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

Lecture- 16
Language Comprehension – I

Hello and welcome to the course introduction to Advanced Cognitive Processes. I am Ark Verma from IIT Kanpur and we have been talking about language in the past lectures; we have talked in the last two lectures about aspects of language acquisition. Today I am going to take the discussion towards comprehension of language see in the beginning we talked about, what is language? What are the salient characteristics of language?

And we also saw in the last lectures about how does a child acquire various different aspects of language and we appreciated that a child starts his journey with appreciating what are speech sounds as composed to not as opposed to non speech sounds and we talked about how does a child figure out segmenting this continuous stream of speech into words and then connecting words to meaning and eventually you know mastering the other niche other aspects of language like syntax and rules and those kind of things.

Today I am trying to give you a brief introduction into how the child or not even a child how adults might be making meaning out of stuff say for example, what are the critical aspects of understanding language and what I am trying to do here is I will try and divide the section into 2 parts I will first talk about words in today's lecture I will try and take you to sentences and larger texts in the different in a different lecture. So, let us begin with talking a little bit about words, now if you remember again taking you back to the first lecture in language we defined language earlier as a system of symbols and rules.
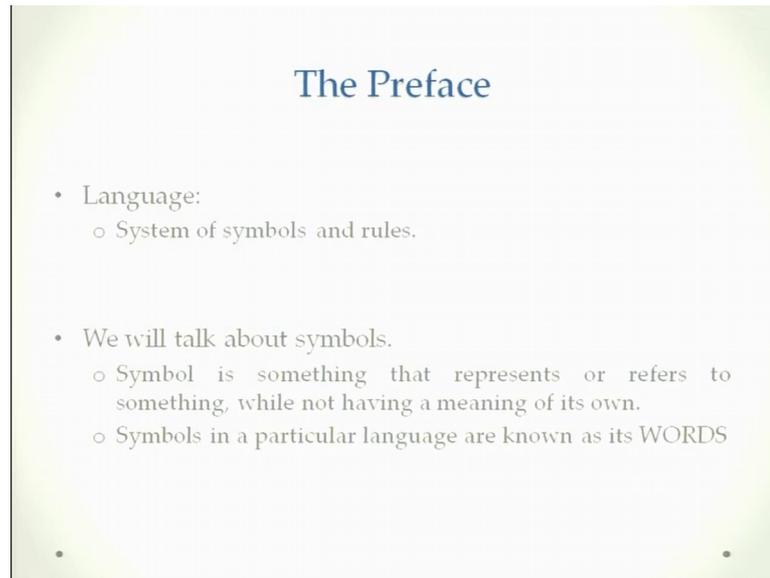
In today's lecture our attempt will be to talk about these symbols. So, what is a symbol what does a symbol really signify a symbol is something that represents or refers to something while not really having a meaning of it is own. Suppose I could say that the word apple refers to the red fruit called apple, which is sweet in nature, which is found in place like Shimla or California or someplace like that. But the sound apple in itself does not really have any meaning.

So, it is a major task for somebody who wants to comprehend or understand language to be able to link between apple that is the form of this you know word the sound of this word or the written aspect of this word to the meaning which is the fruit itself and the various connections, you might have with relation to the fruit, you might remember that it is sweet, you might remember that it is edible and those kind of things.

So, symbols in a particular language are referred to as words and I am again talking both about written words and spoken words, but you will see me really we are shifting from written to spoken word form because generally I am just talking about language at the moment I am not really talking about only speech or I am not really talking about only written word form.

So, we will try and understand in this lecture about how people you know.

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Use words now this is a again cartoon strip I came across during the in you know on the internet and you know sometimes we will come across with these kind of things you know it is difficult to describe in words, a lot of times you will wonder that this is something I want to talk about, but I am finding it slightly difficult to describe this feeling or this emotion in words. The point is and that is exactly what words are supposed to do is not it I mean words are supposed to describe phenomena and events and objects and so on and so forth and they do it in a pretty interesting way suppose I mean if you look at the examples.

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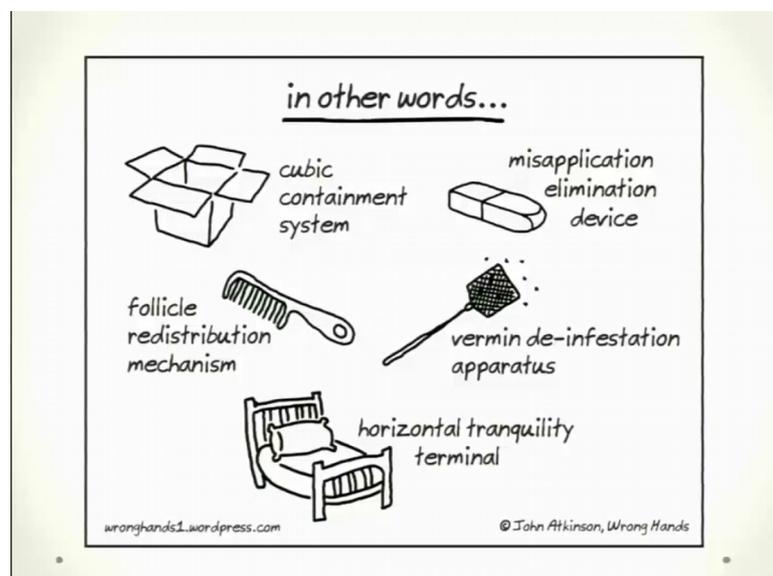
I am putting up here copyright to john Atkinson from this wrong hands, but the idea is if you see I mean we are using you know objects here and describing them using these set of words, typically you would probably you know refer to the comb as a comb itself, but you know you can also choose to describe it in other words and that is pretty much what the function of words is the function is to describe or to in some sense denote the physical object or an event that is happening in a symbolic form.

So, all of the words that you will come up with are symbols for what is actually happening and as a comprehender as somebody who wants to understand a particular language what you have to do is connect this symbol to the actual physical object or the actual physical event that is taking place. So, again these are some of the examples I kind of picked up and brought in here for you to see.

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Let us now move on to how do people talk about words?

How do you academically approach the concept of understanding words? So, when you talk about words or symbols for that matter there are two things that you would want to you know appreciate, first is the form of the symbol or let us say the form of the word and when I am taking word I can talk about two things here, I can talk about how the word sounds that is the sound form or the phonological or the phonetic form and I can talk about nowadays because you write almost everything.

So, you can talk about the orthographic form or the visual form so, that is the phonological form, sound base form, there is the orthographic form, that is the visual form and the other important aspect is other than form you also need to connect the form with some meaning. So, you would want to know, how is it that you are storing the meaning of this word, how is it organized in the brain and we will talk about these 2 aspects in the course of this lecture and I hope by the end of it you kind of make the both of these connections and try and understand how word meaning is understood.
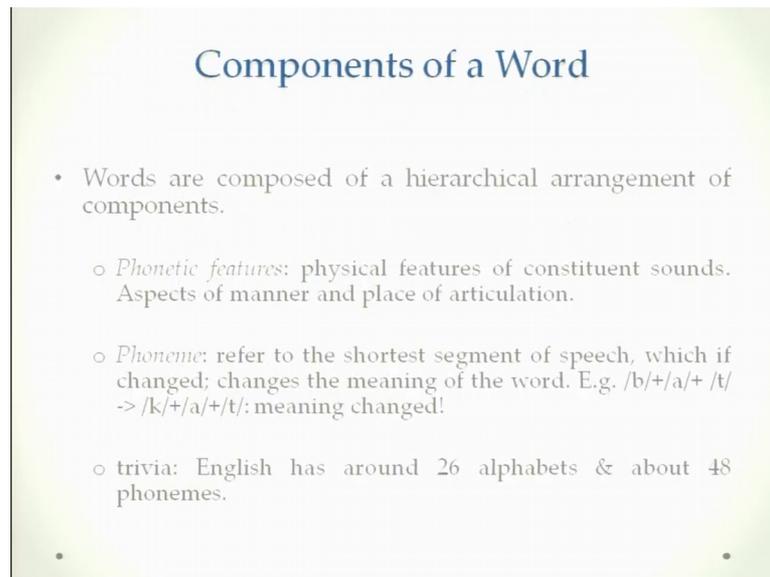
So, let us begin with the form let us begin with how words are constructed. So, when you talk about physical sound based features then you are actually talking about what is called phonetics. So, the idea is you are basically concerned with describing the constituent sounds of the word because most language is spoken language I mean; obviously, we are writing it nowadays or we have been writing language for you know thousands of years now.

