so, you can see the professor said, the student had on socks that did not matter it's either the professor, is having socks they do not match or the professor is telling that there's a student that has socks that do not match, pauses effect the meaning of the sentence. And pauses are a good cue, to phrase structure as well. So, at least as far as spoken, language comprehension, is, is there. So, again just let me read this, the professor, said the student, had on socks that did not match. So, you can kind of get to two different structures here, however such information is not available all the time, also not valid all the time that's. Alright?

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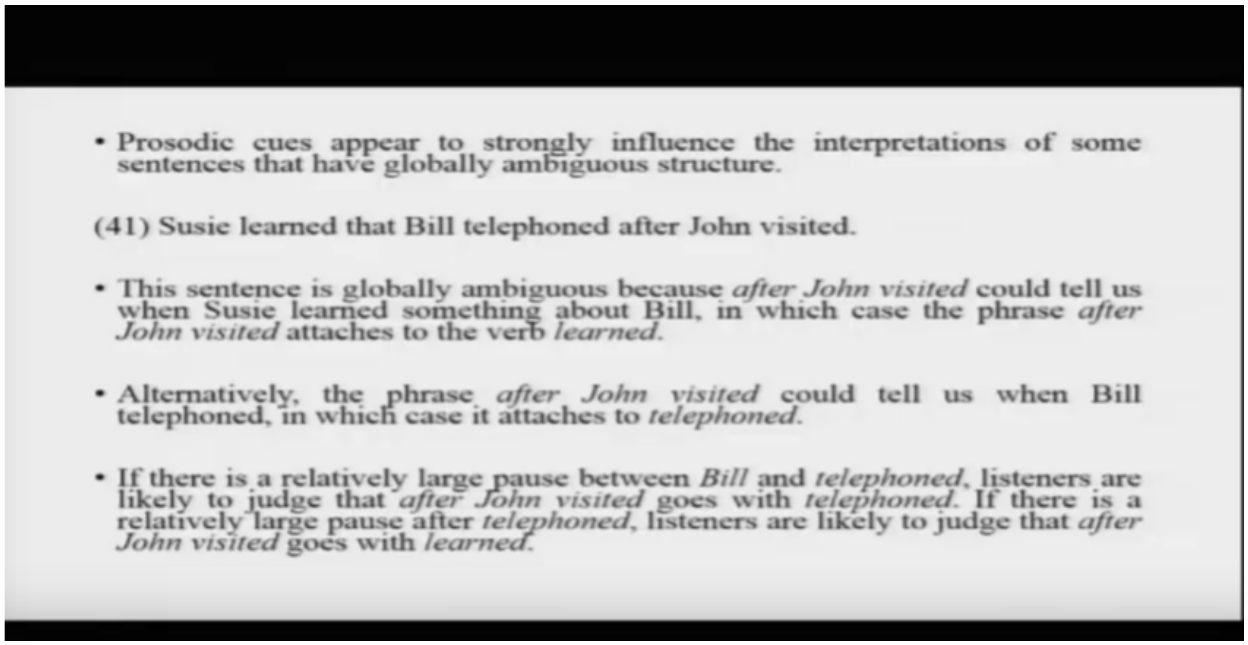

But prosperity cues appear to strongly influence the interpretations, of some of the sentences that you would you know that you usually, have a globally ambiguous structure. Let us look at this Susie learned that Bill telephoned after John visited, Susie learn bill telephoned after John visited, Suzie learned that bill telephoned after John with something like this. So, you can kind of create multiple structures, on the basis of pauses. Let me do it again Susie learned that Bill telephoned after John visited. So, Susie learned that bill had telephoned, after John had visited. So, probably John told her that you know Bill had telephone or Susie learned that bill telephone, after John visited. So, be called after John had visited or Susie Lee came to know that bill called after. So, it can kind of lead to multiple structures on the basis, of where you actually pause. Okay? Now this is obviously, you can this is a globally ambiguous sentence, depending on various places that I pause, I can create multiple possible, syntactic structures, all of which are plausible grammatically, acceptable but will lead to different meanings. Okay? So, yeah alternatively so, if there is a relatively large, pause between bill and telephone listeners are likely to judge and after John visited goes with telephoned. Okay? Let's look at what is happening here, a pause after John visited, could tell us that when Susie learned something about Bill, in which case the phrase after, John visited attaches to the verb, learned, alternatively, the phrase after John was dead could tell us when bill telephone. So, it could then attach to the word telephone or alternatively if there is a relatively large pause between bill and telephone. Susie learned that Bill, telephoned after John visited, listeners are likely to learn that after John raised it goes with telephone. Okay? So, three possible, interpretations are there, if there is a relative large pause, after telephone listeners are likely to judge that after John visit it goes with learn. So, obviously as I'm saying multiple things, you can generate out of it.

