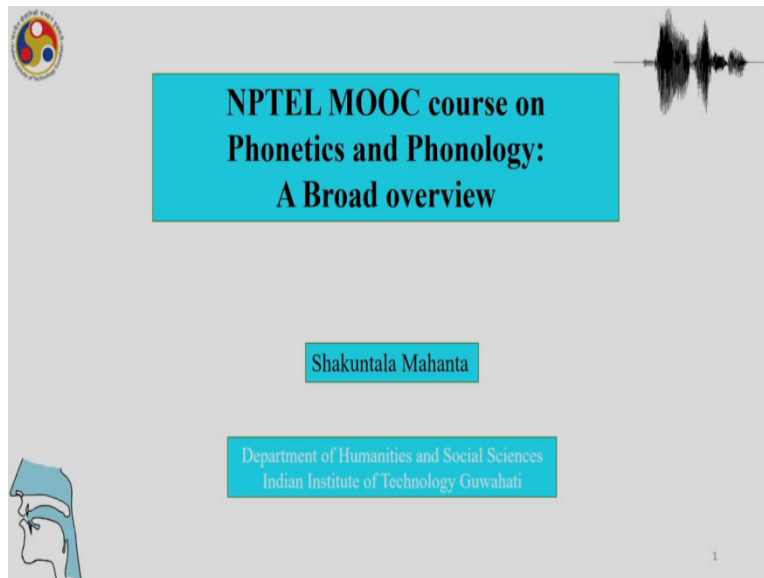**Phonetics and Phonology: A broad overview**
Professor Shakuntala Mahanta
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Lecture 15
Development of the ideas of phonemes and features
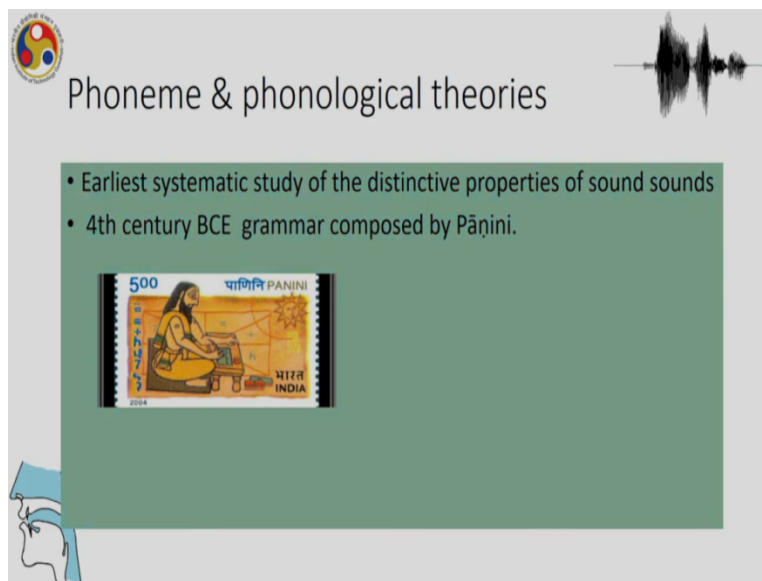
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Welcome to the NPTEL MOOC Course in Phonetics and Phonology: A broad overview. Today we will start with Phonology.

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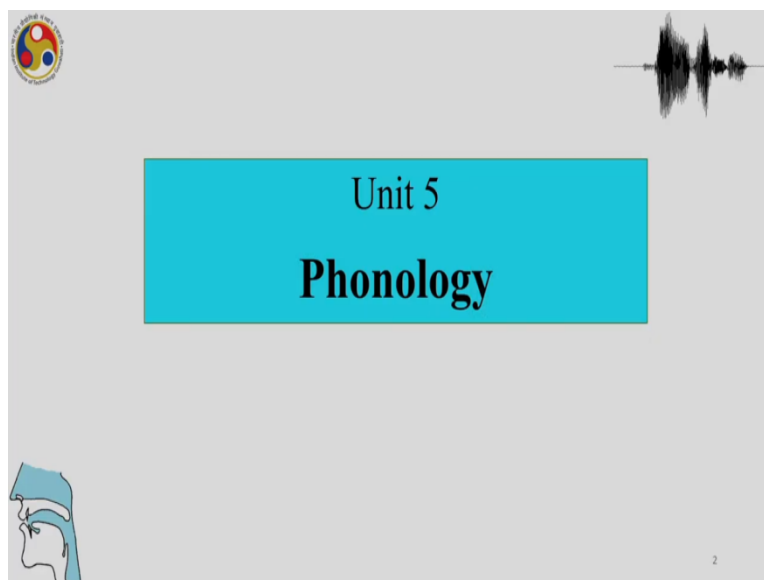
So till the last lecture we concentrated on various aspects of sounds including phonetics articulatory phonetics, acoustic phonetics, perception, different sounds of the languages of the world and we now will start with a very important aspect of sounds that is as studied in linguistics and that is Phonology and in this lecture I will go a bit into the development of the field of Phonology and where we are today and where do we get those tools to analyze sounds from in the field of Phonology.
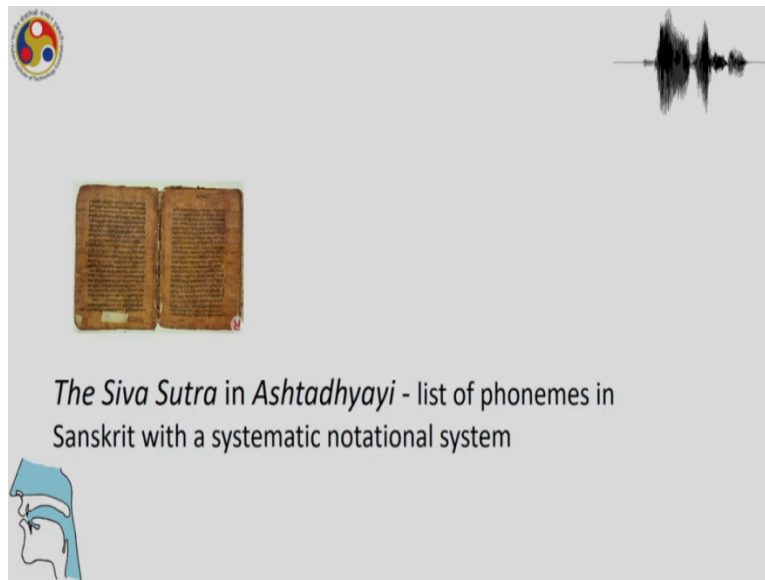
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So here as you can see there have been earliest attempts to study phonetic properties of sounds and 4th century BCE grammar composed by Panini is one of them.

