**Fundamentals of language Acquisition**

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**Lecture 044**

Lec 44: Geographical factors, statistical learning, social brain

Welcome back! Today, we will start with lecture 4. In lecture 3, we started looking at the socio-cultural factors in the environment of the growing child and how those factors might impact a child's language acquisition and the various domains within the larger area of language acquisition. So, for example, vocabulary size, grammaticality, conversational rules, and so on. So, we also looked at epistemic trust and various other factors. Now, we will look at a couple more factors: geographical factors, statistical learning, social brain, and so on. So, with respect to the geographical factor.

Let us see what we have. So a child's microsystem includes the immediate surroundings, which is what we have been discussing until now. Microsystem means the caregiver of the child who are in the immediate vicinity of the child. So it can extend maximally to the family.

But he is also part of a larger area, a larger geographic location which pertains to what we call an exosystem. So, "exo" is outside, and "indo" is inside. So, the exosystem is the larger outer world, a bigger world within which the child functions. So, that also has a role to play in terms of language acquisition practices, language acquisition milestones, or simply the kind of words the child learns. So, location is found to influence the words to which the child is exposed and the number of words that the child knows.

For example, the climate and the terrain in the child's environment might influence the terms a child knows for weather conditions, food and clothing variations, and all types of flora and fauna. This is almost commonsensical, but there are some interesting studies that have looked at, for example, children speaking Afrikaans, who will have a higher

number of words at the same age with respect to other kinds of Western languages. Now, Afrikaans, you might already know that Afrikaans, though it sounds like an African language, is actually a variety of Dutch spoken in South Africa. So it is a language; it is a variety of Dutch. However, if you compare Afrikaans with Dutch, you will see a lot of variation in the vocabulary, even in adult speech.

This is simply because of the environment in which they grow up. So, there have been studies on metaphors in the Afrikaans language, where the usual metaphors have a very different source domain; I am talking about adult language that has also been studied. So, the source domains for metaphor in Afrikaans and Dutch differ even though they are varieties of the same language. So, as a result, it also derives from there that the children will learn words that are different with respect to the genres they belong to and the semantic domain they belong to. So, if you are living in a domain where you have a larger variety of flora and fauna, the children will learn those names more frequently, and they will have a higher vocabulary in those domains. So, that is the idea. So, in this, you also have the division between the rural and urban domains. So, some children who live in rural areas will have a different kind of vocabulary compared to urban children. So, we have already looked at this particular study. This is where they looked at some urban-rural division, which was also one of the variables.

So, Spanish-speaking children in Argentina and American English-speaking urban children in the US have larger expressive vocabularies; we have already seen this. But rural, on the other hand, in Italy, they found that the children had a higher number of verbs. So, rural life differs from urban life in many ways, and some of these differences might affect language learning. So, for instance, mothers in urban areas, for example, in the case of Bali, this has been studied by Williams et al. in 2000; urban areas in Bali expect their children to acquire verbal assertiveness at a very young age, unlike rural mothers.

When you inspire your children to be confident speakers, nowadays you have various kinds of programs for children to be confident speakers, stage speakers, and so on. But in certain cultures, it is already embedded. This is one such case in which mothers want children to be verbally assertive. As a result, they are found to have a better expressive vocabulary. So, that is about our geographical location having an impact on your children's language acquisition. Let us move on to statistical learning; we have looked at statistical learning before as well when we were talking about phonological acquisition, as to how children probably map the kind of positions in which certain phonemes occur, and based on that idea, they probably know how to figure out how to segment the speech stream. So, for example, we have talked about the pretty baby example before. So, the

question was, do infants learn by computing the probabilities of sound combinations? So, this has been an old question, and there are very interesting findings that suggest children are statistical wizards to some extent. So, in the case of "pretty," when "pre" and "ty" occur together, it will most of the time mean that it is a word-internal combination, whereas "ty" and "bab" is an inter-word kind of combination. So, this is something that, if the children figure it out, then they will be able to segment the speech.

So, a simple statistical inference using the relative frequency of co-occurrence of the sound is used by infants to find the word boundaries; that is the idea proposed by the statistical learning hypothesis. Now, this has led to the hypothesis that experience-dependent mechanisms might be strong enough to influence language acquisition. So, depending on the kind of language environment you are in and the child's experience of it, there will automatically be an impact on statistical learning because they are basically trying to find the relative frequency of co-occurrence and thereby figure it out. So, because these experiences will in turn motivate innate statistical learning capacities that is what this theory says. But there are some problems; we have seen this before, and we will go through some of the issues that have been flagged in this domain, that this will not always help.

So, however, before we go there, the debate here is between the statistical property of the language input and the innate knowledge of the language system. So, is there a tussle between the two? So, the kind of relative frequency in which certain combinations occur, will that be enough, or will it confront the innate language knowledge of the language system with which the child is born? So, this is not a very easy thing; the debate has been quite strong. So, some scholars have said that Chomsky and his followers underestimated the power of learning and thereby overestimated the need to build language-specific knowledge into the organism in advance. So, while experimental results do provide strong support for the remarkable computational ability of the child or the human brain in infancy, they do not solve all the problems, as I was just beginning to say. For example, infants at a very early age are remarkably aware of the sounds of their language.