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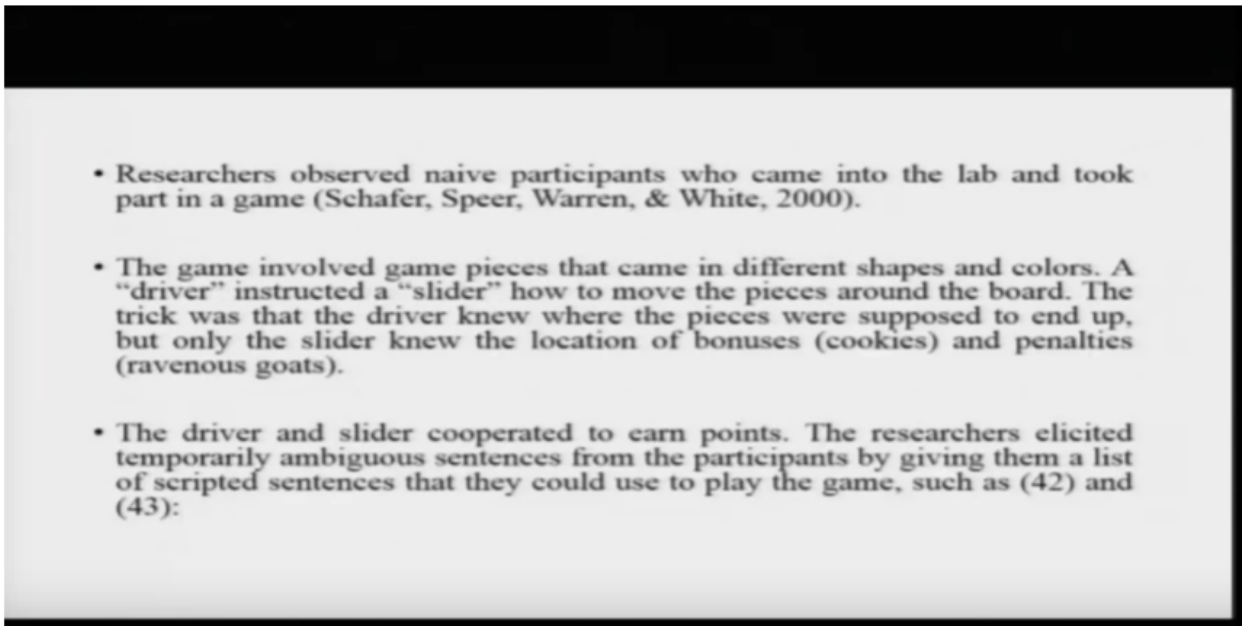

What is the point of this? Researchers have observed that knife participants, who come into the lab, basically they're you know researchers brought these knife participants into the lab. And basically and they were made to take part in a game, the game involved, putting together pieces that came in different shapes and color. So, there were two kinds of particles one was a driver and there was a slider. And the driver basically instructed the slider, on how to move the pieces on a board, the trick was that the driver knew where the pieces were supposed to end up but only the slider knew the location, of the bonuses. So, say for example if you put this piece here, you get a bonus point, something like that now the driver, in the slider needed to cooperate, to earn points the researchers elicited temporally ambiguous sentences, from the participants, by giving them a list of scripted sentences that they could use to play the game. So, basically they came up with the list of sentences very cleverly, some of them are meager some of them not and they stole the driver that you have to use these sentences, to instruct the slider, on the basis of whether the slider, correctly interprets the sentences, the game will move further. So, let's take example of this the sentences that moves the square should land in a good place, when that moves the square, it should land in a good place. So, you can see again on the basis of pauses the multiple structures, can be generated in this study it was observed that the drivers, spontaneously produced, disambiguating prosody cues in order that would help, to disambiguate the sentences.

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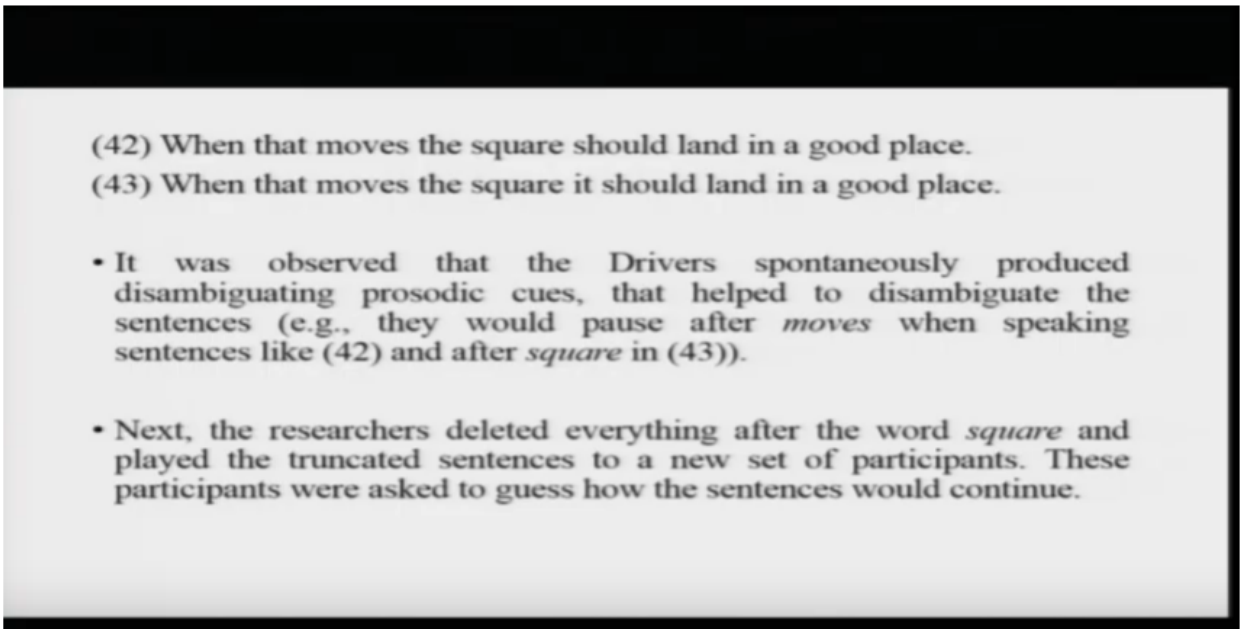

So, if the sentence were 42, when that moves the square should land in a good place, when that but instead the, the speakers would actually say, when that moves the square, it should land in the good place. Okay? So, it kind of already December greats. Okay? Now also then what happened the structure and the researchers, deleted everything after the word Square and played the truncated sentences to a new set of participants, these participants were asked, how the sentences would continue.