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And in this, The Siva Sutra in Ashtadhyayi has a list of phonemes in Sanskrit with a systematic notational system. Now, this is considered to be the earliest and then there were other early attempts by the Greeks and also some Islamic documents which show a systematic study of sounds.
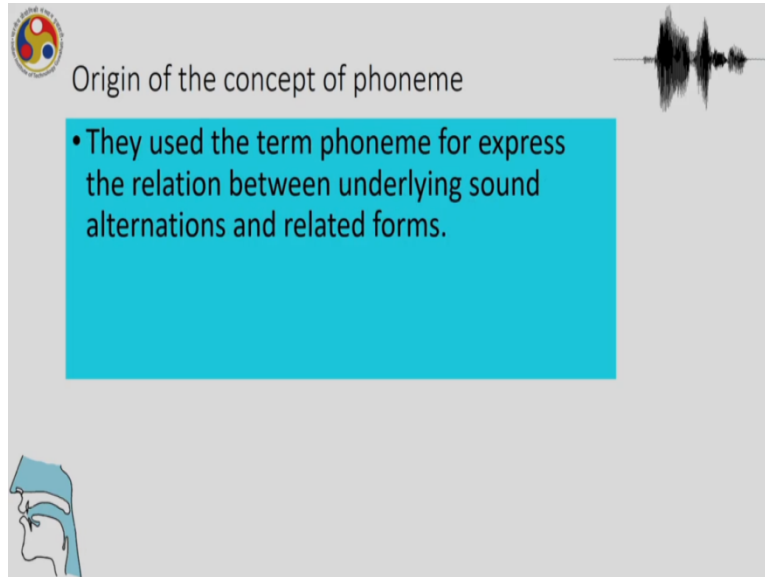
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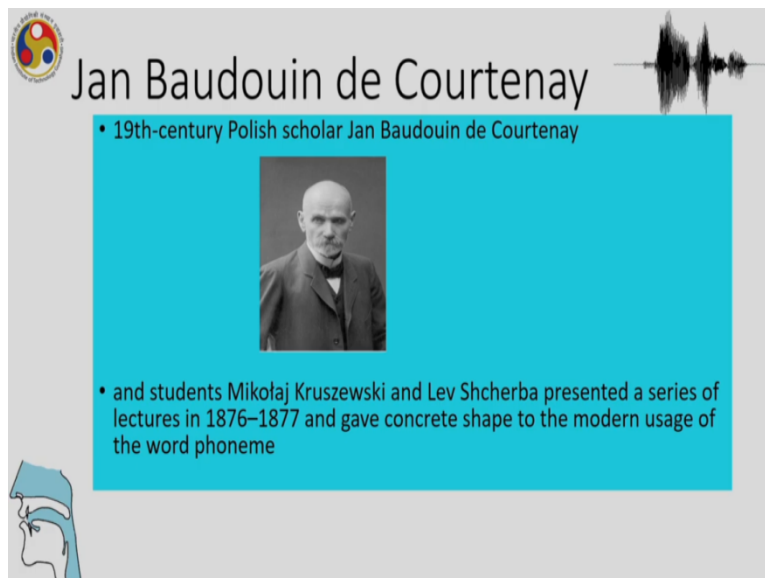
And after that there were major movements, major developments in the 19th century, when Polish scholar Jan Baudouin de Courtenay and his students Kruszewski and Shcherba presented

a series of lectures in 1876 to 1877 and gave concrete shape to the modern usage of the word phoneme.

