

Fundamentals of language Acquisition

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Lecture 013

Lec 13: Attunement theory

Hello and welcome back. So today we will start with lecture 3. In lecture 2, we looked at a few theories of speech perception among infants, and most notably, we examined the motor theory and the universal theory. So, during our discussion on those two theories, the primary assumption, the primary theoretical position that we looked at was that human children are born with the capacity for categorical perception. So, that understanding of how acoustic signals map onto phonetic codes is something of an innate feature among human children; that is what the idea was. So, motor theory had one position with respect to how we do that; universal theory, on the other hand, also has a separate position.

So, both of these theories basically talk about how it is an innate feature and probably that we are all born with some sort of capacity to distinguish among sound inputs that we receive, and this is nearly universal in the sense that children are capable of making the distinction between native and non-native languages. However, there is also some amount of proof, on the other hand, that shows that this is not exactly universal. So, not only do we not lose all the capacity for distinguishing between different sounds at a later age, but sometimes even the sound contrasts that are native to the child's language are not always correctly figured out. So, there are these kinds of contradictory findings, and because of this, we have now come to a situation where a few understandings emerge.

One that human children are born with some innate capacity to understand the differences between sounds. May be based on acoustic features, may be based on gestural features, or, you know, if you go by the motor theory, it can also be dependent on the articulatory feature, which is, you know, at a perceptual level, that categorical differentiation is possible. And we also talked about how the finding of mirror neurons has provided some

sort of support for this theory. Now, the idea that emerges from the contradictory findings is that probably during the first few months of life, until the age of 1, children's ambient language also has a role to play in how they are eventually able to segment sounds and how they are able to distinguish between the phonetic and phonological contrasts. So, the idea of how this started and the theoretical position based on this basic idea is called the attunement theory.

Now, attunement theory is not one theory; attunement theory primarily takes the baseline as the idea that there is some sort of tuning in, or let us say readjustment and realignment of perceptual capability based on the ambient language to which children are exposed. So, there are primarily two premises on the basis of which attunement theories are discussed. The first one is that infants begin life with the ability for categorical perception. That ability is already there; they know how to segment sounds and how to differentiate between different sounds. Now, this is the ability to partition sounds into categories.

However, in an important departure from the previous theories, this capacity from the attainment theory perspective is just a basic level cut. In the sense that you do not really have the capacity to create phonemic distinctions at that level, it is a basic level cut where you are able to partition sounds based on certain features, but that does not necessarily translate into being able to distinguish sounds in all languages of the world; that is the main point of departure. So, this is not the same as being able to segment all the sounds of all languages. There is an innate ability to distinguish between sounds, but this is a very basic level, as they call it a basic level cut. So, it is a very basic level of understanding.

The second premise is that the experience with language tunes those basic perceptual abilities. If you remember, we have also talked about those perceptual abilities being present, to some extent at least, in some other animals as well. So, the experiential domain fine-tunes the ambient language for humans. So, experience means that different sounds lead to different meanings in words. So, the same sound appearing in different cases, and if you just change it to a different sound, the words will change their meaning.

So, that is the kind of understanding the child develops as he grows through life in the first year of his life. So, this is not the same as the maintenance or loss mentioned earlier. So, as we go, we have to constantly remind ourselves of the previous theory. In the previous theory, they said that the ability is kind of, you know, fully developed, developed in the sense that children, including infants, can distinguish between the sounds of the language. Now, the sounds of the language primarily mean the phonemes of a language.

So, the difference here is that they are not able to distinguish between phonemes as such at that early age, but they are able to make some judgments on the basis of the sound

system. That understanding of phonemes develops a little later, and that development is dependent upon the child's exposure to language and more linguistic cues. So, this and then as a result what happens is that some sort of perceptual reorganization occurs. So, this includes tuning, modification, and reorganization of the perceptual abilities by exposure to a particular language. So, depending on the language they are exposed to, that tuning in will happen; that is the second premise.