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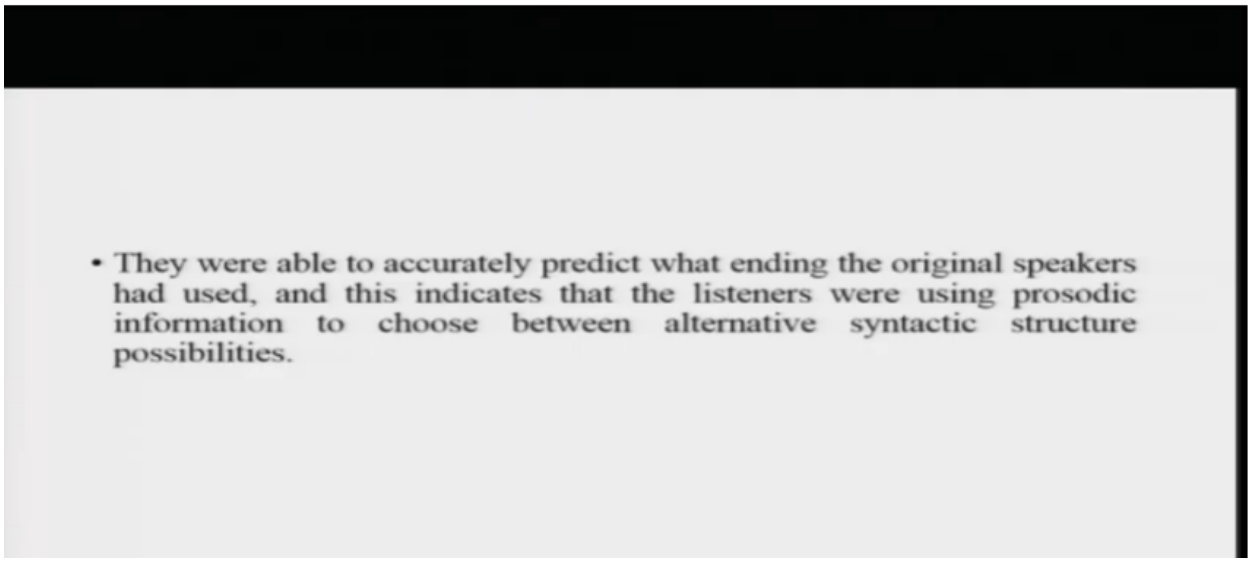

Now what did they find was these, new participants were also able to accurately predict, what ending the original speakers would have use and this indicates that the listeners were actually using prosodic cues and not only the word cues in order, to choose between alternative syntactic structures. So, this kind of serves as a very nice demonstration, of the fact that people are very, good at using these use, the prosthetic use in order to generate multiple syntactic structures. And also evaluate the structures against each other. Now finally we can talk about, visual context, see a lot of our conversation happens in the world, you know it happens in a place, in a setting and the setting has objects and elements. Now one of the things is that when we are talking to each other or mean talking to somebody else. Now we are also conscious of the world, you know you remember we talked about point and say and neutral exclusivity and principle of contrast, in a child picking up meaning, but adults also take cues from the visual context, you know we're talking about, something and somebody says .Okay? You know look at that, look at that and you know exactly what this person, is referring to, this kind of information, the GPT, was not really taken into account the GPT said no, no, no word category, information and the thematic processor, will be sufficient, to tell you the meaning of the word. The CVP slightly is more flexible, in broader instable view. And it says that the visual context, of their the confirm info you know communication is taking place, should also play a part, in a person kind of you know, understanding how or what is meant or kind of what kind of syntactic structures can be generated and then evaluating them.

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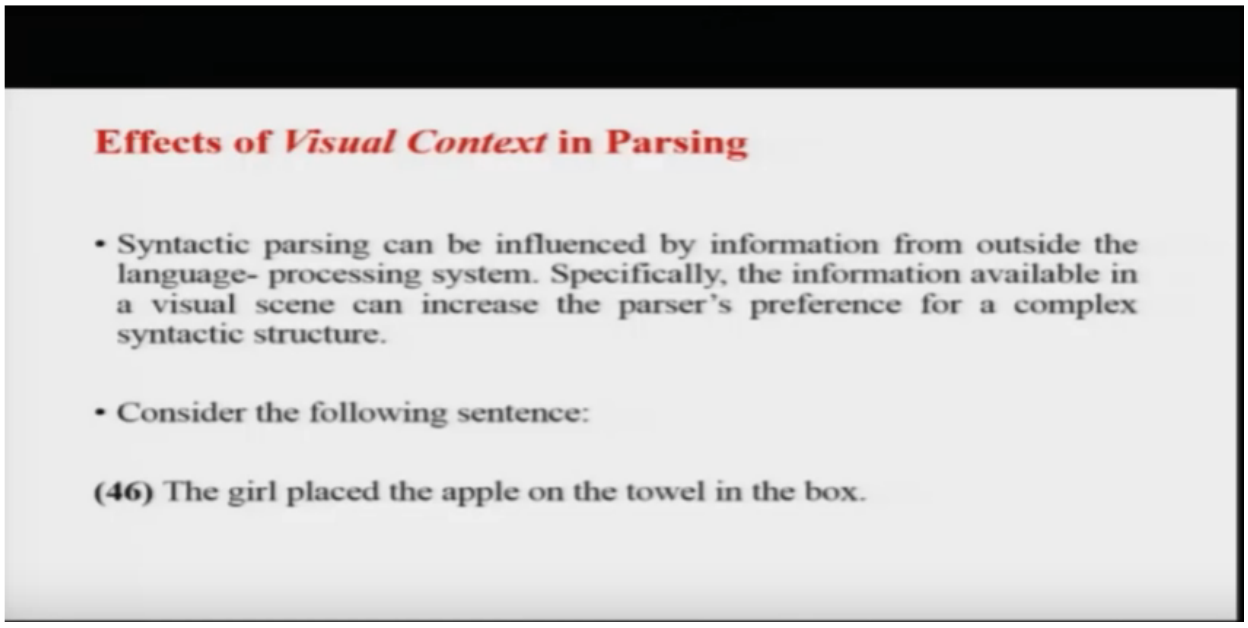

So, let's say let's take this sentence you know sin tact the girl plays the apple on the towel in the box, frost radically I can do a lot of things, with this the girl plays the Apple. On the towel, in the box or the girl pays the Apple on the towel, in the box you know you can do different things with this.