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And de Courtenay used the term phoneme for to express the relation between underlying sound alternations and related forms.
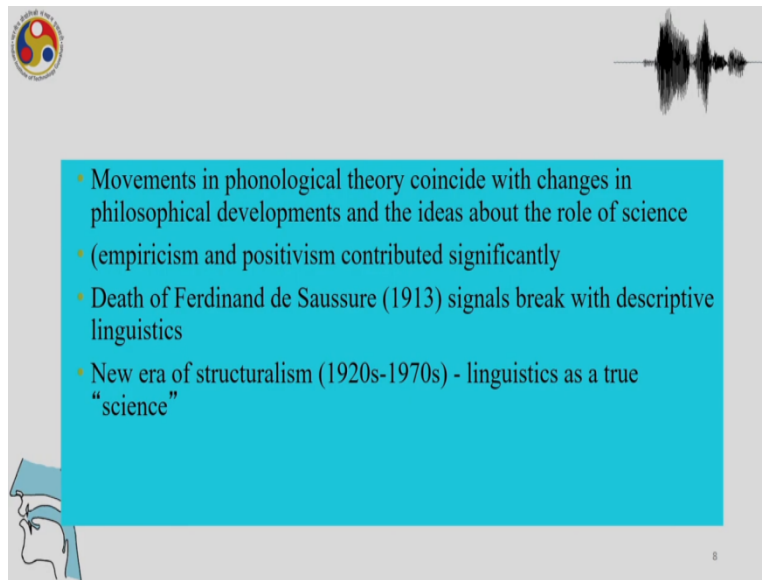
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So, after that we have Ferdinand de Saussure and whose work was very influential in the development of the field of linguistics in general.

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And his work showed that linguistics can be studied scientifically and also the work he had done has shown that signs are important in studying linguistics and so with that, we can now think a bit about how phonological theory coincides with changes in philosophical developments and ideas about the role of science.

And empiricism and positivism contributed significantly to the development of the field of linguistics. And Ferdinand de Saussure influenced linguistics a lot and his death brings a different kind of linguistics and then we have an era of structuralism from 1920s to 1970s and

there were a very significant attempts to develop the field of linguistics as a discipline where it can be seen as true science.
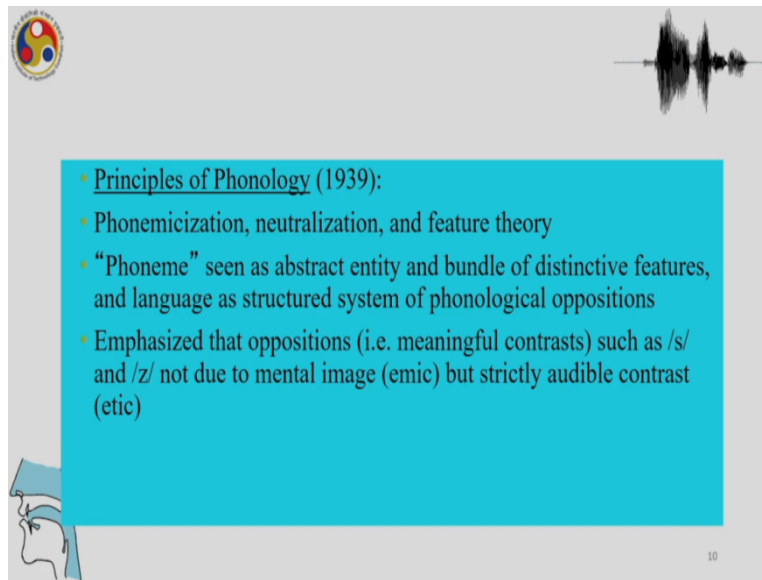
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- The premise of structuralism – there is no meaning without structure
- Language is thus a system of structures.
- Prague School (1926-40s) – plays down the importance of phonetics
- Trubetzkoy (1890-1938) and Jakobson (1896-1982)
- Developed the foundation of modern phonology, developed many of the key concepts, ideas, theoretical underpinnings and methodologies

The premise of structuralism that there is no meaning without structure and that language is a system of structures was something which was developed greatly in the Prague School from 1926 to 1940s and where the importance of phonetics is played down a lot and later on Trubetzkoy who was there from 1890-1938 and Jakobson developed the foundation of modern day phonology, developed many of the key concepts, ideas, theoretical underpinnings and methodologies.
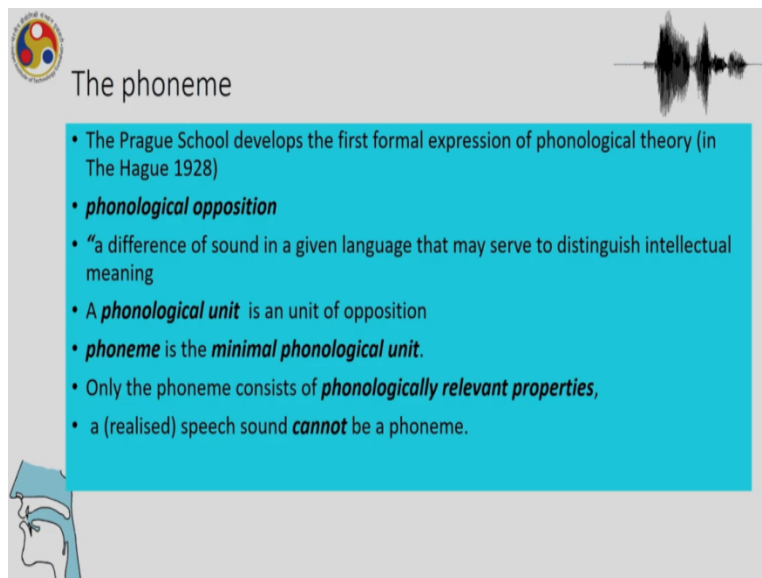
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Principles of Phonology, 1939 showed phonemicization, neutralization and feature theory. The phoneme is seen as an abstract entity and a bundle of distinctive features and language is structured system of phonological oppositions. And emphasize that opposition's meaningful contrasts such as signs are not due to some mental image but strictly audible contrast.