But the primary form when I am talking about language is sounds. So, you have to appreciate the phonetics or the physical features of the sound you know, what is the energy content? What is you know, what the frequency, where in the vocal tract the sound is being produced from those kind? What is the manner of articulation? These are some of the features you would like to talk about when you are talking about the phonetic features of a particular word, this is one aspect the other aspect is, what are the sounds that the word contains?.

So, now, you are coming on the phonemic or the phonological aspect of it so, basically the phonological aspect will tell you how many phonemes a particular word has and a phoneme is basically is the shortest segment of speech which if you change it will change the meaning of the word let me give you an example. Suppose there is a word called bat, bat has 3 phonemes let us say ba and ta and if you change the first phoneme if

you kind of replace it with ka then you have ka and ta bat becomes cat the meaning has also changed.

So, a phoneme is the shortest segment of speech which if you change it from the beginning of the word or the end of the word it is bound to change the meaning of that word. So, basic sound is if it is replaced, just a trivia fact that English as a language has around 26 alphabets and it has around 48 different phonemes 48 sounds from which the entire English language is actually constructed.

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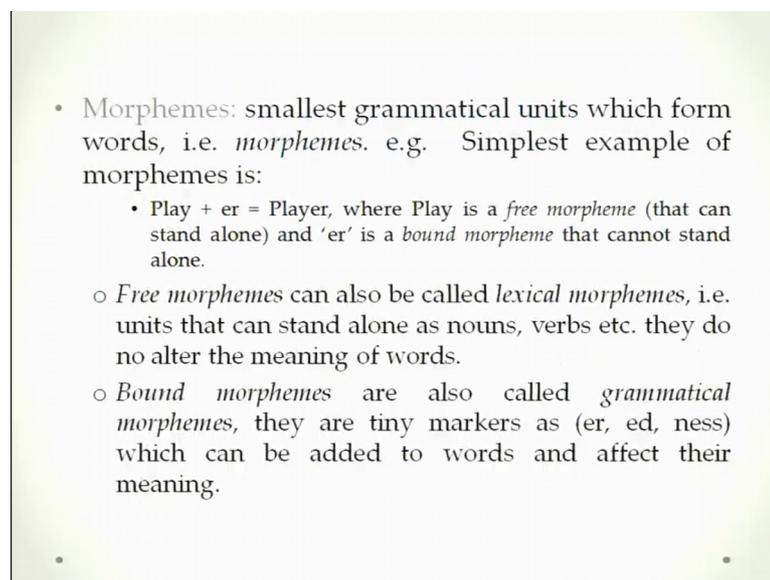
So, this is one so, phonetic features phonemic features those are the other things also when you are talking about how words are constructed, then you would be actually talking a little bit about morphemes or this field which studies morphemes or different kinds of morphemes called morphology. Now, what is a morpheme? Morpheme is basically the smallest grammatical unit in a particular language suppose say for example, there is a word called player and you can see the example here in the slide play and er these are the 2 units.

So, play is referred to as a free morpheme or a lexical morpheme and these things have an entire meaning of their own, they can be used as they are and they can be used as independent words. On the other hand you might have you know affixes like er, ed, ness and those kind of things these things if they are attached to particular words also have an impact on the meaning of particular of these particular words they can turn them into

past tense they can turn them into plurals passives so, on and so, forth, but these things basically more or less have a grammatical function. Suppose if I am if the word is player and I am you know adding er to the word play here er is basically telling me that I am not talking about the act of play anymore I am talking about the person who plays the game.

So, it is performing a grammatical function that is why it is referred to as a grammatical morpheme it is also referred to as a bound morpheme for the reason that if you just look at er independently it does not have a meaning of it is own it does not really stand alone on it is own in the entire language; however, it changes the meaning of the word to which it is added to.

So, that is why it needs to be bound to something to be of you know to be something of an entity for that matter. So, you have in morphemes you have free morphemes words like play, sleep and those kind of things and you have bound morphemes which are words like er and you know a y for example, if you had to sleepy if you are making those kind of things. So, those are bound morphemes the first is free morphemes then yes bound morphemes.

So, we talked about phonetics we talked about phonology in terms of phonemes and we are now talking about morphemes and morphology.

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Some typical effects in word perception

- Context affects our perception of language.

  o Phonemes: *phonemic restoration effect* (Warren, 1970).
  o Meaning as an important aid to perception, "top-down" influence.
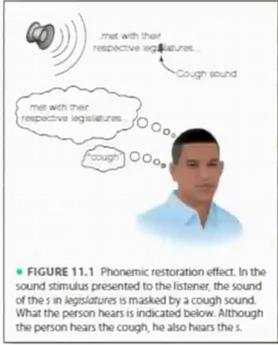
● FIGURE 11.1 Phonemic restoration effect. In the sound stimulus presented to the listener, the sound of the *s* in *legislatures* is masked by a cough sound. What the person hears is indicated below. Although the person hears the cough, he also hears the *s*.

Image: Goldstein (2010). Cognitive Psychology_Connecting Mind, Research & Everyday Experience. *Wadsworth Publishing.* Page: 298.

Now, before I move further let me just describe some of the very typical effects people have come across who have researched with word perception or production etcetera one of the very interesting effects happens at the phonemic level is suppose you know you are listening talking on a you know disturbed phone line, a lot of times you will see if during the you know conversation there are parts of the signal that are missing parts of what the other person is saying and you could not hear a lot of times your mind kind of fills up that gap.

So, there was this experiment done by warren in 1970 and basically the idea was to present participants with the conversation on the phones in some sense and at a critical part. So, for example, if the sentence is met with their respective legislatures just at the point where the s has to be there they in induce the coughing sound. So, when the coughing sound comes the participant does not really hear the s. So, the parsimony is hearing met with the legi and the coughing sound and lature.

So, he is not really heard the s, but then later participants were asked what did they hear and most of the participants ninety percent of persons probably mentioned and they said that they heard the s sound even though the sound the s sound was actually never really you know even presented. So, the idea is that a lot of times because we know the meaning of the word because we have already predicted what words they will be, what we do is, we fill up these missing parts of the signal this as this effect is basically called the a phonemic restoration effect.

So, the phonemic restoration effect is basically because you know the meaning of the word you are filling in the missing phonemes and this filling in of the missing phonemes is also referred to as a top down effect in perception it is a top down effect because your brain or your mind already knows the meaning and it is trying to intervene in the basic procedure in the basic you know incoming source of information just by supplying what aspects are kind of you know if the signal, signal is shoddy.
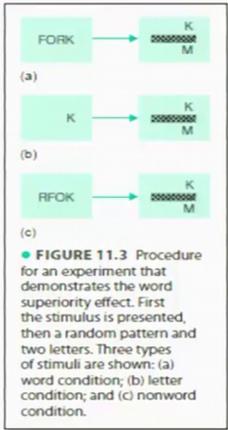
If the network is not very clear, then because you already know the signal it is like you know because you already know the ally and somebody is trying to tell you the paths to reach somewhere because if you know the location little bit sometimes you can also pitch in, this is the you know thing I know already. So, this is a little bit of what our you know perceptual system, does also this is helped a lot by context as well. So, in a

particular context sometimes you are aware of what the conversation is going to be about.

The next important effect is a bit similar to what I was already talking about is referred to as the word Superiority effect.

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It was demonstrated by Reicher in 1969 and Reicher actually showed that if you want to give participants a task of recognizing letters or memorizing letters and if you can present these letters in you know 1 of 3 forms first is if you see the figure a here again this is the figure is borrowed from Goldstein's book.

The figure a here the idea was we had to ask participants whether a particular letter was there suppose the R was there or not first part is when the letter R is embedded in a word the second form is the letter K is presented in an isolated fashion and the third presentation is when it is embedded in a non word kind of a fashion just a string of letters and you have to remember a particular letter it was seen that letters were remembered much better letters were easier to remember if they were contained in a word as opposed to contained in a you know non word scenario or just presented in an isolated fashion.