Now, based on these two primary premises, there are three important theories within this larger domain. Perceptual assimilation model, which is better known as PAM. Then comes the Pre-IMIR model by Werker. And then, Kuhl's native language magnet theory. We will go through each of them one by one, but each of them is a very important theory.

We will just give a brief overview. Due to a paucity of time, you can always look up the references. So, the primary starting point of the perceptual assimilation model is that it agrees that speech perception is shaped by perceptual attunement. So, there is some sort of attunement that happens at a perceptual level based on the ambient language. So, the phonological contrast that the infant learns is due to the ambient language environment.

Phonological contrast, for example, in Indian languages, pa and pha are contrasted, meaning they are two different phonemes; in most Indian languages, these are two independent phonemes. But in the English language, the same two sounds are not two different phonemes. So, in English, when the letter P appears in the alphabet, it typically has a sound like "pa" in word medial or final position. If it comes in the initial position, the sound that you will hear is somewhat closer to "pha" in Indian languages. So, that is the contrast we are talking about.

So, in what two sounds create a phonological contrast is dependent on the language you are living in. So, in the case of the first language, the native speakers first become sensitive to the important single-feature phonetic difference that signals the phonological distinction. What does a single feature phonetic difference mean? Given the same example, pa and pha, in our case in Indian languages, we have something called aspiration, and we also have voicing. So, pa and pha differ in terms of aspiration, pa and ba differ in terms of voicing. That is why we have pa, pha, ba, and bha.

So, you just permute and combine the voicing and the aspiration; thereby, you get four different four-way contrasts. This is not the same way as in English, for example. So, this is the singular feature of phonetic differentiation. So, pa and pha differ on one feature; similarly, pa and ba differ on one feature, and so on and so forth.

Like that. So, they also learn those phonetic differences within the category that do not

lead to phonological distinction. For example, again going back to our previous experiment where we saw that artificially created 6 different sounds that were different in terms of the VOT, infants could distinguish exactly where pa turns to ba. But within the entire inventory of all the different VOTs that create pa, they did not really show interest. So, that is what we mean by within-category phonetic differentiation. So, within that larger category of PA, there were different VOTs that they heard.

So, that means the infants are able to distinguish between the phonetic difference that creates two phonemes as well as ignore those differences that do not create a phoneme. So, this is what assimilation means. So, the features responding to one particular phoneme get assimilated into one category, and then you differentiate it from the neighboring category in that way. So, they learn to attend to the relevant variation as well as ignore the irrelevant variation that is present in the case of the native language. Now, in the case of a non-native language, if the phonological contrast is perceptually assimilated as similar to the native language, then it should be easily discriminated.

So, that is how PAM tries to explain the ability of some infants who could distinguish between the differences in sounds of different languages, even if it is not their L1. So the reason here for what they are saying is that this theory talks about the perceptual assimilation of features into one category, one phoneme versus another category in terms of another phoneme; if that matches the non-native languages' differentiation, then the child will be able to distinguish even non-native languages. So plainly spoken, if the phoneme inventory of two languages is similar in some sense, then there is a higher likelihood of the child being able to distinguish those phonemes in a language that is not its own native language. So, conversely, if the contrasting non-native phonemes do not assimilate to the native contrast, then they will find it difficult to distinguish. As I just said, there is a difference between pa and pha in the case of Indian languages versus English.

So, in Indian languages, the features that distinguish between pa and pha do not assimilate to the same contrast in the English language. As a result, the infants might find it more difficult to distinguish English phonemes as opposed to the native language phonemes; that is the idea. So, how do the features come together and create the contrast between phoneme 1 and phoneme 2? If they match the L2, then the child will be able to easily discriminate; that is the fundamental idea. So, as a result, this theory predicts that performance on non-native contrast will vary from poor to excellent depending on the contrasting non-native phonemes. So, basically how the match can be is not a this or that kind of thing; it is a graded difference, as the theory describes that you can have a 1 to 1 mapping.