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And since then, we have more developments in the idea of the phoneme. The Prague School develops the first formal expression of phonological theory and calls it phonological opposition

and a difference of sound in a given language that may serve to distinguish intellectual meaning. And a phonological unit is a unit of opposition.

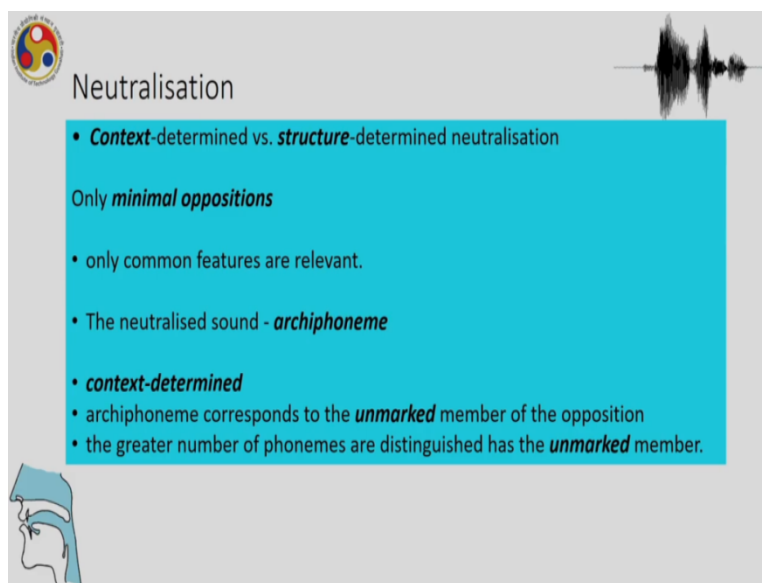The idea of contrast being very essential for phonemes is something which is developed in the Prague School and the phoneme as minimal phonological unit is developed during that time and only the phoneme consists of phonologically relevant properties and realized speech sound cannot be a phoneme. So, we have a very firm establishment of the idea of phoneme during this time, during the Prague School.

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The other important idea developed during that time is the idea of Neutralization. And the idea of context versus the structure and whether neutralization is determined by the context or whether it is determined by the structure, that is, if there is a voiced-voiceless contrast which is neutralized because of a context or because the structure because final position etc. Those were deemed to be different in this idea of neutralization and also minimal oppositions were deemed to be important.

Only common features were considered relevant and the neutralized sound was called the archiphoneme and had to be context-determined. Another important aspect is that the archiphoneme corresponds to the unmarked member of the oppositions. So, the idea of contrast, that the contrast essential is captured in this idea of minimal oppositions and developed under

neutralization in the Prague School. And another important idea around that time was the greater number of phonemes which are distinguished has the unmarked member.

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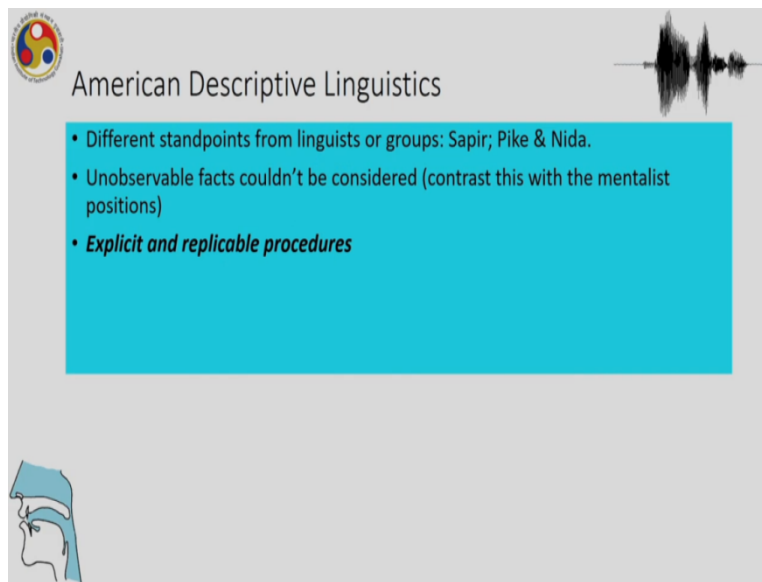
So, American structuralism also developed in around that time and there were important differences between the two and which we will look at in this lecture. The Prague School considered the phoneme to be analyzable as a bundle of distinctive features. And whereas American structuralism regarded the phoneme as a smallest unit of analysis, which means the underlying aspects of it were not considered important and the Prague School did not phonemicize prosodic aspects of phonology and whereas the American system had stress, intonational, junctural of properties that suprasegment properties and considered them as junctural phonemes.