So, this is a word superiority effect this is again a context based effects in some sense because if you kind of remember the word and words are slightly easier to remember than non words or letter strings, because you kind of just remember that fork was the

word that was presented you will be able to remember that F O R K all of those 4 letters were there if you just kind of present a thing like this RFOK then basically because it does not really have a meaning you will have to remember each of these letters separately and that is a cognitively more demanding task. So, your performance will anyways suffer here so, these are the two effects the other effect also is in terms of understanding words or perception of words is, what is referred as the frequency effects.
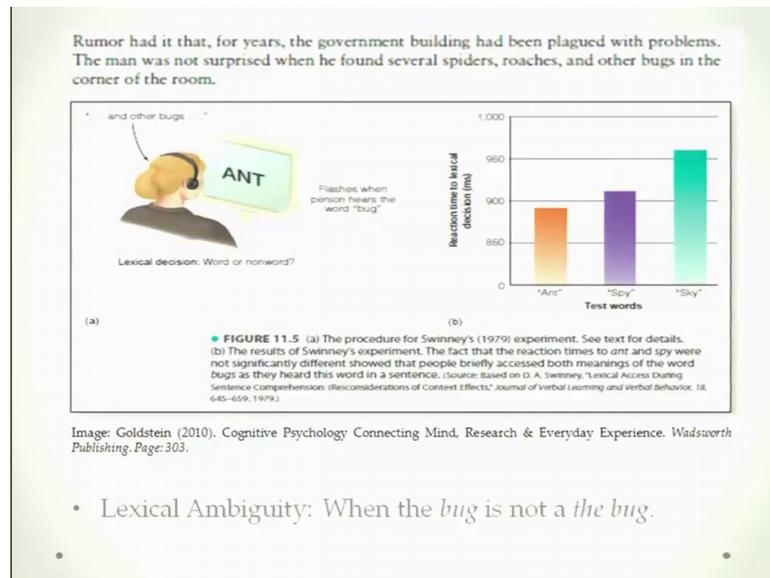
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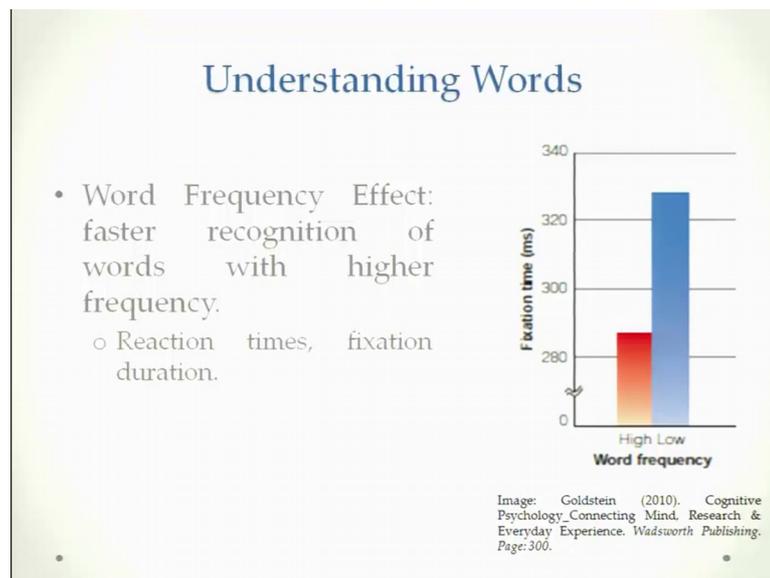
Now the frequency effect basically says that whatever dependent measure you are getting reaction time or fixation duration or those kind of things for words that are high occurring in frequency the words that occur with high frequency are remembered are sorry are responded to faster as compared to words that are occurring in you know less frequency. The idea is frequency basically is the number of times a particular word occurs if you take a sample of let us say one million words from the entire you know spoken language or written- language or wherever.

Now, if a word is occurring let us say 5000 times or 10000 times or 20000 times in this one million corpus it is very likely that you have come across with this word. So, many more times as compared to if a word is appearing only for you know hundred times or 200 times or 300 times. So, the idea is the words which you have encountered more you will react to them faster, in terms of making decisions about semanticity making decisions about whether it is a word or non word even making sound or other kind of

decisions. So, this is referred to as the word frequency effect and again this is a very robust effect and it is there for people to see across so many different languages, now the final effect I wanted to talk to you about is called the lexical ambiguity effect.

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Rumor had it that, for years, the government building had been plagued with problems. The man was not surprised when he found several spiders, roaches, and other bugs in the corner of the room.

● FIGURE 11.5 (a) The procedure for Swinney's (1979) experiment. See text for details. (b) The results of Swinney's experiment. The fact that the reaction times to *ant* and *spy* were not significantly different showed that people briefly accessed both meanings of the word *bugs* as they heard this word in a sentence. (Source: Based on D. A. Swinney, "Lexical Access During Sentence Comprehension: (Reconsiderations of Context Effects)," *Journal of Verbal Learning and Verbal Behavior, 18,* 645–659, 1979.)

Image: Goldstein (2010). Cognitive Psychology Connecting Mind, Research & Everyday Experience. *Wadsworth Publishing. Page: 303.*

- Lexical Ambiguity: When the *bug* is not a *the bug*.

Now, lexical ambiguity is something and this is again an experiment which was done some time back this was done by Swinney in 1979 and the lexical ambiguity stuff is something like you know that sometimes a particular word does not mean just one single thing it might mean a couple of things or 3 things or 4 things and depending upon the context you will make out what is basically being referred to.

Suppose if I am talking to you know if I am giving a sentence that X went to the bank for lunch now if there is a river nearby you would probably imagine they have gone to a river bank for lunch not really a you know bank which is a monetary institution, but suppose I am a bank employee and I am saying he is gone to the bank for lunch then you might think maybe he is gone to his office for lunch maybe there is a party there or something like that.

So, Swinney did this experiment he presented the person with this sentence I am just going to read it out for you now. So, the sentence was rumor had it that for years the government building had been plagued with problems the man was not surprised when he found several spiders roaches and other bugs in the corner of the room. Now again there are 2 kind of context here, one context is that we are talking about a government

building and the other context is more local because I am talking about spiders and roaches and other things. Now the word bug might mean either an insect which is more congruent to this local effect or it might mean in terms of government building something you know a device that kind of is used to tap information illegally.

Now when the participants were hearing this in a headphone they were being presented with the lexical decision kind of a task and in this task they had to actually respond to words that were coming and those words could be either very either related to in you know insects or something or related to spy utilities or something or just unrelated and it was seen that while they were hearing this their reaction times to ants etcetera was much faster because the local context is congruent and their reaction time to with a spy or a spy utilities was also slightly better because again you are talking about a government building and that you know context is there.

But the reaction timing was unaffected were slightly larger when you talk about unrelated things like sky so, this is called the lexical ambiguity kind of an effect. So, a lot of times sing single word might mean multiple things, but the context might help you resolve the meaning we might talk about this at some point later in the lecture as well. So, these were some of the basic effects you will come across you know across different range of studies when you talk about people really trying to understand words.

Let us now kind of move towards recognizing words let us see how this is done now the act of recognizing words is basically you know you have to access a representation of that word in your head.
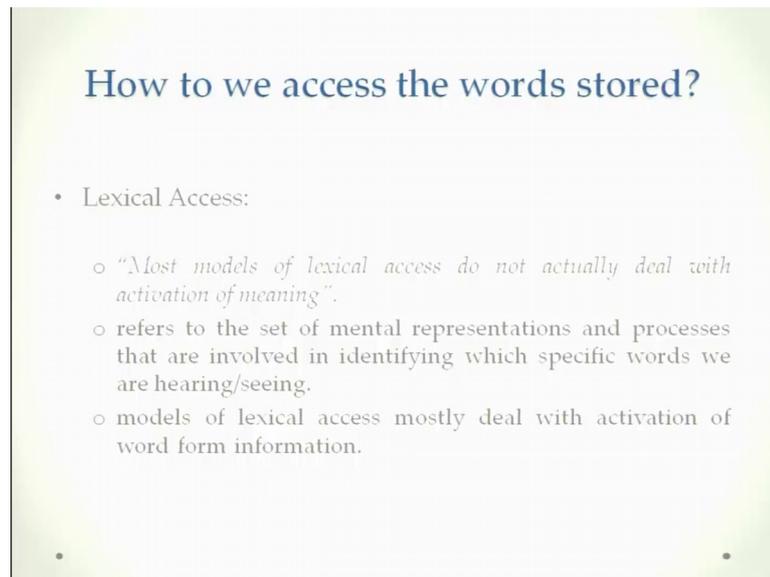
And this representation accessing of this representation in your head is referred to as lexical access. Now again lexical access is not really complete meaning making, lexical access is reaching the point where you reach the representation of the word be it visual or be it auditory and after that only meaning will be generated. So, when I am talking about lexical access let me define this for you most models of lexical access do not actually deal with activation of meaning rather they deal with activation of form it is assumed that you have a mental dictionary mental dictionaries refer to as the mental lexical and the mental lexical is storing representations of words.