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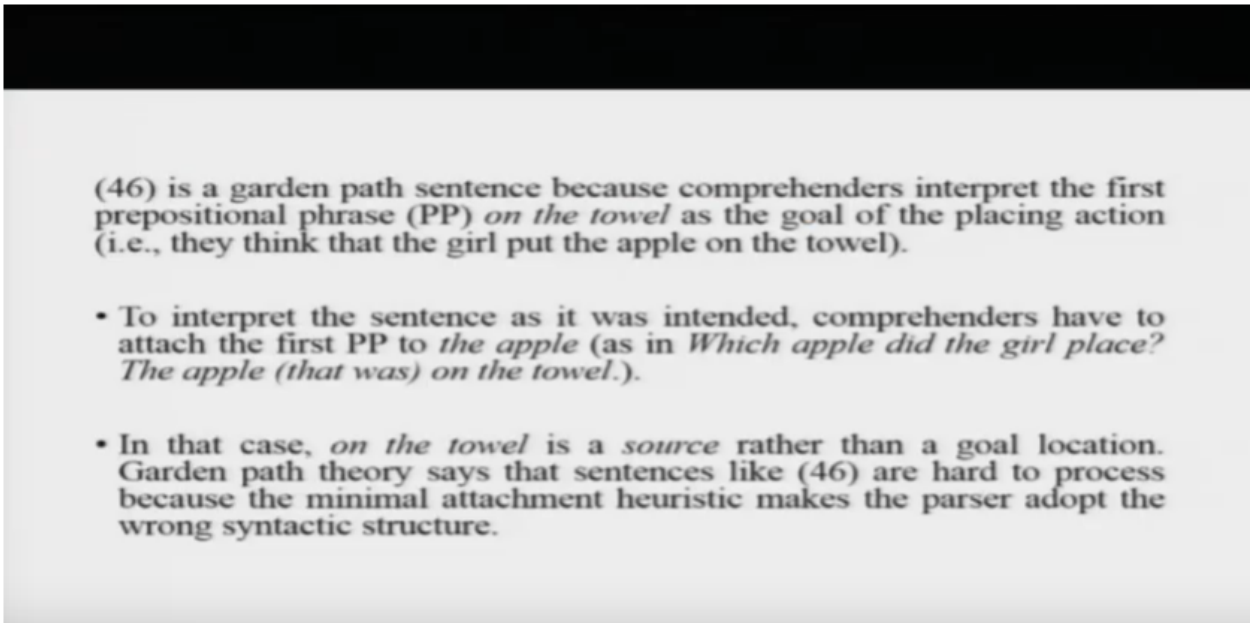

Now 46 this one is a garden path sentence, because comprehend errs interpret the first prepositional phrase on the towel, as the goal of placing the towel initially, but then they realize that no, the goal is actually the box. Okay? To interpret the sentence as it was intended comprehend us or listeners, will have to attach the first prepositional phrase, the Apple, has in which Apple needed the girl place, they will actually place the Apple, on the towel in the box, there could be others happy other and those apples, could be somewhere else. But the girl actually picked up the Apple that was on the towel and place it in the box. That is what the sense you have to make, in that case on the table is a source rather than a goal location, GPT says their sentence like 46 are very hard to process, because the minimal attachment heuristic makes, the parcel adopt the wrong syntactic structure. What was the minimal attachment thing? It says that you have to kind of you know choose the simplest possible structure.

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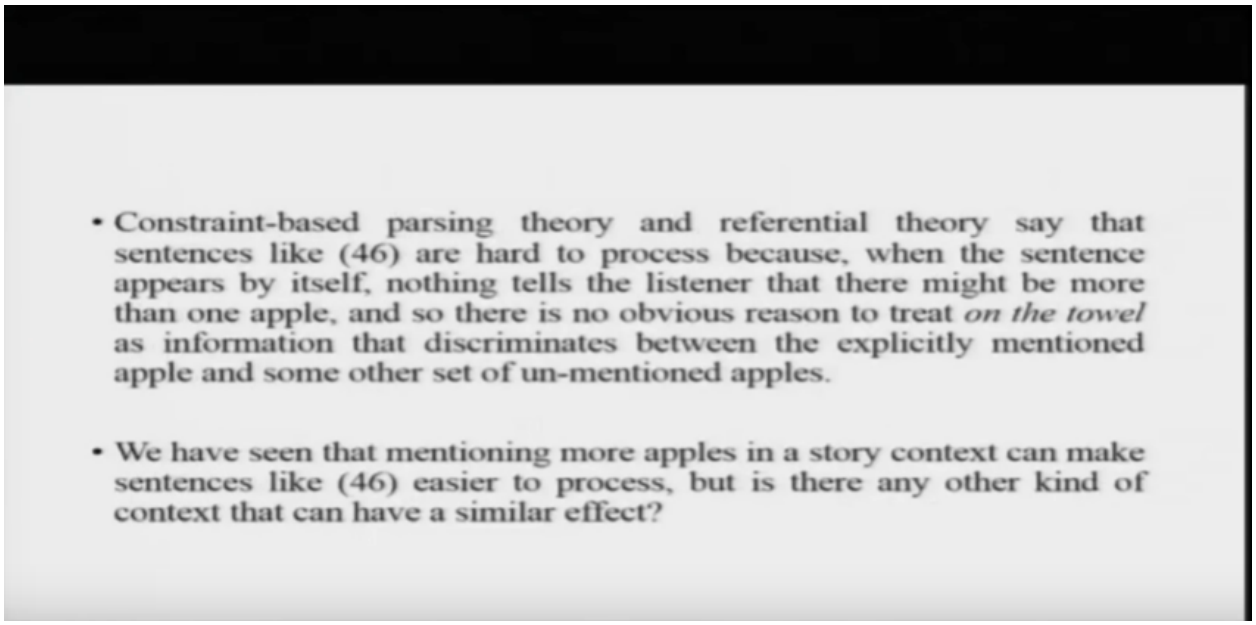

Now CPP says that and even the referential context theory says, their sentences like 46 are hard to process, but because of a different reason, then the sentence appears by itself, nothing tells the listener that there might, be more than one Apple. Okay? And so, there is no obvious reason to treat, on the towel as the source and that kind of leads to a problem. Okay? So, as information that discriminates between explicitly mentioned Apple and some other unmentioned apples. So, that kind of will lead to problems, you have seen that mentioning more apples, in the story context, like we did with the burglar drew blue, of the Safeway there are still log that case actually helps. Okay? So, you've seen that mentioning, more apples, in a story context can makes Indians like for a6 easier to process. But is there another way to make this easier.