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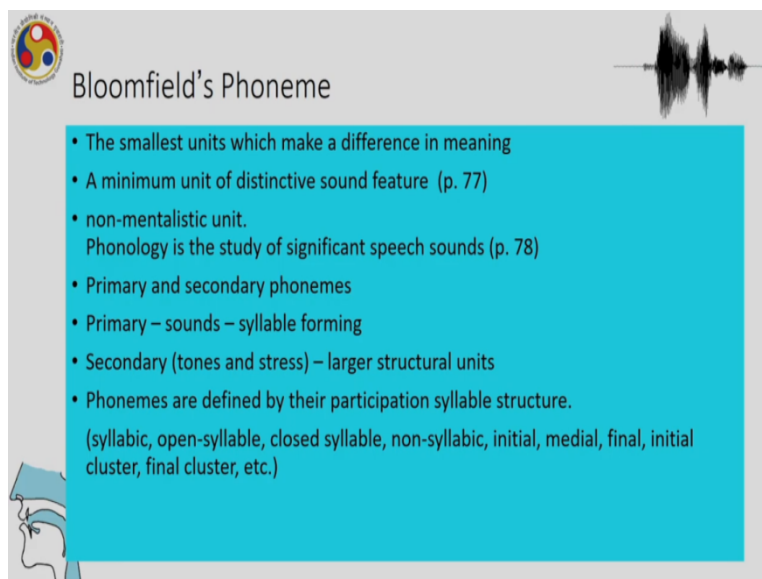
So, American descriptive linguistics offered different standpoints from very prominent linguists such as Sapir, Pike and Nida. So, one of the hallmarks of the American descriptive school was that unobservable facts were not considered. Hence, mentalist positions would consider underlying forms which were not considered in American descriptive linguistics. And explicit and replicable procedures were emphasized.

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And Bloomfield who was one of the most important member, the smallest unit which makes considered phoneme to be the smallest unit which makes a difference in meaning and a minimum

unit of distinctive sound feature also consider it to be a non-mentalistic unit. Phonology is the study of significant speech sounds.

And also primary and secondary phonemes, primary sounds are syllable forming. The secondary ones are tones and stress which appear in larger structural units. And phonemes are defined by their participation in syllable structure, for instance syllabic, non-syllabic, open-syllable, closed-syllable, initial, medial, final so these structural positions were important in the Bloomfield's idea of the phoneme.

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And then we have underlying forms, which Bloomfield put some importance on and later argued for morphophonemics separately and he chose the simplest possible description.
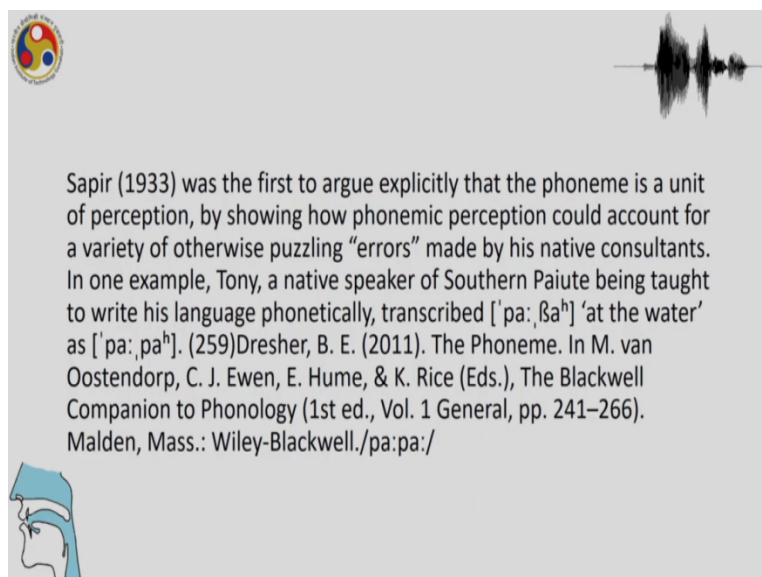
Another important person in the development of American structural linguistics is Sapir. Sapir published Language: An introduction to the Study of Speech. He was a pioneer in the field of anthropological linguistic research, an approach which situates language primarily in social context.
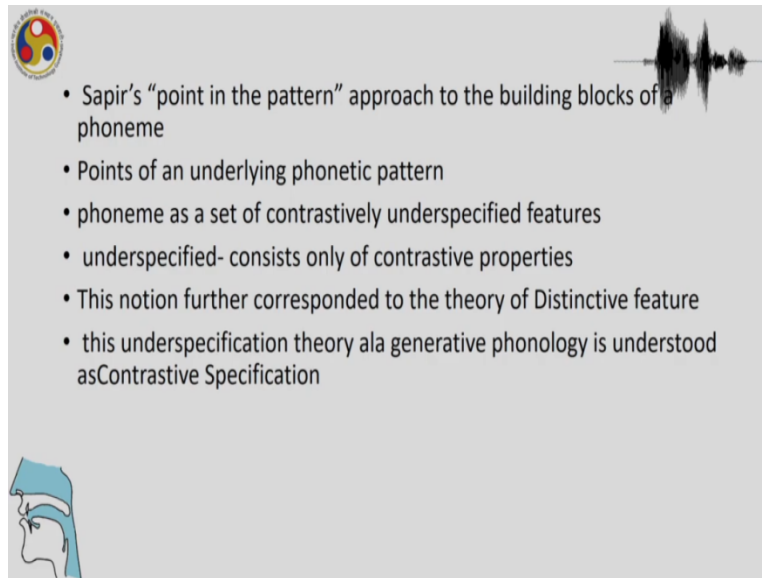
Sapir was the first to argue explicitly that the phoneme is a unit of perception, by showing how phonemic perception could account for a variety of otherwise puzzling "errors" made by his native consultants. In one example, Tony, a native speaker of Southern Paiute being taught to

write his language phonemically, transcribed as 'pa:, Bah, 'at the water' as 'pa:, pah and this is from Dresher, 2011. And this is, we also discuss this when we discuss the psychological reality of phonemes from the next lecture onwards.