Now if it is the auditory lexicon it is storing auditory representations if it is a visual lexicon, it is representing the visual features of the word. Now what happens is whenever somebody is speaking that word in the auditory domain, the auditory lexicon you know the representation of that word in the auditory lexicon will be activated. If you are reading that word somebody is showing you the written form of that word then their representation in the visual lexicon will be activated and only after this you will be able to recognize this word which is spoken or shown to you and you will understand the meaning and so, on and so, forth you know this aspect is called lexical access.

Let me just define this to you again lexical access refers to the set of mental representations and processes that are involved in identifying which specific words we are seeing or hearing also models of lexical access as I said again mostly deal with just

the activation of meaning and not with the activation of form or anything else. So, let us move ahead with this you know understanding.
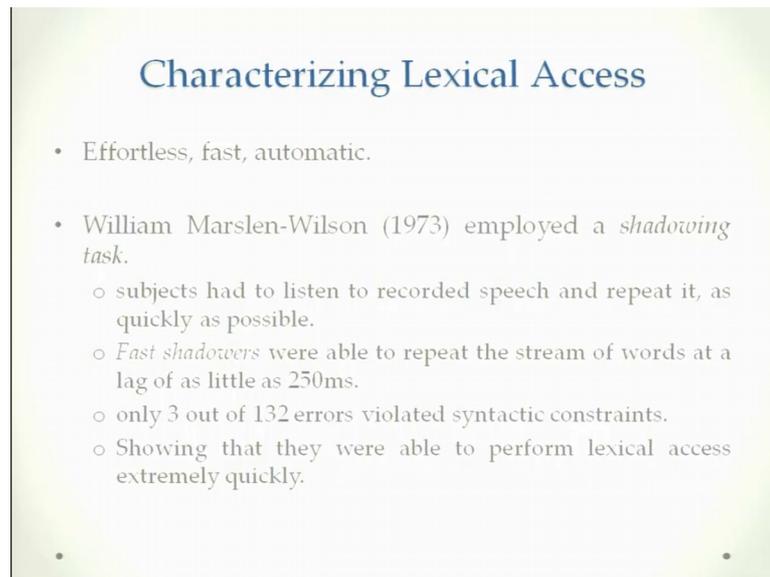
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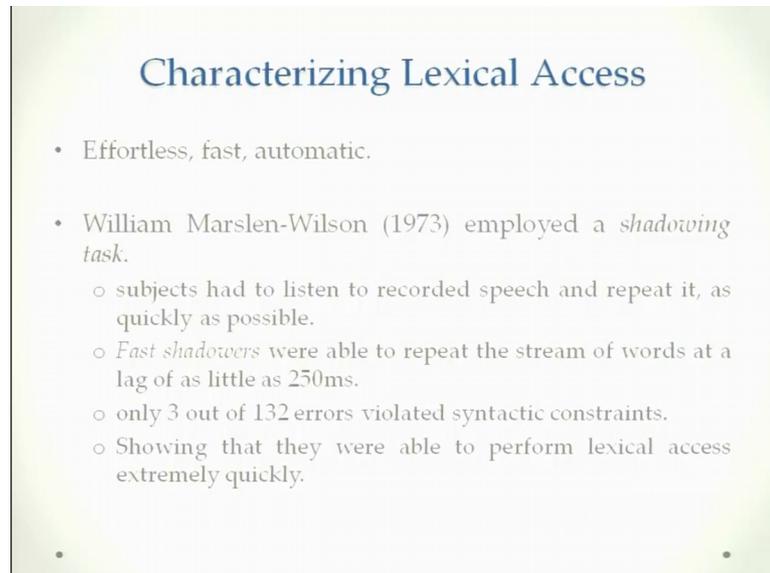
Characterizing Lexical Access

- Effortless, fast, automatic.

- William Marslen-Wilson (1973) employed a *shadowing task*.
    - subjects had to listen to recorded speech and repeat it, as quickly as possible.
    - *Fast shadowers* were able to repeat the stream of words at a lag of as little as 250ms.
    - only 3 out of 132 errors violated syntactic constraints.
    - Showing that they were able to perform lexical access extremely quickly.

Now lexical access is something which is very fast it is effortless you do not really you know decide to activate a word or something it just when you see a word or hear a word lexical access is already achieved, it is very fast, it is effortless and it is almost automatic unstoppable kind of a thing. Also William Marslen – Wilson, William and William Marslen and Wilson actually showed this in one of the experiments and it employed a shadowing tasks and the shadowing task was that the participants were hearing something hearing the recorded speech and they had to repeat it just after the recorded speech.

Now, I will talk to you about production in some time, but the idea is if you have to repeat something if you have to produce something this has to start from the top from the lexical access part. So, the idea is if people are able to repeat it they must be going through the lexical access and with this assumption they showed that fast shadower people who could very quickly repeat this did this repetition with as quickly as 200 and milliseconds. So, lexical access is something that is happening very quickly it is happening around 250 milliseconds which is just one - fourth of a second for a word.
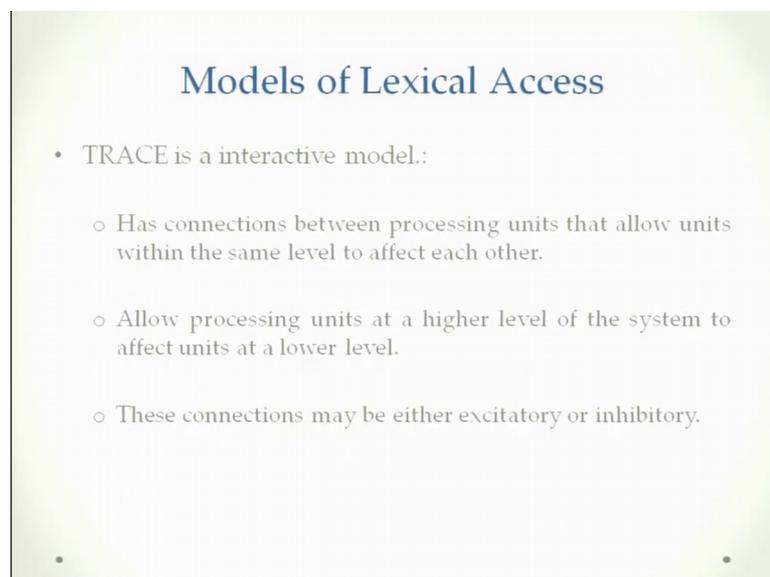
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Also it showed that you know people are very good at gaining this information because there were only 3 errors which were actually a major errors, but for the most part there were very little errors in this kind of a task.
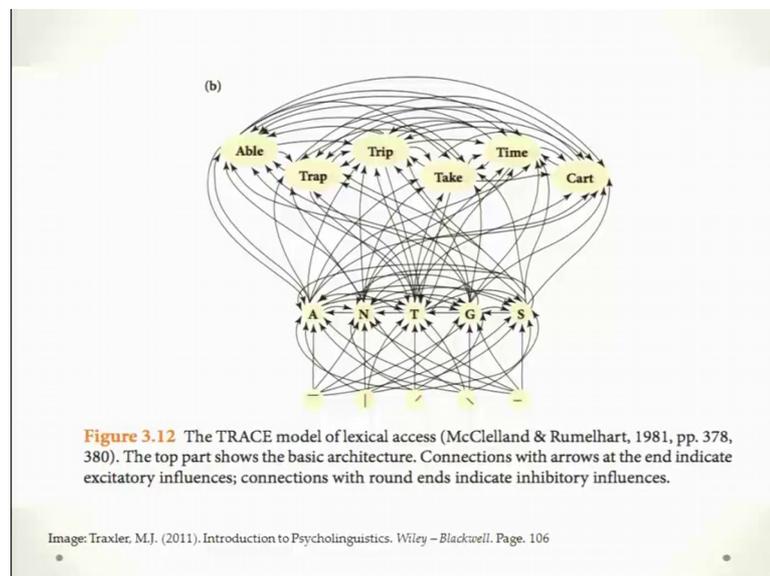
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So, this is there and let us now visits couple of models of lexical access. So, one of the models I will talk about is the trace model, trace model is basically a model of visual lexical access you know reaching out to visual word forms. Now trace model I quickly show it to you in a in a moment, it has basically 3 levels it has a feature level, it has a

letter level and it has a word level. Now at a feature level and there are connections between these different units. So, it has basically connections between processing units that allow units within the same level to affect each other. I will show you about all of these things in a while it also allows processing at a higher level of the system to impact the lower level of the system if you remember we are talking about word superiority effect or phonemic restoration effect.