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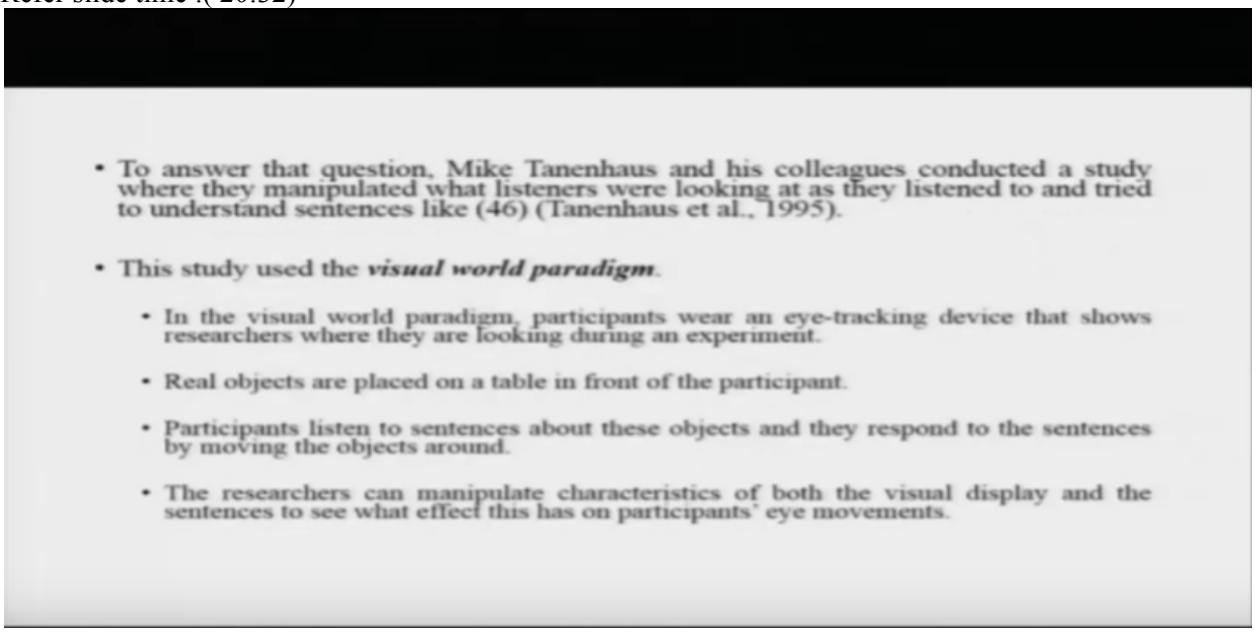

Yes the other way, is that you kind of provide a context. Let us look at that. Now to understand this kind of question, there are people like mike Tanenhaus and his colleagues, they conducted a study, where they manipulated what listeners were looking at, the visual context as they listened and try to understand sentences like 46. Now they do particular experimental, paradigm that is called a visual world paradigm. And the visual world paradigm is basically the department veers and eye tracking device that shows the researchers, where they are looking during an experiment. So, typically I am wearing a head based eye tracker. And I'm kind of again reading these sentences; real objects are placed on the table in front of the participant. So, I am kind of sitting on a table, there are real objects on a table, I'm wearing that tracker and I'm also reading the sentences. The participants are listening to the sentences, about these objects and they respond, to the sentences by moving the objects around. So, the girl moved the Apple on the towel in the box and I have to do so for example, please move the Apple on the towel in the Box something like that. And I will have to follow the instruction and the way, I follow the instruction, will tell you, how well or poorly I have understand, understood this, the researchers can manipulate the characteristics of both the visual display. And the sentence is how the sender's are being read. And to see how basically parchments eye movements kind of go, where do they go.

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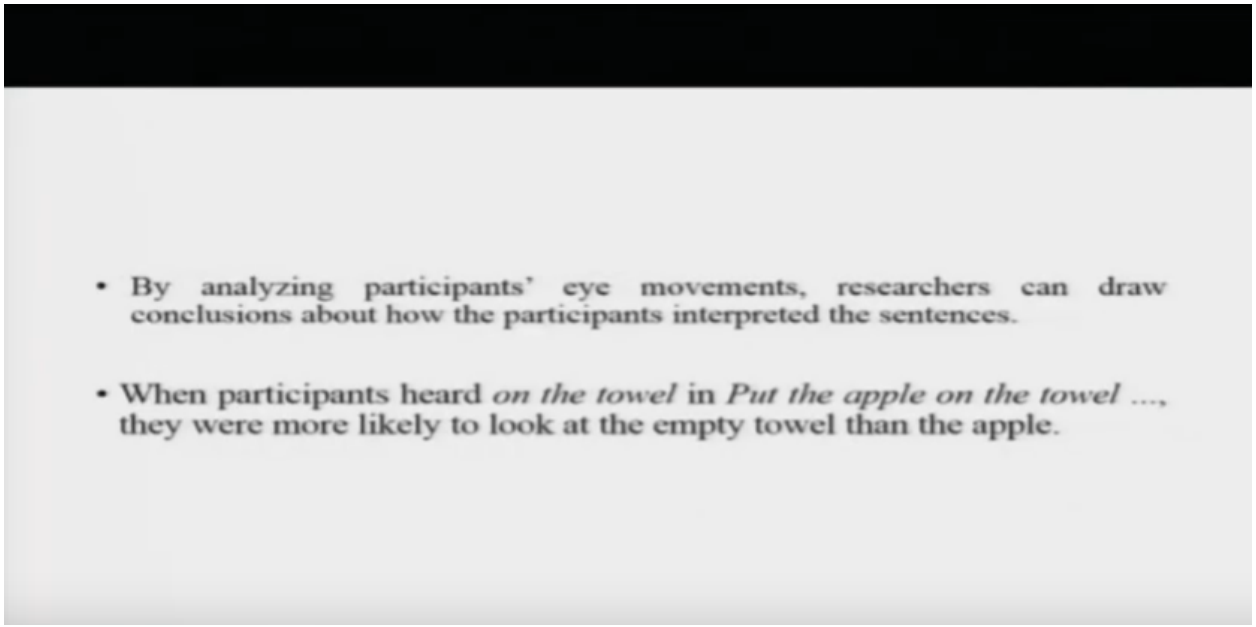