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So Sapir's idea of phonology is mostly presented in two widely acknowledged papers and they are the "Sound Patterns in Language' 1825" which promotes the psychological reality of sounds within a linguistic system and the other is "The psychological Reality of Phonemes". So, one is the sound patterns in language and the second is psychological reality of phonemes and in most of his ideas of phonology are presented in these two works by Sapir.

And Sapir's point in the pattern approach to the building blocks of phoneme is a system where it points an underlying phonemic pattern and the phoneme is considered to be a set of contrastively underspecified features. And in this underspecified system, what consists of the phoneme is merely the contrastive properties and this notion further corresponded to the theory of Distinctive features and this under-specification theory is understood in generative phonology as Contrastive Specification.

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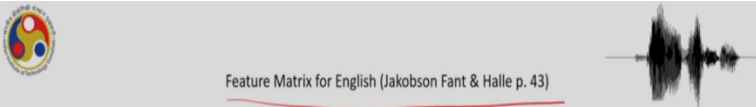
Now, one of the very important developments in phonological theory is the development of the idea of feature system of which Jakobson can be called the father of the distinctive feature theory. And so distinctive features were characterized by minimal linguistic units and they are supposed to be binary oppositions and description should be based on a minimum number of features. And these are selected from a limited set of universal features. The phonetic descriptions of the features is important and the feature value for the sounds for language are arranged as a feature matrix with plus and minus values called the feature matrix.

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So, this is the feature matrix for English from Jakobson Fant & Halle and we have to notice that this is only the nine features here and the features are divided according to Vocalic/Non-vocalic, Consonantal/Non-consonantal, Compact/Diffuse, Grave/Acute, Flat/Plain and something to be noticed here is that, the same features, so for instance, Grave/Acute or Flat/Plain are features which are prosodic features and then Compact/Diffuse or a Consonantal/Non- consonantal, Vocalic/Non-vocalic are features of segments.
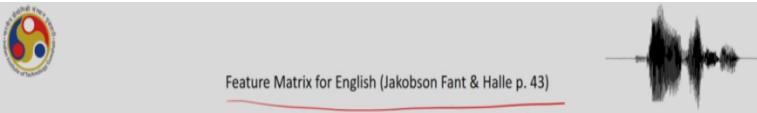
So, prosodic features and segmental features were put together. Now, this was called the protensity, the Tense/Lax features and these are called Tonality, Grave/Acute versus Flat/Non-flat versus Sharp/Non-sharp. So, Tense/Lax is not important for tonality, for tonality Grave/Acute, Flat/Plain are important and another one which is Sharp/ Non-sharp which is not here. So, we can see that this feature matrix for English is different from the features that we use in linguistics because we can see that same features can be used for a lot of segments which is not the case anymore.

Features are grouped together in depending on their cross-linguistic behavior and also same features can be used for vowels and consonants which is also not the case to a great extent in the feature sets that we have and we do not have features which are described as Flat or Plain depending on the prosodic aspects which is not considered to be part of segmental descriptions anymore, but this is one of the feature matrix for English is one of the stepping stones for the development of feature theory in linguistics and this is considered to be one of the hallmarks in the development of phonological tools which are available for us to analyze phonological problems.

- The formal development of distinctive feature theory is due primarily to Roman Jakobson. a) DFs are the minimal linguistic units (not just classificatory dimensions). b) Only binary oppositions are accepted. c) Descriptions should be based on a minimum number of DFs. d) These are selected from a limited set of universal DFs. e) The phonetic description of the DFs is important. f) The DF values for the sounds of a language are arranged as a matrix with +, – and 0 (not relevant) values.
- Inherent Features Sonority: vocalic/non-vocalic: glottal source; free vocal tract; formants; conson/non-cons:low F1, low intensity; obstruction in v. tract. nasal/oral:nasal formant, low intensity; oral + nasal resonator compact/diffuse:narrow, central frequency energy; horn-shape resonator abrupt/contin:no energy above voice-bar; burst or fast transition strident/mellow:high intensity in high frequency, supplementary obstruction. checked/unchecked:higher energy discharge in shorter time; stoppage of pulmonic participation voiced/voiceless: periodic low-frequency excitation
- Inherent Features Protensity: tense/lax: longer duration of steady state; greater deviation of vocal tract from neutral configuration. Tonality: grave/acute:predominance of energy in lower part of spectrum; peripheral artic. /less compartmentalized oral resonator. flat/non-flat:lowering (and weakening) of higher frequency energy; narrowing at front or back of resonator sharp/non-sharp:raising and strengthening of higher frequency energy; dilation of back resonator with palatal stricture.

Feature Matrix for English (Jakobson Fant & Halle p. 43)

Only 9 of the 12 features are needed. No [sharp], [±checked], [±voiced]

The formal development of distinctive features theory is primarily due to Roman Jakobson and distinctive features are the minimal linguistic units in the system and not just classificatory dimensions. Only binary oppositions are accepted and descriptions are based on minimum number of distinctive features and these are selected from a limited set of universal distinctive features.