So, there is an scope of top down influence from there suppose I am reading a word as soon as I have just read half the word because I know the meaning I will kind of fill it up and I will say the task is done. These are the kind of things that will help me achieve a very fast pace of reading, we will see how this model really works and the connections between these 3 levels which I am saying the letter at the feature level, the letter level and the word level are can be either excitatory or inhibitory. So, it might be that you know input coming at one level might excite you know a representation at the next level or they might inhibit representations at the next level.

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Figure 3.12 The TRACE model of lexical access (McClelland & Rumelhart, 1981, pp. 378, 380). The top part shows the basic architecture. Connections with arrows at the end indicate excitatory influences; connections with round ends indicate inhibitory influences.

Image: Traxler, M.J. (2011). Introduction to Psycholinguistics. *Wiley – Blackwell*. Page. 106

So, this is how the model really looks if you look at the bottom you will see that these are features horizontal line, slanted lines, vertical lines, then you see in the letter level there are letters which are made up of these features. So, you will see if there is a word you know if there is a letter called T, T is basically linked favorably by a horizontal segment and a vertical segment N is basically linked positively by 2 vertical segments

and one slanted segment and similarly you will see from the letter level the activations go upwards and then there are words which have either A or N or T and if there are words like A and N they will actually activate only those words where A and N are both present suppose there is a word like banana.

So, then A and N will both activate those they will try and inactivate or inhibit other words that do not contain both of these letters. So, this is one way where competition is kind of you know playing out so, again you can look at this again and the model of the trace model is freely available for you to look at.

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Image: Traxler, M.J. (2011). Introduction to Psycholinguistics. *Wiley – Blackwell*. Page. 106
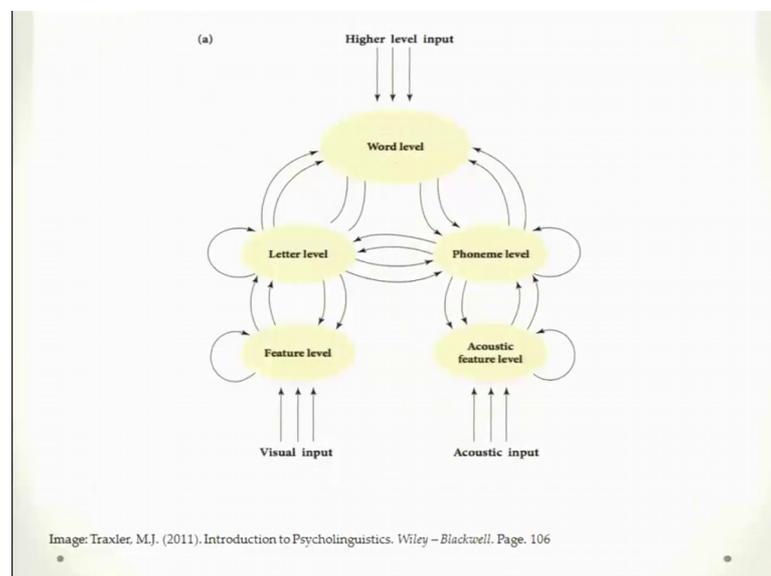
Now, this is how the processing really works. So, you have the visual input or you might have the acoustic input, now from the visual input level I am just talking the input goes to the feature level, feature level input goes to letter level, letter level goes to word level, you will see there is no feedback from the letter level from the feature level downwards, but the idea is that there is this interaction between the word level and letter level and letter level and feature level.

Similarly if there is a acoustic input you will see that there is a acoustic features phonetics phonemes those kind of things then your acoustic features in your phonemic features and then you have word level features this is how the activation of words will actually happen.

Let us talk a little bit more in detail about these things now, the most basic unit of analysis in the trace model is the visual features the visual lines you know slanted lines, horizontal lines, vertical lines.

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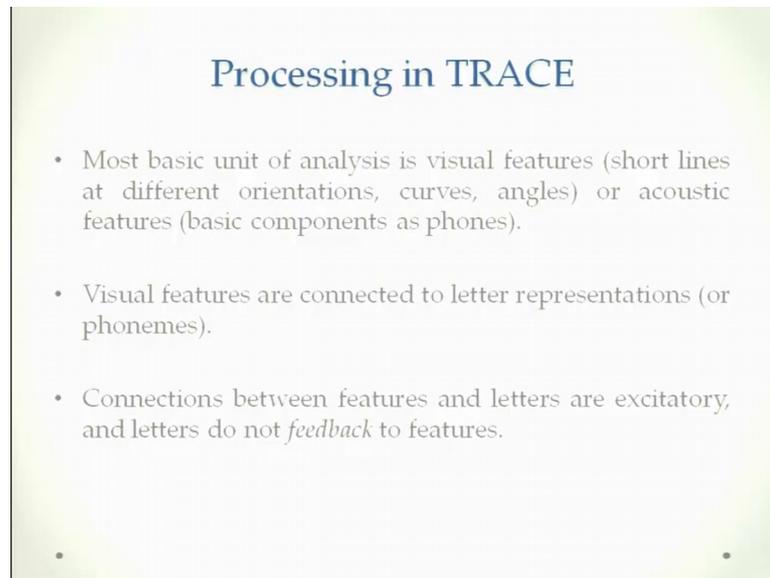
Processing in TRACE

- Most basic unit of analysis is visual features (short lines at different orientations, curves, angles) or acoustic features (basic components as phones).

- Visual features are connected to letter representations (or phonemes).

- Connections between features and letters are excitatory, and letters do not *feedback* to features.

Or if you are talking about auditory then there is an acoustic level, now visual features are connected to letter representations the you know the bottom level is connected to the second or later level and then connections between letters and features are excitatory, but letters do not feedback to features. So, letters level can does not really rule out the features because all the features need to be present.

- Using cascaded activation, visual features in TRACE start to send any activation forward as soon as they begin to be identified; so letter level becomes active soon after activation in feature level.

  o Individual features are connected to more than one letter units, (-) is connected to "A", "T", "G" etc. in an excitatory way while it is connected to "N" in an inhibitory manner.

  o Within the layer of units representing letters *all* of the connections are *inhibitory*.
    - When a letter-processing unit starts to get activated by the bottom up input, it will try to decrease the activation of the other letters it is connected to: *lateral inhibition*.

Using a mode of activation called cascaded activation what is cascaded activation cascaded activation is if there is activation received at a lower level then it will automatically start activation in the upper level and in the upper level it does not really wait for the process to be completed at this level and only then the activation will go. So, cascaded activation any activation that begins any input that is coming in will already activate the up of levels as well. So, the letter level becomes active very soon after activation at the feature level and so, on; in the word level also get activated.

So, individual features again I am just describing this whole thing to you. So, individual features are connected to sometimes more than one letter you saw the slanted lines are connected to A and N for that matter the horizontal and vertical lines are connected to G and T and so, on and so, forth. Now within a layer of units within the feature level or within the letter units there will be things like you know it will be representing letters of all the connections and some of these connections will be in inhibitory in nature as well.

So, when a letter processing unit starts to get activated because of the incoming input, it will try to decrease the activation of other letters. So, in the same level one letter is getting activated so, A is getting activated, at the same time A is trying to deactivate G because this is the competition that is happening this competition here is referred to as lateral inhibition.

Now, there are 26 letters not all should get activated so, as soon as the evidence for one of the letters starts increasing the evidence for the rest 25 starts decreasing that is how a will actually win up and it will go up and it will be recognized as one of the constituents of the word that you are reading second cycle second letter will go third cycle third letter will go and this is how the recognition of the word will happen similarly for phonemics as well one sound gets activated then the other sound gets activated and so on and so forth.

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- Letters have excitatory connections to the words they are components of, and inhibitory connections to words that they are *not* components of.
  - "a" -> able, trap but −x time.

- Letters also have excitatory and inhibitory feedback connections from the word level.
  - "able" will start to activate "b", "l", "e" but start to inhibit other letters.

- This property helps the user to deal with *degraded input*.

Now letters have excitatory Connections to the words because letter will look for whatever words are constituted by them and they are components of and they inhibit other words that they are not concerned and they are not part of. So, if the letter A is there it will activate all the letters that contain A. But it will at the same time try and inhibit all the words that do not contain a suppose there is a word called fry and there is a word called fram and A is getting activated, A will activate fram and similar words a bit more, but a will try and deactivate words like fry or fly and others because it does not contain a letters also have excitatory and inhibitory feedback connections from the word level.

So, once suppose for example, I am talking about you know a festival and some frying has to be done and whenever I see the word you know fram as fr is there I am kind of expecting that fram is supposed to be there I will automatically kind of boost the

activations for a because I am expecting that word to be there and trying you know take away the activation from the another word like fry or something because idea is I am also trying to have it this top down influence on selecting the words both of these the combination of both of these processes basically what is going to make my access faster.