By analyzing the participants eye movements, researchers can draw, conclusions about, how the participants would have interpreted the sentences. Also by however moving, it or versus how I am kind of you know we are moving my eyes around, when participants heard, on the towel, in put the Apple on the towel in the box, they were more likely to look at the empty towel, rather than the Apple.

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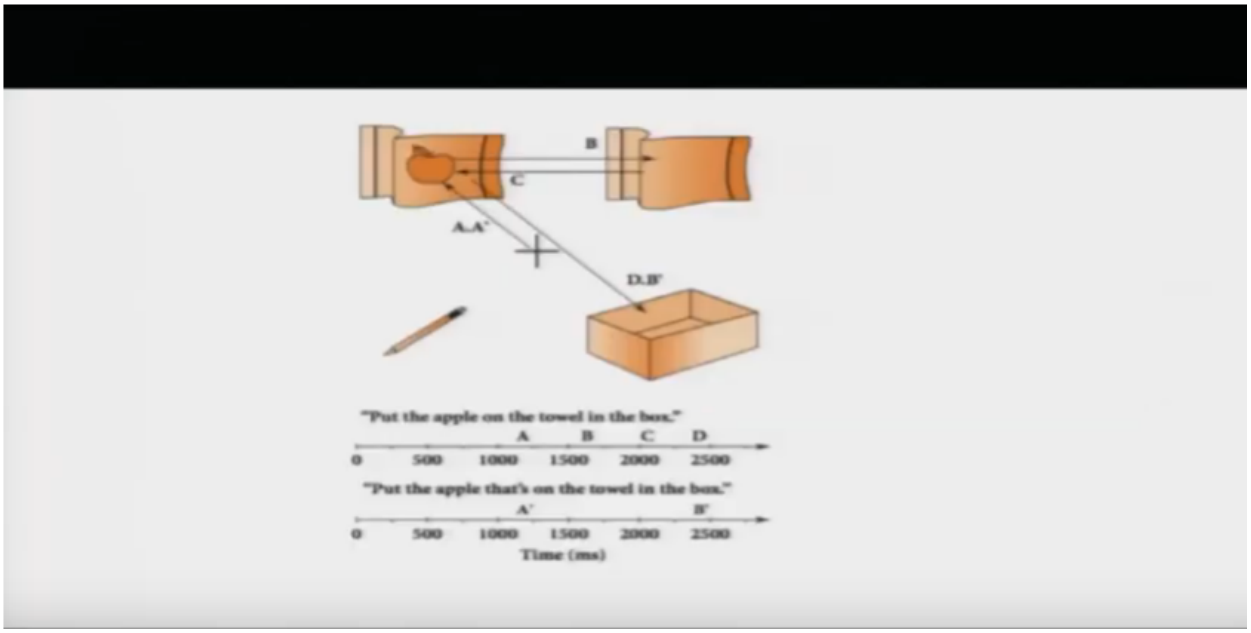

So, look at here. So, this is the setup, this is basically on the bottom you can see the time. And then you will see, two scenarios there is a box, there is a pencil, there's a Apple, on the towel and there's a towel that is empty, put the Apple, on the towel, in the box. So, what people are actually doing is, initially participants heard, on the towel, they were more likely to look at the empty towel, rather than Apple as soon as they hear on the towel the thing they. Okay? Apple has to be moved on the towel. Okay? So, they kind of go with that, however something really different happens,

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- But something very different happened when the visual display had two apples (one on a towel and one on a napkin) and an empty towel.
- Under these conditions, when participants heard *on the towel*, they were more likely to look at the apple that was on the towel, rather than looking at the empty towel.
- So it looks like participants were (correctly) interpreting *on the towel* as going with *apple* when the visual display had two apples.
- When the display has two apples, the expression *the apple* by itself does not successfully refer to either apple.

when the visual display has more than one Apple. Okay? So, under these conditions, what happens? When Parsons heard on the towel, they were more likely to look on the Apple that was actually, on the towel, rather than looking at the empty towel. Let us look at how this really happens.

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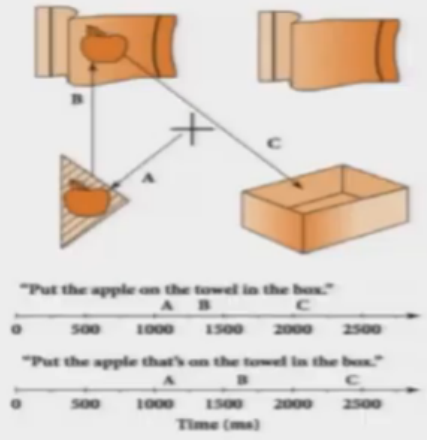

So, here you have two apples and you have two towels. Okay? When Apple is on the towel, one Apple is on the napkin then there is a box. So, when the people kind of are, hearing this sentence, in this kind of a scenario, there is you see, no ambiguity almost. So, people kind of say that put the tao, apple on the towel. So, which up the Apple on the towel, has to be put into the box, rather than the Apple on the napkin.