The phonetic description of the distinctive features is important and the distinctive features for the sounds for language are arranged as a matrix with plus, minus and null values. So, there are these inherent features as we see here. These inherent features are sonority and also acoustic
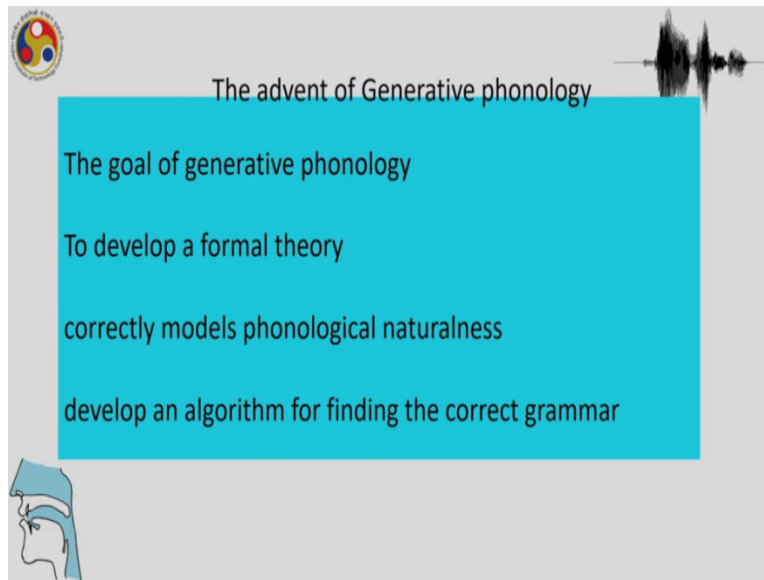
features are considered inherent features in Jakobson's Feature Theory and that's why vocalic/non-vocalic and glottal source and free vocal tract, formants and consonantal/non-consonantal, where low F1, low intensity, obstruction, all these could be inherent features in Jakobson's Feature Theory.

Also, there are other aspects of relating to supra-segmental properties like protensity and Tense/Lax, longer duration of steady state and greater deviation of vocal tract from neutral configuration. Tonality and grave/acute, predominance of energy in lower part of the spectrum etc. are there as inherent features. Also, a Flat/Non-flat and lowering and weakening of higher frequency energy, narrowing at back or front of resonator, Sharp/Non-sharp: raising and strengthening of higher frequency energy, dilation of back resonator with palatal structure. So, all these are inherent features.

In this chart, were to see as non-consonantal and Grave/Acute, Tense/Lax is expanded here. And you can see that what is considered consonantal/non-consonantal, they are low F1 and low intensity, the formant frequencies could be considered for the consideration of vowels versus consonants and also other acoustic properties such as nasal resonator and nasal formant etc., for nasals and burst or fast transition strident/mellow and high intensity in high frequency and supplementary obstruction etc., checked/unchecked, for the checked/unchecked also a higher energy discharge in shorter time etc., were considered for components of features in Jakobson's Feature Theory.

So, this is only a brief overview of Jakobson's Feature Matrix for English and this is not going to be asked for any evaluative purposes and only to show you that these were the features which were there in Jakobson's Feature Matrix and we will look extensively at the feature, list of features which are considered important in phonological theory now in the later lectures. So, this feature matrix as we just said, has a few drawbacks as a result of which that was developed further and further in the phonological literature and the feature theories which we have currently will be discussed in another class but this is where it all started with the Feature Matrix for English as shown here.

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The goal of generative phonology is to develop a formal theory which correctly models phonological naturalness, develops an algorithm for finding the correct grammar and so generative phonology now starts after what we saw in 19th century and in the early 20th century. So, there were great developments in the idea of the phoneme, in analysis, in the idea of development of the idea of features and also other analytical tools. With the advent of generative phonology, the goal of linguistic analysis was received the slight modification. Now, it is to develop a formal theory, which correctly models phonological naturalness and develops an algorithm for finding the correct grammar.

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"given a set of observations from a language, determine which of a set of analyses is the best. The goal is not to develop a function which generates the grammars, given the data (except in the relatively trivial sense in which all possible grammars can be enumerated).

The function is called an evaluation metric

"Second, the phonological grammars themselves algorithmically (that is, fully explicitly, in a fashion compatible with a digital computer such as a Turing machine) generate surface forms
on the basis of underlying forms composed by a lexicon or morphological component."
Goldsmith, J. & Laks B. (2012). Generative phonology: its origins, its principles, and its successors. Retrieved from
http://hum.uchicago.edu/~jagoldsm/Papers/GenerativePhonology.pdf

So, this quotation that is from Goldsmith & Laks, Generative phonology: its origins, its principles and successors. So, given a set of observations from a language to determine which of a set of analysis is the best. So, the goal is not to develop a function which generates the grammars, given the data except in the relatively trivial sense in which all possible grammars can be enumerated. So, this function is an evaluation metric. So, the goal of generative phonology was to develop evaluation matrix which will finally give us an algorithm for finding the correct grammar.