So, this is something and this basically this is the property which I was already referring to will help users deal with some kind of degraded inputs suppose you are trying to read something the ink has spilled you cannot read the entire thing, but if you can read the beginning and if you can read the end a lot of times you will be able to fill up the middle part you know the just like the experiment in legislatures so, that is one of the aspects.

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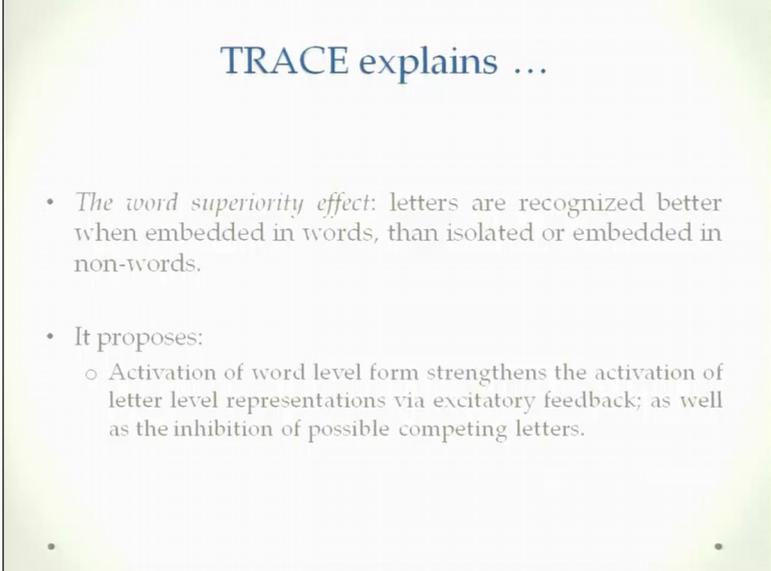
Now trace using the same property can explain what is referred to as the word superiority effect, letters are recognized better when embedded in words and not when presented in an isolated fashion proposes that activation from the word level strengthens activation at the letter level representations via excitatory feedback as soon as you have received almost half of the word, but something is missing you will kind of get a feedback from the word level to the letter level which will kind of help you, you know select the correct input representation and in that sense the word superiority effect will be there because you already know what was the word. So, this is again one of the things that the trace model explains.
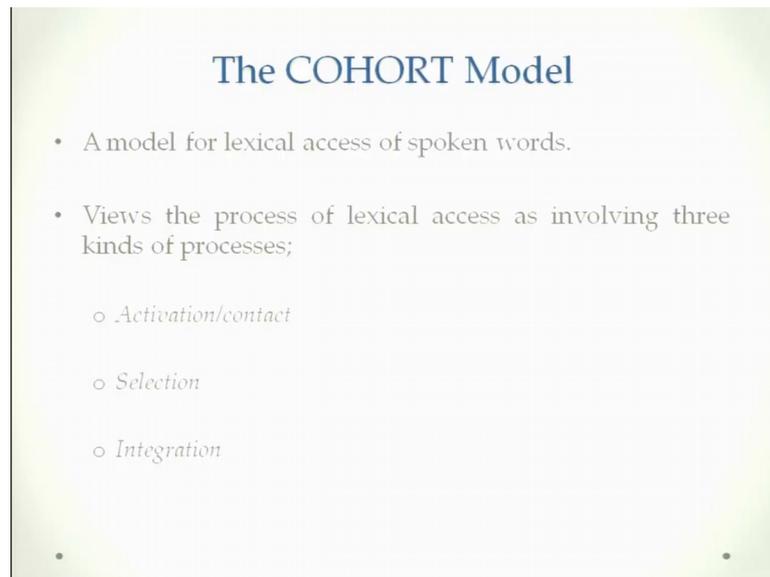
Now, let me take you towards the model of spoken you know recognition speech recognition let us talk about lexical access for spoken words. Now the lexical access of spoken words as in the cohort model is referred to as involving 3 processes, first is the activation phase, second is the selection phase and the third is the integration phase, let us talk about these phases now.
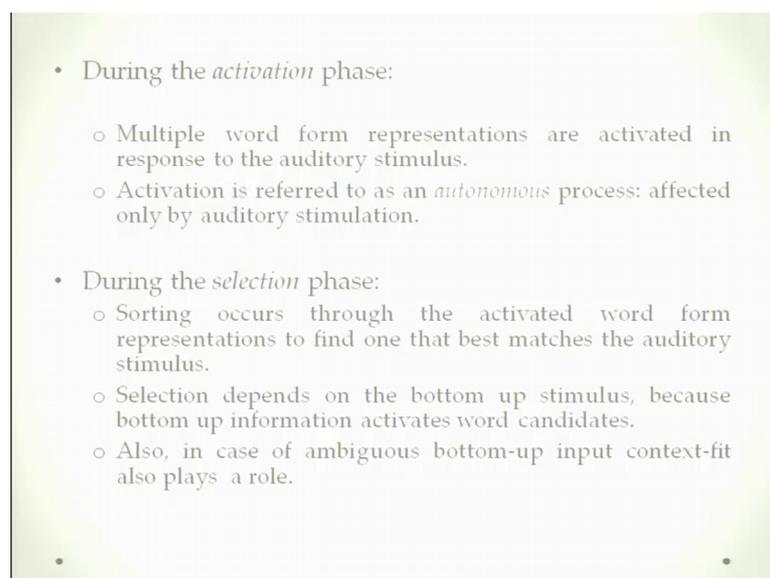
What happens during the activation phase? Now when you are hearing words in your environment when somebody is speaking something or you listening to the TV or radio

or somewhere else multiple word form representations will get activated, suppose I am saying ka, ka can activate cow, cat, king, may any kind of things you know. So, multiple representations will get activated this activation is referred to as autonomous process as soon as I say ka everything that starts with ka will get activated. Now, imagine there are so many words you know that start with the sound ka and now your task is basically to be able to just select the correct ka or the correct thing that I am going to speak from this whole thing.

So, you have to move to the next phase, what is the next phase? The next phase is selection because I activated. So, many different candidates now I have to select 1 or 2 of them which are more probable. So, what happens is sorting starts to occur through the activated word form and these word form representations that are best matches to the auditory suppose I am saying ka you will probably expect car or cup or those kind of things as compared to king or queen or something like that.

So, the idea is as soon as my you know the input is in unfolding in time your selection process is also unfolding in time selecting best matches and you know kicking off the worst matches. So, selection depends upon the bottom up stimulus where speech is something that is unfolding in time, you know it is not really as a visual representation all put together at once it is something that is incrementally unfolding. So, selection depends upon the bottom up stimulus because bottom up information is responsible in activating different word candidates.

Also in case of ambiguous bottom up, information context also might play an important role as I was saying if I am suppose in you know in a car or in I was talking about some conversation about you know traveling from one place to other you will probably take ka as I was talking about as that I am going to talk about a car or something else. So, context also plays a bit of a role here, we have talked about you know activation we have talked about selection then what you have to do is you have to integrate whatever is getting activated with the previous conversation so, let us see how it happens.

Features of the selected words are incorporated into the evolving because this is unfolding in time evolving representations of the entire utterance, what have I been speaking before speaking this word and you will try and match this different candidates and see their fit towards the entire sentence and that is something that will kind of help you really select the correct word. Properties of these selected word candidates and syntactic and semantic are evaluated according to their context and this will basically help you select the correct candidate.

Now lexical access basically as per the COHORT model it is a basically results from the continuous evaluation of the similarity between the auditory input and the activated word candidates, the stored word, representations and this one is highly incremental because again speech nature is highly incremental and word form representations get activated as soon as the initial sounds come. So, as soon as I am saying ka everything related with ka kind of get activated as I move to the next sound, then some of them are left out and as I move to the second sound or the third sound most of them are there by the time I finish speaking just one candidate is going to be automatically selected.