So, both features can occur in a two-way contrast. So, pa-pha in Bangla and pa-pa in Hindi, let us say. So, it is easy, but sometimes what might happen is that the pa-pa

distinction in Indian languages versus the only phoneme, which is pa. So, the matching between native and non-native phoneme contrasts can happen at various levels, as a result of which the performance of the child can go from poor to good to excellent. So, that is about, in short, what PAM, the perceptual assimilation model, is.

Another important theory within the attunement theory group is the native language magnet theory, which was proposed by Kuhl. Now, the idea here is that infants start their life with the ability to partition sounds roughly into categories that are the same as those that pervade all throughout these three different theoretical positions. So, language experience, however, is necessary to fine-tune this ability in order to perceive the sounds of their own language. Now, the main focus of this theory is the process through which this tuning occurs. Until now, it is the same thing that the perceptual abilities are similar; then you fine-tune the ability based on the ambient language.

But how does it happen? This theory has a very interesting take on it. So, she proposes that exposure to language changes the wiring of the neural pathways. So, there is a neural underpinning to how we finally learn to distinguish between the sounds. So, through experience, the neural pathway becomes committed to one particular configuration. This way, it creates some sort of sound map; she calls it a sound map of sorts.

So, in our brain, in the neural architecture, there is a sound map where various slightly differing sounding phonemes will be grouped together. So, it creates a map that is not a point, but a map; that is why this name is very significant, as it can take care of the within-category differences. So, ultimately, language learning produces a dedicated neural network that codes the patterns of native language speech. So, as the child grows up hearing different kinds of manifestations of the same sound, it all gets coded in the brain, creating a dedicated neural pathway to understand and process that. Over a period of time, it creates a prototype of that particular sound.

So, the one consequence of this neural commitment is what they call the perceptual magnet effect. So, the brain stores representations of highly frequent sounds as prototypes, and this acts as a magnet for other members of the same sound category. So, going back to our pa/pha distinction, an Indian child will hear various kinds of manifestations of the pa sound in different word environments. So, the "pa" sound will appear in different positions: word-initial, medial, and final positions, as a result of which the various, you know, small distinctions between those sounds will be all clubbed together. And there will be a prototypical representation in the brain that will be the "pa" sound for a Hindi-speaking child, for example.

As a result, phonemes that are similar to the prototype are made to sound similar because

they have all been clubbed together in some sort of satellite around the prototype. This decreases the ability to tell the difference between members of the same phoneme categories. That is why we now go back to our VOT experiment; this is why it was difficult and not possible for the child to distinguish between the minute VOT differences within the same category of sound, pa. Because they do not recognize it, the brain does not recognize it, as they have all been clubbed together in the same sound map. So, all variants of that phoneme sound the same to us in spite of possible differences owing to different factors like VOT and so on.

Now, this process makes us less sensitive to the within-category differences as well as the between-category differences of other languages, because what is a between-category difference in another language may not be a between-category difference for us. So, similarly, this works both ways. Now, it has also been claimed that this perceptual magnet effect may be human or language-specific; it may not be part of the all-purpose general broad perceptual ability; it is a separate kind of ability. Now, this theory also provides explanation as to how this tuning in happens. So, tuning in happens at the neural level, but how does it happen? How does the connection between the neural and the auditory apparatus work? This is how they proposed it.

So, each time we hear phonemes like "ra" and "la," Now, ra and la belong to the same spectrum, ra on one hand, let us say, and on the other end the la sound; so, this is a spectrum. Now, depending on the language in which the child is growing up, they will hear different parts of that segment being produced. For example, in both Japanese and English infants, it is likely that they will hear a range of different sounds within that spectrum. Some more like la, some more like ra, and some in the middle. What does this mean? Is there a very famous experiment carried out on a different sound spectrum, ba da? Let us just see an example here.