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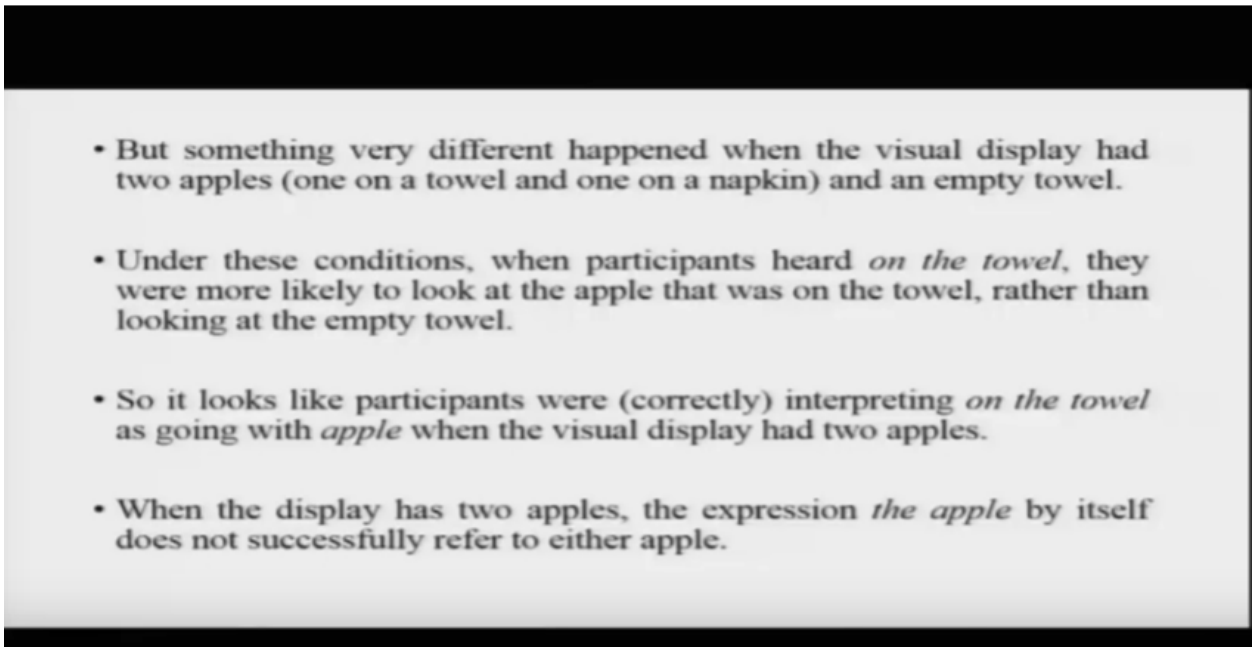

So, under the under the conditions, where there were two apples, when the persons hurt on the towel, they were more likely to look at the Apple that was on the towel, rather than looking at the empty towel. So, what happens is how did this happen how did this come about, it seems that the particles were correctly, interpreting on the towel in this case, because the visual context provided, them a means to interpret that. Okay? So, when the display has two apples, the expression the Apple itself kind of you know gets disambiguated by this by the following on the towel thing.

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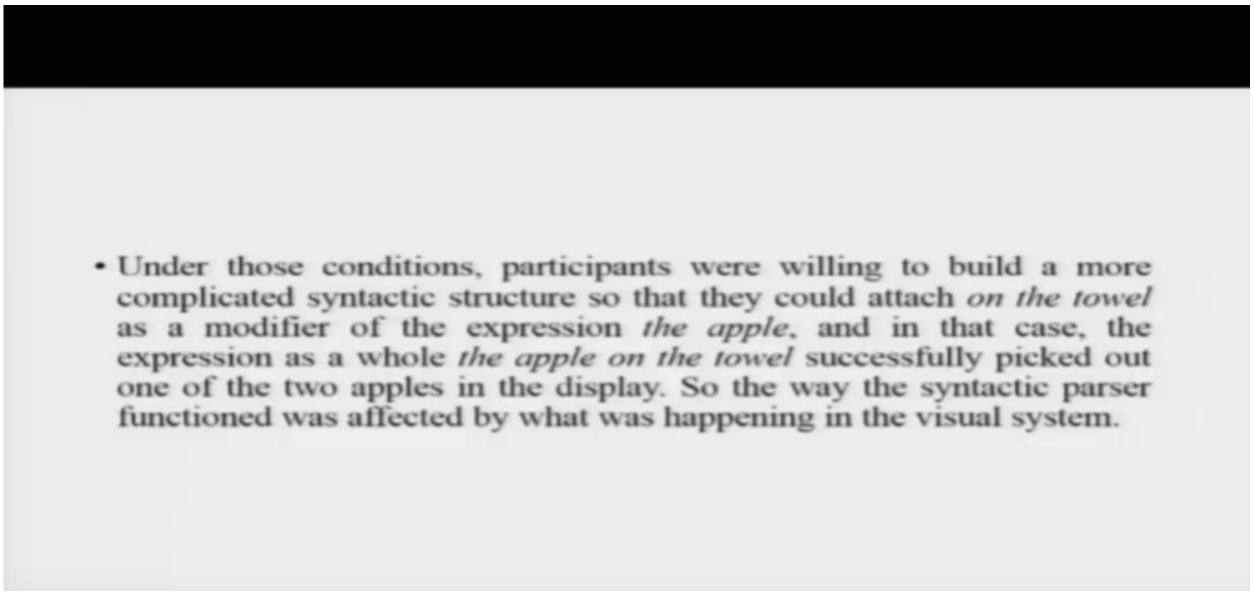

Under these conditions participants were willing to build a more complicated syntactic structure, put the Apple on the towel on the box is obviously kind of is going to, lead do you lead you to a more complicated structure. So, that they could attach on the towel, as a modifier of the expression, the Apple and in that case what happens is that the whole expression, the Apple on the towel is successfully picked up by the individuals. And it kind of leads to a sort of a disambiguating scenario, it's very easy to understand, when the context is helping you to. Okay? That is predominantly a demonstration, of how people kind of all the time use the visual context, to disambiguate a lot of you know, plausibly confusing, syntactical structure possibilities. Okay?