Now in the cohort model, what is referred to as the Cohort, Cohort is basically all of those candidates that are getting activated you know the group of highly activated word candidates is referred to as cohort. Suppose if I am saying ka cap and cat and candle and

you know cattle are all getting activated and this is basically going to form the cohort of my spoken word you know activation.
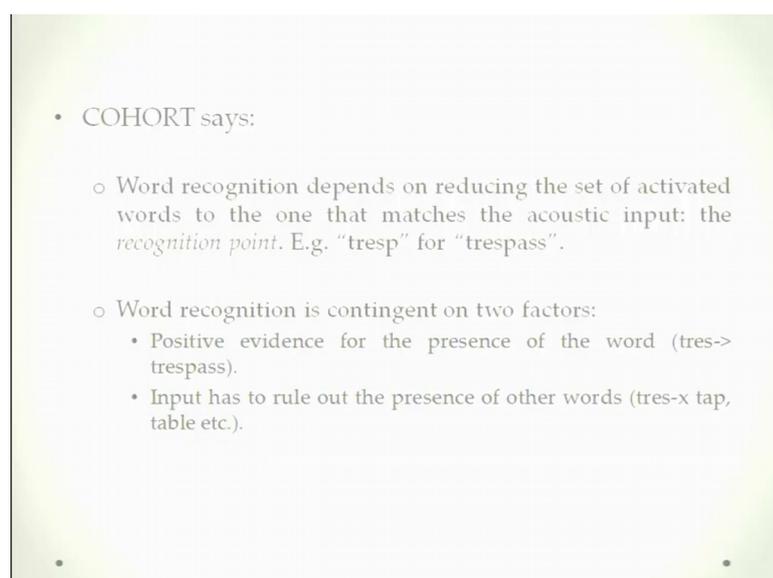
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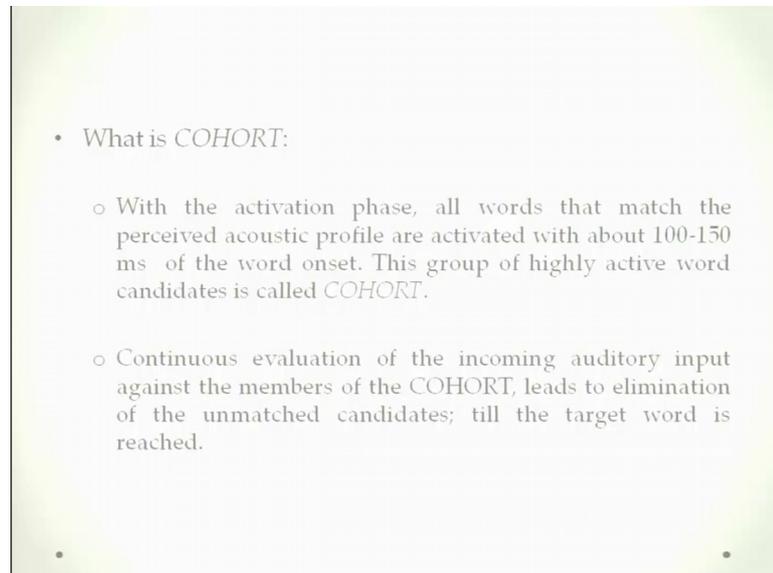
- What is COHORT:

  o With the activation phase, all words that match the perceived acoustic profile are activated with about 100-150 ms of the word onset. This group of highly active word candidates is called COHORT.

  o Continuous evaluation of the incoming auditory input against the members of the COHORT, leads to elimination of the unmatched candidates; till the target word is reached.

Continuous evaluation of this incoming auditory input against this member members of this cohort is going to happen and this is going to lead to the elimination of all the non matching or less matching candidates and till the target word the exact word that I am speaking is really achieved.

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- COHORT says:

  o Word recognition depends on reducing the set of activated words to the one that matches the acoustic input: the recognition point. E.g. "tresp" for "trespass".

  o Word recognition is contingent on two factors:
    - Positive evidence for the presence of the word (tres-> trespass).
    - Input has to rule out the presence of other words (tres-x tap, table etc.).

Cohort says word recognition depends upon reducing the set of cohort reducing the set of these activated members to just reaching the one which matches the acoustic input. So, the recognition point let us talk of a recognition suppose I am saying trespassing as soon as I am I have reached to tres say tree is getting activated triangle is getting activated, but as I as soon as I move forward I moved to tre then there is little activation that I have as soon as I moved to tres then there is only 1 or 2 words that are there and trespassing it basically gets selected.

Word recognition then in this case has to be contingent upon 2 things first is positive evidence for the presence of the target word that I am looking for. An input basically has to rule out the presence of other words. So, the context and the features should actually try and help me rule out all the other possible candidates. So, this is how the cohort model works and again there is you know evidence experimental evidence in the favor of this as well.

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- Evidence for COHORT: The cross - modal priming experiment::
  - Primes: captain and captive.
  - Visual probes: early (at or before "t") or late (during the final syllable, ain or ive).
  - Target words were semantically related to one of the two: ship or guard.
  - Early in the word, both ship and guard were primed but later, only ship was primed.

So, they did this experiment and the prime and the experiments was a priming experiment and they had primes like captain and captive and they had visual probes they had at a early visual probe or a late visual probe. So, early they basically there were something like there was a picture of a ship and later there was a picture of something else and idea was target words which were basically related to semantically related to one of the 2 there was a picture of a ship and a guard and I was going to say capped, as

soon as I would have shown capped and the pictures of a ship you would assume that is this captain, as soon as I am saying capped and the picture is of a prison or a guard then you will probably assume captive.

And this is what was observed early in the word when you the visual input was there both ship and guard were primed because capped and early if you see ship or guard you are not really sure of either is going to be captain or captive, but later when you show the visual thing then only one of the ship one of the things that is ship was primed. So, because if you moved wait till the end that is the one candidate that is active for most of the time. So, this is against some experimental evidence in favor of how the cohort model really works.

So, now let us move towards word meaning we have talked about how form is used to activate you know to achieve lexical access let us talk a little bit about word meaning how is the form going to be connected to meaning. So, one of the ways is to just by introspection you think that, this is the word form and you think back and you see that this is how the meaning is connected.

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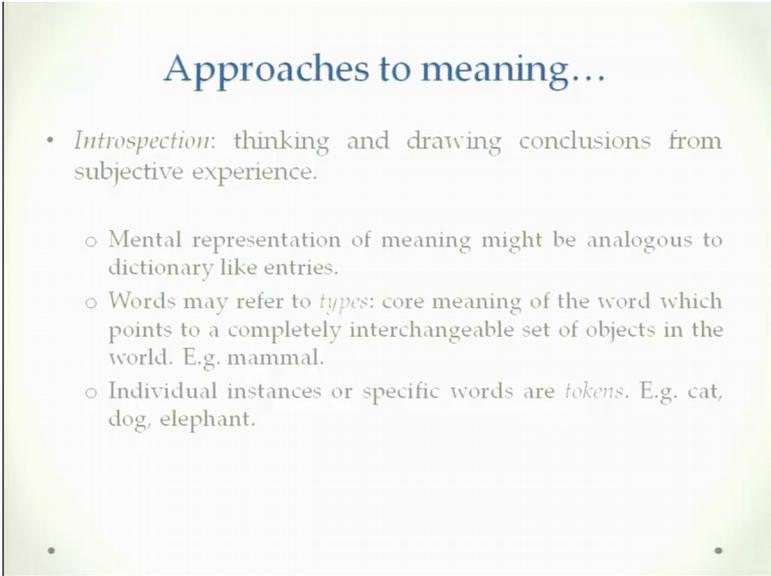
So, you have a mental representation of meaning and this meaning you know the mental representation could be analogous to dictionary like suppose you know you have apple, red fruit, sweet etcetera etcetera in meaning. There could be two kinds of things there could be either types like fruit animal etcetera are types or it could be tokens like apple,

grapes, mango is tokens of the type fruit, dog, kitten, kangaroo is basically tokens of the type animal. So, either you could have types or tokens those kind of things.

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- How to represent *types*?

    o One way is to define core characteristics.:
        • "bachelor": human, adult, male, unmarried.

    o However, the approach of defining core characteristics does not suffice, often.
        • Real words and referred concepts do not always have necessary, core or defining features.
        • Categories are also not always clearly defined, they are *fuzzy*.
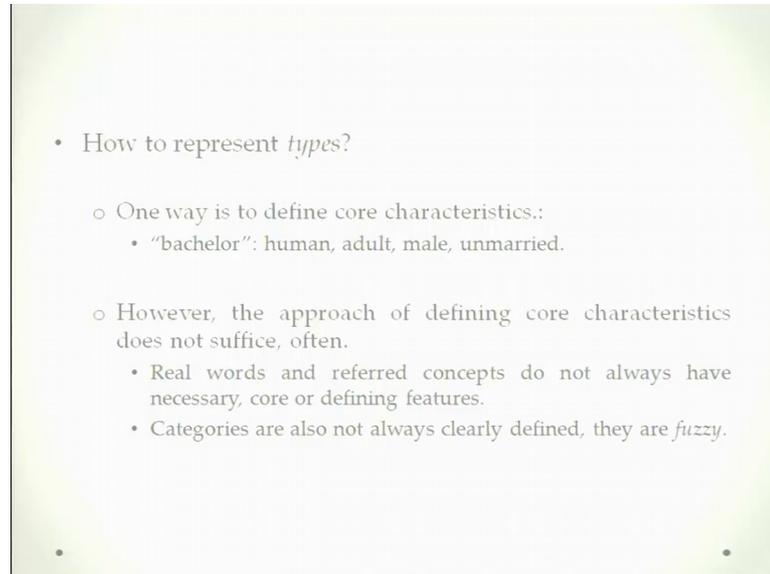
Also one of the things is, how do you represent types in the brain, again I am kind of now referring back to the lecture we have had on you know knowledge. So, how do you represent types you can either have definitions. So, bachelor is definition of human adult male unmarried, but there is also another you know it is slightly difficult to find everything that is fitting with this definition.