So, let us say this is a spectrum; here you have the ra sound, and on this end, you have the la sound. Now, during the infant's exposure to the speech sounds in the environment, it is not necessary for the child to hear the "ra" always at this point. Sometimes it can be here, sometimes there, sometimes here like this. Somewhere in the middle, the distinction will be blurred. And again, on the other hand, when you hear the "la" sound, it could be here; it could be here like this.

So, this is what we mean by the spectrum: the children, the infants, will be exposed to different kinds of, you know, different sounds within that spectrum. Now, depending on which of those manifestations you are exposed to more, that is how your differentiation will finally build up. So, there are different distributional properties; this is what we meant by distributional property in the speech signal of different languages, and these properties

help different prototypes to develop. So, Japanese and English infants will hear different distributions of the pattern. Thus, English infants develop two prototypes at separate points of the spectrum, while Japanese infants develop an intermediate one.

So, to go back here, it is highly likely that the Japanese hear more sounds in this part of the spectrum. However, the English children will hear their auditory signals peak here and there. So, this could be a range here, another range here, but very little in the middle. For the Japanese kids, most of the iterations of the sound will be somewhere in the middle, and that is what will decide whether they hear it as two sounds or as one sound.

So, this is the idea behind the entire theory. So, this was checked by another very famous study by May et al. (2002). So, they had 6- and 8-month-old infants who were made to hear 8 artificial syllables varying along the ta-da continuum by changing the distribution. Half the infants heard these syllables in a bimodal distribution; by bimodal, we mean. So, let us say this is our ta here and we have our da here, right? Now, half the children heard the bimodal means that they heard a lot of distinction here and a lot of sounds here, and the other half near the ends of the continuum.

So, this is the continuum and these are the ends of the continuum. So, half the children heard a lot of sounds here and quite a few there. So, these are the two ends of the continuum, and on the other half, they heard more of the sounds that were somewhere in the middle. So, they were in the middle of the continuum. So, this is neither the extreme ta nor the extreme da sound.

In the test phase, they either heard the alternating sound "ta-da-ta-da" like this, or they heard the non-alternating sounds "ta-ta-ta-ta" or "da-da-da-da." A very simple example. So, half of the very young children and infants were made to hear sounds, you know, on the spectrum. Half the children heard it in the two bimodal distinctions, bimodal as in two modes within the same spectrum, but two modal, two endpoints, and the other half heard only those sounds that were somewhere in the middle of the spectrum. Hence, they were exposed to only one kind of bundle sort of sound.

And in the test phase, they were hearing either the same sounds or alternating sounds. So, what they found out was that infants from the bimodal group listened for longer to the non-altering trials. So, those infants who heard both the "ta" and "da" were looking and listening longer to the unimodal. So, the non-altering only ta ta ta ta or ba ba ba ba kind of thing.

Da, sorry. So, that means they have figured out the distinction that this is not the same as the one they heard before and the alternating ones. So, this meant they could distinguish between the groups: the group before and the group now. The unimodal group, on the other

hand, did not show any difference in behavior, indicating they treated both varieties of sounds as similar because they heard those sounds that were in the middle of the spectrum. So, they only knew one. So, whenever they heard whichever sound they heard, they would consider them as the same sound.

So, by simply varying the frequency of input of the different variants of the syllables, they could create different category boundaries for sounds among the test subjects. Thus, they concluded that infants are able to use distributional information in input speech to detect phonetic category structures. So, how do you create your phonetic categories? How do you create those boundaries? It depends on the spectrum that you are given, which the infant is given. If it is a bimodal kind of input or a unimodal kind of input, that will decide what kind of category boundaries it will create.

However, like all theories, this has also been criticized. One of the most important ones is this particular study that was carried out in 2001. They believe that the infant's ability to distinguish sounds has been overestimated. They do not really have that kind of fine-tuned sensitivity to the boundaries. So, they had 6 to 14-month-old infants and 2 to 3-year-old children, and they had 3 different kinds of contrasts that were created in the stimuli. And the task was to distinguish between these three types of contrasts.