And note that this correct grammar has to be not just descriptive, it has to be explanatory as well. And it has to base itself on phonological naturalness and it has to be a formal theory. So, we developed the theory from a stage where we were not very clear about the basic minimal units to a stage where we can develop formal theories. So, we can say that there were significant development in the way we analyze phonology.

And secondly, the phonological grammars themselves algorithmically that is fully explicitly in a fashion compatible with digital computer such as a Turing machine generate surface forms on the basis of underlying forms composed by a lexicon or morphological component. So, and again this is another important point that you may take note that, it has to be algorithmically explicit so that you can think of a digital computer such as a Turing machine which generates surface forms on the basis of underlying forms. So generate surface forms on the basis of underlying forms.

Now, how can you generate surface forms on the basis of online forms? Obviously there has to be a process involved, so we will see that the processes involved during this part of development of phonology were mostly rules. So, you can generate surface forms from underlying forms and with the help of rules.

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So, a couple of important ideas is that phonologists should employ derivational means, sequential, processual analysis to generate the forms of a language. So, the derivational means is important here to understand that we will see how those derivational means were employed and to generate the forms for language and the observed forms are to be the output of phonological rules which are applied on an underlying form which we had just said phonological rules are applied on the underlying form.

So, we have the underlying form on which phonological rules are applied. So we have a UR, which is subjected to a phonological role. So, then the other issue is that of phonological representations. So, now with the advent of generative phonology, we have an approach where we saw the importance of features which was developed initially by Jacobson Fant Halle. The features gained a lot of importance and as a result, other representations for instance, that of the syllable were no longer used. So, generative phonology put a lot of emphasis on features when it was developing.

And then we have phones which were to be represented as bundles of binary features. So, now the importance of phonemes can be seen and the other important idea is that of total ordering. So what is total ordering? So, suppose there are two rules, then there should be a complete grammar as to why one rule should be ordered before another rule.

So, if we have a rule which says that there should be lengthening of a consonant, of a voice consonant has to be lengthened before a vowel and then we have another rule which says that voice consonant suppose is deleted in a position and then if we have a lengthened vowel as a result, so we have to order those two rules to find out whether we have a lengthened vowel already or we have a lengthened vowel as a result of the deletion just of the consonant. This is just an instance to show that total ordering involved if there were rules A, B, C. So why A or B or C has to be ordered? There has to be a total ordering of these pairs.

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So, this idea of generative phonology which we can see as a development beyond what we saw as structural linguistics before development of generative phonology can be attributed to Chomsky and Halle 1968: Sound Patterns of English. So, the main ideas here in the sound pattern of English can also be called the cognitive turn.

So, phonology was seen to be a function of human mental processes and where language is a computational system and where the methodology of pursuing this idea of language the computational system obviously included tools which are previously there that is data collection

but now with an increased emphasis on typology. So, data had to be collected from languages but there was an increased importance of typology, so as to see what are the universal characteristics and cast your analysis in such a way that reflects typological considerations.

And typological generalizations, therefore became very important as the idea of the universal properties of sounds gained more and more importance and other aspects such as observational adequacy to which helps in the final run to correctly generalize based on what we see in one language correctly generalized across data sets.

And, this method ensured descriptive adequacy as well as explanatory adequacy because not only do you describe the data in front of you, but you also go ahead and explain why the data behaves in a certain way. So, if there is a lengthening of a vowel before a voice consonant then why does it happen? If there is word finally voicing why does it happen? Do we see this in language after language? Then there must be something in that property which is inducing these properties. So, with the goal to, finally the goal of generative phonology is then to understand the internal the properties of the way the mind, the brain works, how the brain works.

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And this can be contrasted with structuralist approaches which put importance on the phoneme and allophone on complementary distribution as to see where the two sounds have contrastive distribution or complementary distribution, where the contrast is, where it is occurring or is if it does not occur in the same position then it must be in complementary distribution. So, those

ideas of contrastive distribution, complementary distribution could be attributed to the structuralist approaches.

The structuralist approaches did not put a lot of emphasis on underlying representations and things which could not be observed and the phonetic aspect was given more importance whereas in the generative approach, we have underlying representations and which are then mapped to surface representations.

And in structuralist approaches again, data collection was important but because of the approach which did not put a lot of emphasis on the cognitive aspects but it put more emphasis sometimes on the socio-cultural aspects did not really strive for that kind of an explanatory adequacy which is seen in generative phonology.

Also, however, structuralist approaches contributed to our general understanding of phonology, to our understanding of phonemes and various and the crucial ideas about opposition, about minimal units, about also our ideas about features etc. they were all developed during the phase when structuralism was prevalent.

And we have seen the trajectory of this development of phonology from a level where we did not know what phonemes were. So the way things developed from Saussure all the way to sound pattern of English and the generative, the cognitive development that we have seen in linguistics and we have again, from there again there have been many developments in phonology which we have not included here but from the next class we will look at the phonemic analysis in linguistics, in phonology. So what is the phonemic analysis?

So, basically in the phonemic analysis we try to find out phonemes from given data sets and there are various ways of doing this phonemic analysis. We will study this in great detail and we will perhaps also look at the great importance of phonemic analysis in phonological literature and not just that we will also look at how phonemic analysis may have had some drawbacks and from there we will also see what are the other available options for analyzing phonological analysis which have been developing from the 19th century. Thank you very much for your attention. I will see you in the next lecture.