So, suppose for example, you are talking about a monk, a monk is also human adult male unmarried, but a monk is rarely referred to as a bachelor. So, definitions are slightly hard to really you know play with. So, sometimes these things do not really match, but again there are different ways we have talked about this in the lectures and knowledge about how different kind of approaches really works.

- Semantic Network Theory

  o Explains how word meanings are encoded in the mental lexicon and to explain certain patterns of behavior that people exhibit when responding to words.

  o Word meaning is represented by a set of *nodes* and *links* between them.

    - *Nodes* represent concepts whose meaning the network is trying to capture.
    - *Links* represent the relationships between concepts.
    - *Subordinate concepts*: inherit the properties of superordinate nodes via transitive inference.

So, another way could be the semantic networks way we have talked about Semantic networks Collins and Quillians Collins and Loftus earlier. So, I am just very briefly going to refer to them here and then move on. So, semantic network theory basically explains that word meanings are encoded in a mental lexicon to explain the patterns of behavior that you know people show when they are encountering these words. So, word meaning is represented by a set of nodes and links nodes are these specific concepts and links are properties and things like you know has is those kind of things.

An example of a *semantic network*.
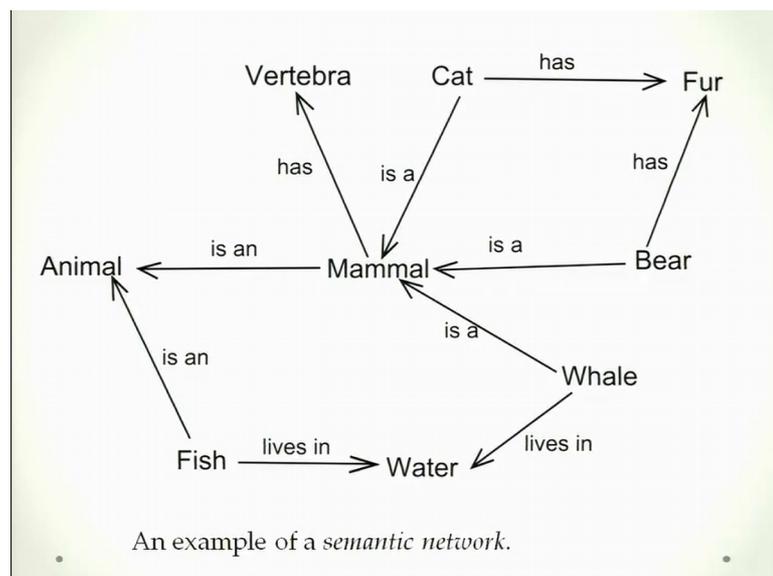
And this is just an example of a semantic network you have nodes in animal, mammal, bear, cat, whale, fish, those kind of things and then you have links like your representations which are the animal mammal is an animal or fish is an animal fish lives in water you know cat has fur those kind of things this is how they believe that you know a representation of meaning is made in the brain we have talked about this in much detail in the you know lecture on knowledge so, I am not really going to elaborate on this here.

Another very interesting approach to meaning is the embodied Semantics approach.

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- Embodied Semantics Approach to meaning.

  o Abstract symbols like words, carry meaning because they are tied to representations outside of the linguistic system.

  o Specifically, representations that we built using our perceptual apparatus (vision, touch, taste, smell, hearing).

  o So, words evoke perceptual experiences with real world objects. E.g. *frog.* : *indexical hypothesis* (Glenberg & Robertson, 2000).

The embodied semantics approach basically says that words can carry meaning because they are tied through perceptual representations one of the basic things here is the Chinese room problem and Searle pointed this out is that if a symbol describes you know something only in terms of symbols then you have what is referred to as a grounding problem you know if you ask me what is an apple, I will tell you apple is a red fruit again I am not really pointing you out to actual apple. So, if I am kind of just moving in this you know word of symbols I will not really be able to make enough meaning, but I make meaning of apple because apple is tied to the representation the perceptual representation of that red fruit, that it is red in color, is round in shape, it is sweet in taste.

So, the idea is that embodied semantics says they are representations are a symbols or words are tied to these perceptual representations and these representations are built using our senses. So, we make word meaning from the fact that these words kind of you

know invoke the perceptual representations simulate those perceptual representations and this is how by invoking those perceptual experiences we actually make meaning. So, if I am saying frog and one of the hypotheses was the indexical hypothesis it says if I am saying frog I am kind of talking about what a frog looks like what is the actual object.

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- According to the indexical hypothesis establishing a word's meaning requires three processes:

  o Indexing: words must be tied to actual objects in the word or analog representations of those in the mind.
  - Analog representations: collection of features, perceptual symbols.
  - Abstract representations: JPG files.

  o Affordances: using the indexed object to derive affordances. Determined by possibilities of interaction of our perceptual abilities and the physical characteristics of our bodies and physical properties of the objects in the world. E.g. chair *affords* sitting.

  o There is a need to *mesh* or combine the affordances of the different indexed objects and characters in the utterance.
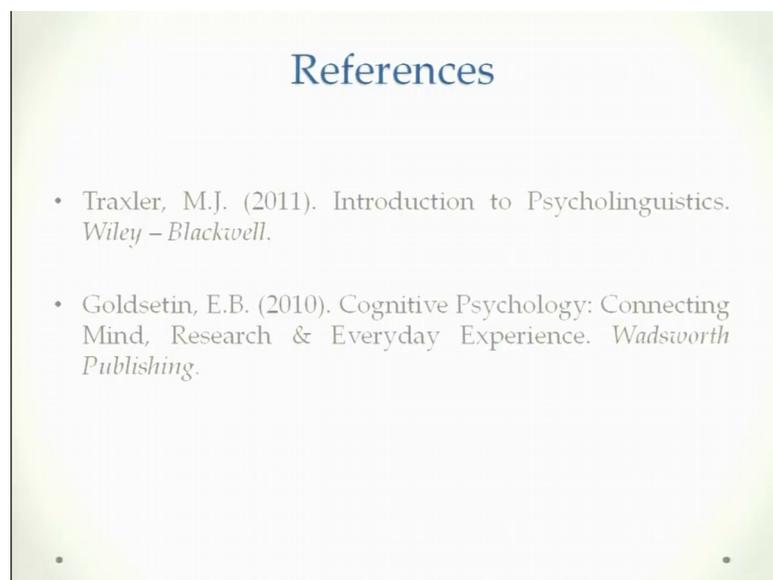
So, I am just kind of elaborating this, the indexical hypothesis says there are three aspects indexing, affordances and meshing. Indexing is that if I am saying frog there must be a real object out there in the world called frog and I should index the word frog with that actual object I should have analog representations things like collection of perceptual features green in color particular in shape and those kind of things then I should have some affordance I should have some knowledge of how to interact with this. So, I should know that is an amphibian very difficult to catch those kind of things and then I should be able to match these two things.

I should be able to know that this is the shape of this thing and this lives in water and these are the different features suppose unless I have all three of these factors; I will not really be able to make meaning out of this simply you can I can take another example if I am talking about chair. Now chair is something that has particular properties which allow you to sit. So, you can refer to so, many things as chairs you know anything that you can sit you have to also link the aspect of affordance there that anything that allows to sit can

be referred to a chair loosely and then with the mixture of these two things you will now be able to understand what the meaning of the term chair is now.

These are some of the approaches that have been used to explain how meaning is made again I have not been very exhaustive and not really gone into a lot of detail about these things, but this is just in a very brief you know highlight of how word meanings are made. So, I think that is all from my side in today's lecture, I will talk about sentences in the next session.

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Thank you.