So, they had a vowel contrast. So, the a-u distinction, the VOT contrast on the basis of which sound will change from ta to da, and then the fricative contrast, the sa-sha distinction. So, there were three-way distinctions, and they tested on two groups of children: infants and young children aged 2 to 3 years old. What they found out was that only 65 percent of infants could pass the vowel distinction, which is not that impressive; only 65 percent could distinguish between the vowels, specifically the distinction between "a" and "u." 35 percent VOT contrast, which is quite low. So, the VOT contrast is our ta-da contrast; only 35 percent of infants could.

Among children, only 56 percent pass the vowel contrast. So, basically, the result is not that impressive. Had they been able to judge and create the boundaries easily, this would not have happened because they are the 6 to 14-month infants; they are not very small children. Fourteen months is more than one year, and they also did not do very well. So, as a result, she said that the data do not support that infants have clearly defined phonetic boundaries. And the reason she finally said that the earlier findings could be provided by the previous researchers is that they probably did not include the data that had fuzziness.

Fuzziness in the case of infant data basically refers to all those things where the children lacked attention, were crying, were fidgeting, or whatever. So, they basically wanted to say that the data has been cleaned only to keep those data points that showed the distinction.

So, as a result, she did not quite agree with the previous findings. Another study was conducted similarly in 2003. They pointed out that this kind of experimental study involves infants being given repeated iterations of the same kind of contrast, like the ta/da and pa/ba sort of thing.

So, this is not how real life really works. So, laboratory findings may not be good. The indicator of how real-life sound processing and sound perception occurs in the case of infants is the idea. So, in normal speech, these sounds appear in variation because of the variation; by variation, we mean allophonic variation, for example. So, depending on the environment in the world, morphosyntactic structures, and so on and so forth, the sounds will vary; the same sounds will vary.

So, depending on the speaker and so forth. So, the success of lab studies does not presuppose real-life success. So, that is the other criticism of it. However, like all theories, we have some groups of evidence in favor and another group of evidence against the findings. So, on the basis of this, they have said that there is no need to propose innate knowledge at all; that is what Pierrehumbert said. Rather, infants could be building up their knowledge from the bottom up through experience, as May said that experience plays a larger role than innate ability in distinguishing.

As they grow up through the entire first year of life, the experience probably helps them fine-tune their abilities. So, some work is still going on in this domain. Now, we will move on to the third theoretical position by Werker and her team. So, where they propose a developmental framework for processing rich information from multidimensional interactive representations.

Now, this theory also talks about attunement. However, in this case, they have taken into account not just the phonetic properties of the acoustics of the sound, but also a lot of other information that creates a very rich environment for the child to grow up in. So, this is not just a one-plane, one-dimensional kind of development, but a multi-dimensional development. Based on that multidimensional input, there are different planes in the mind of the child on which they eventually are able to create the phonological inventory, which in turn helps them to learn language. So, let us go one by one. So, in order to account for contradictory findings regarding infants' speech perception and its relation to later language acquisition, they came up with this theory.

The main idea is that infants receive a rich set of information in speech input. And this input is organized along multidimensional interactive planes. So, it is not only multidimensional, but it is also interactive. So, those planes interact with one another. So, at first, the first important thing is that the processing of speech input happens at two levels:

phonetic and indexical. So, phonetic, we have already seen the phonetic properties, for example, acoustic features or articulatory features; those are part of the phonetic level of input.

So, when you hear a sound, there is this phonetic input: the sound, the VOT, the other acoustic properties, and so on. Indexical, on the other hand, is also sometimes called paralinguistic. It is very difficult to distinguish, I mean to parse them separately, between indexical and phonetic. Sometimes, they actually have a lot of interactions. But still, for the purpose of description and explanation, let us look at how they have put it.

So, indexical properties are basically paralinguistic features, such as properties in the speech input that carry information about other things, like gender and affect. Then, you have speaker identity, age, emphasis, and so on and so forth. So, for example, pitch could be one acoustic feature, but pitch also has a lot of interaction with affect. So, when you want to be, when somebody is angry, their pitch might go up, or you know, various other things. So, speaker identity, pitch could be higher for female speakers as opposed to male speakers, and so on and so forth.