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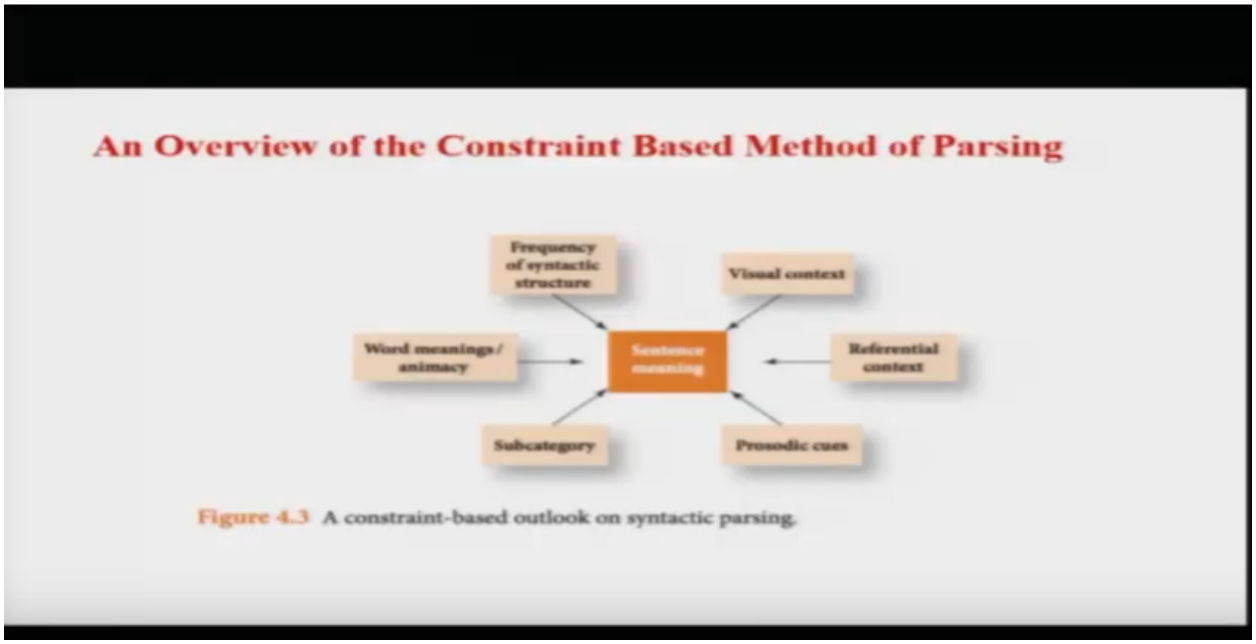

So, that brings me to the end of looking at the constraint based method of parsing. We've talked about at least six you know sources of information, that can affect or that can modulate your syntactic processing, what are these frequency, of the syntactic structure. We talked about that, word meanings anime see in anime see, grain size verb subcategory. We talked about that prosodic cues. We talked about that visual context, referential context, cross linguistic information. We talked about quite a few things, which may have you know an important role to play, on how we parse sentences. We had two theories one was the garden path theory, simply simple two-step two-stage process. But does not take into account a lot of different kinds of information. And the other theory was the CBP model of parsing, which had so, many of these information, all of which you can use simultaneously parallelly in order, to resolve any of the ambiguities arising from syntactic structure. So, that is all from me about,

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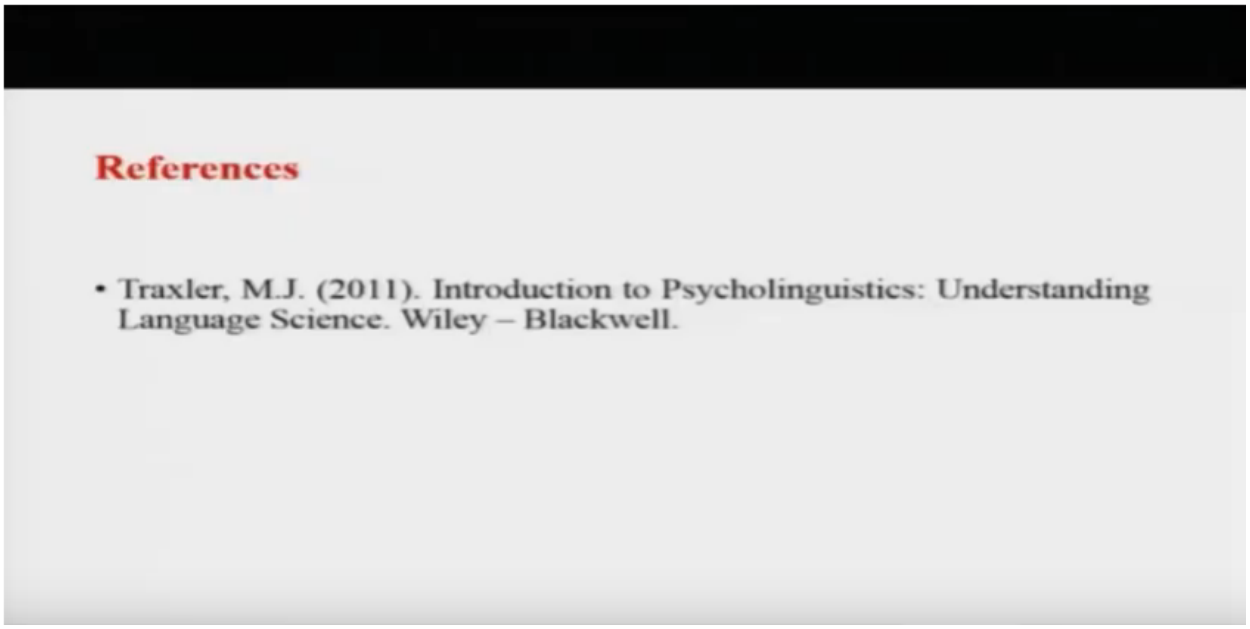

parsing there's one more lecture left and we talked about some of the other factors, continuing our discussion on parsing, with respect to sentence cooperation. Thank you.