So, these are interconnected features, but there are two features in the speech input that are there. Now, grouping information on the basis of similarity, co-occurrence, and other statistical regularities are the tools that the infant uses on the incoming speech input. So, the infant is not just absorbing everything that happens as it is, but it actually applies some sort of statistical mechanism to figure out based on the co-occurrence. How many times do these two sounds co-occur, how many do you know what the pattern of occurrence is, and what are the various kinds of similarities across boundaries, word boundaries, or whatever? So, these are the things that the mind also applies on the basis of which we finally create; we finally group those inputs in a multidimensional plane. So, there are three primary planes that the theory talks about: the general perceptual plane, a word form plane, and then the emerging phonetic-phonemic plane.

So, first and foremost, the perceptual plane is where you have the processing of phonetic and indexical information, and that feeds into the word form plane, where some sort of category without the meaning part is created, which in turn creates the phonemic boundary. So, the understanding of the phonemes of a language actually goes through this kind of structured, multilayered, interactive format that is what the theory talks about. So, this is how I have put it for you to understand it easily. So, the general perceptual plane is where there is this coming together of the phonetic and the indexical properties; that is the general perceptual.

So, at the very basic level, That is what you are creating. This is where they are coming

together, and this feeds into language-specific categories. So, this is what we were talking about before, as well. So, by language-specific categories in terms of sound, that will feed into the word form plane, which is not the same as words. When we say words, we mean a kind of category that also has meaning attached to it. So, form and meaning together come in the word, but here we are just talking about the word form, a kind of structure that is created, and this is what the theory calls extracted sequences that form cohesive units, some sort of coming together of certain sounds that typically co-occur, something of that sort.

And then, once the infant has established a sufficient number and density of meaningful words, generalization of commonality occurs. Once you have gotten an adequate amount of those forms into place, only then will you have adequate data for a contrastive analysis of some sort, thereby enabling you to do so. So, for example, it is only after the child has heard enough instances of pal and phal in different times and in different contexts that they will be able to. So, these are word forms at that point that they do not yet know the meanings, but these are word forms, word planes, and that is when they will realize that because they occur in different conditions, they seem to mean different things.

So, these are two phonemes; pa and pha are different phonemes. So, the phonemic plane occurs at the end. So, after the word "plane," we have the phonemic plane. Right, that is how the, of course, there are other planes after this, but we will not go there; we will just stick to the basics. So, let us look at the general plan; let us explain it a little bit. So, information at this level is in the speech environment; this is what we are getting from the ambient language.

So, various distributions of phonetic or indexical properties will be clustered together to form categories. So, for example, different realizations of the pa sound in terms of position. So, initial, medial, and final positions, and then similarly indexical categories like gender; gender can have two different manifestations: the face. So, the facial identity as well as the voice information. So, the infant's mind takes all of this information and starts to process it in terms of the general perceptual level to create the boundaries, right? So, create clusters of some sort.

So, the pa is not only appearing in different positions in the speech but also uttered by different kinds of people, carrying different kinds of indexical information. Sometimes the environment may contribute simultaneously to both phonetic and indexical clustering. For example, pitch information is used for voice recognition, voicing distinction, as well as vowel color. So, pitch may also contribute to word meaning, vowel color may contribute to affective valence, and so on and so forth. So, that is what we mean by a lot of interaction; that is what one of the fundamental aspects of this theory is.

There are three different planes, and within each plane, as well as across planes, there is a lot of interaction. So, at the general perceptual plane, there is a lot of interaction between the phonetic and the indexical categories, as we have just seen. Then, the word form "plane" is created. The word form "plane" in this consists of extracted units without meaning attached.

This is just a unit. Certain sounds coming together in a cluster appear a significant number of times in order to be represented in the mind as a single unit. So, those kinds of clusters are created. This is an exemplar-based category. So, it is not exactly word-based, but exemplar-based, meaning a kind of example of this kind of cluster.

That is how the feature extraction happens. So, overlapping exemplars based on phonetic and indexical properties are clustered together. In the next level, the infants need to map word forms onto concepts. This is the most difficult part. So, first, they created the clusters in their minds. Because of the repeated number of times that they have heard it, they eventually have to map that cluster onto a concept.

So, a pan refers to this object, and a fan refers to that object; that kind of mapping has to happen. In a naturalistic word learning situation, the child will be exposed to the word in different contexts spoken by different people, and we will also see different instances of the object category again in different contexts. So, they will also see the object. Now, depending on the overlaps that this will create, the child will find it easy or difficult to learn the word concept. So, sometimes they will hear the word and see the object in their vicinity. If that happens enough times, then the mapping will be complete, and eventually, they will learn that this is the word that denotes this particular object, like this is what.

So, depending on the variance in the occurrence of these things together, it will be either easy or difficult for the child to master, but eventually, they do master this. So, that is when the meaning part gets attached to this word plane structure: the extraction that happens at the word plane. Finally, we have the phonemic plane. So, in the phonemic plane, this is the case where the vocabulary has expanded and more words with overlapping features are added.

So, as the child grows, this comes at a later stage. So, higher-order regularities emerge from the multidimensional clusters. They had enough vocabulary by that time. They have heard enough. They have seen a lot of objects denoted by those things.

So, the understanding of the phonemic boundary becomes clearer at that level. Only when they have this, is there this concept of minimal pair. So, this is what we mean here: they do not talk about minimal pairs as such, but this is an easy concept to understand to help this

out. So, they have minimal pairs, which means they have two words, and they know that these two words mean two different things, as a result of which they can arrive at. So, pan and fan differ only in one sound, which is the pa versus pha distinction. So, pa and pha are two different phonemes in this language because just by changing one, I can have a different meaning, which is the understanding of the phonemic level.

And that can happen only when the child has been exposed to an adequate number of words in different kinds of conditions. So, these higher-order regularities gradually coalesce into a system of contrasting phonemes, and once a critical mass of word form-meaning linkage is established, we arrive at phonemic concept formation. So, as the lexicon grows, phonemes get more and more firmly established. Now this model, as a result, describes the interactive representational planes working together to help the infant process incoming speech input. Not only are there these multiple layers of planes at the conceptual level through which the child finally arrives at the phonemes, but there are also other kinds of dynamic filters through which this works.

This is the beauty of this particular framework and this particular theory. There are those interactive planes which also work through interactive dynamic filters as they call them. So, one of them is initial bias, then task demands, and of course, developmental level. So, the developmental level at which the infant is will interact differently with those different multidimensional planes as opposed to another child at a different developmental level.

That is what we mean. But it all starts with initial biases. Initial biases get things started. So, if you have a particular bias, your learning will go in one trajectory, so to speak. So, this is how this entire system kind of works: on the one hand, you have multidimensional interactive planes; on the other hand, you have dynamic filters. All of them interact with each other to give the child the specific kind of speech perception capacity that they will ultimately grow into; ultimately, that will be the building block for them to learn language acquisition, which will happen based on this. So, coordination among all of these eventually helps in language acquisition. So, with that, I hope I have given you a brief overview of the attunement theory, how there are three different kinds of theories, all of which are clubbed together under attunement theory.

Each of them has contributed significantly towards our understanding of how infants might be able to arrive at speech perception and fine-tuning, which they can achieve at the word level understanding. So, starting with whether you are going by the PAM theory or the other in the PRIMIR theory, or whether you are going by the Magnet theory, all of them have contributed to some extent, and adequate literature exists supporting all of them. There are, of course, criticisms, but in their own terms, they all are very significant contributions in this domain of speech perception in infants. So, here we stop with lecture

3. In Lecture 4, we will take it forward and see other kinds of speech segmentation, how it works, and how they eventually figure out how words really work. Thank you.