Hence, the existing knowledge may constrain their induction from the input. They already know it. We have already seen how early the children have been experimented upon to check the level of their understanding of the sounds of their language, and we have seen that a few days old children have also shown remarkable abilities. So, if that is the thing that they are almost born with, what is the role of statistical learning in that understanding? So, if they already know this will constrain their induction from the input. Thus, infants might be looking for confirmation of categories like words that are already present in their minds. So, they may not be learning from the inputs, but they might just

be confirming, you know, cross-checking with the existing words. And frequency effects might strengthen the induction; that is all it might happen; it might be doing. Also, determining word boundaries must override statistical probabilities. For example, differentiating between "about the flu" and "a bout of the flu" or "your" versus "you are," and so on. So, this kind of thing is difficult for statistical learning.

So, you have to find out whether it is a word boundary, an actual word boundary, or a co-occurrence, and then the child has a difficult task at hand. Similarly, the need to determine that "walked," "walks," and "will walk" involve the same word. So, this has to be rule-bound; this has to be based on the underlying system, the structure that the child has already in place. It cannot be dependent on statistical learning. They need to find out that even if they have different surface forms, they are actually the same word.

So, that kind of argument has been made. In some languages, intra-word and inter-word probabilities may not provide adequate information about word boundaries. So, it may not be as simple as the pretty baby example is. In some languages, the difference between the word "internal" and the inter-word combinations might occur with the same kind of relative frequency. So, they might be equally probable. So, one example for the Bantu language, one particular Bantu language, Bukusu, where the /uo/ combination can be equally possible in the word boundary as well as within the word. So, in this kind of scenario, it will not help; the statistical learning will not help. So, this is the statistical learning concerning the input that they receive. So, their use of statistical knowledge is based on the input that they are getting , thereby inducting the information; however, there are cases where there might be a problem. Now, let us move on to cross-cultural differences.

So, generally speaking, the children all around the world, across languages and communities, will have similar kinds of stages of language acquisition that are well attested already. So, as normal children have the foundation of language acquisition in place by 3 years, the stages of those 3 years are similar. However, some differences do exist. Some examples we have here in a cross-linguistic study involving French, English, Japanese, and Swedish infants: late babbling and first words were compared. Japanese infants produced their first words 2 to 3 months later than the others.

The age of attainment of the first 25 words was also delayed for them. So, other than Japanese, French, English, and Swedish children learned their words faster, and their vocabulary size was also better than that of the Japanese in the age-controlled group. So, Japanese children in general were delayed. So the speeches of the Japanese and American mothers here need to be looked at. So there is a difference between the language use of

Japanese mothers and American mothers towards their children.

American mothers provide object labels in their infant-directed speech. So the motherese in America uses more object labels. So if you have object labels, that means automatically you learn more nouns, more words, and more things that have a referent in the immediate environment. On the other hand, Japanese mothers use objects to engage the child in social routines. So, the mothers in Japan do not really teach them labels but teach the children how that object is useful in a social scenario.

So, they provide the bigger picture on the one hand, but the American mothers will first use the label for the objects, and then their children will learn. So, this kind of different techniques of teaching, or different techniques embedded in the mother's speech towards the child, probably is at the root of children learning vocabulary at different ages. Hence, there are some differences in linguistic and cultural inputs across the different kinds of languages. So, based on these various kinds of findings Kuhl has proposed the idea of Social Gating Hypothesis. What she basically means is that gating social interaction creates a vastly different learning situation, one in which additional factors introduced by a social context influence learning.

So, basically what she is saying is that there are various other things in the environment that help children learn language. So, there are other functions that are part of this. So, one is attention and arousal. We have looked at attention and arousal when we discussed Luria's theories of language. The information, a sense of relationship, and the activation of brain mechanisms linking perception and action. So, now action, attention, and arousal are known to affect learning in a wide variety of domains, as Michael Posner has shown. Attention is one of the most important higher mental functions that humans have, and this is useful for various kinds of learning, including language. So, if you are taking attention as one of the key ingredients in language learning, then it will automatically have a positive outcome. So, that is why she has included this. And then there is an activation of the brain mechanism that links this kind of thing between perception and action.

So, heightened attention and arousal could produce an overall increase in the quality and quantity of speech information. Basically, heightened attention will result in better language learning, and as a result, language production will be the baseline. Recent data suggest a role for attention in adult second language phonetic learning as well. Also, infant attention was found to be significantly higher in response to the live person than to

the inanimate source. So, in the previous lecture, we looked at epistemic trust, where children attend to people they trust more.

And who are those people they trust the most? One is the people who belong to their own group, their own in-group. In-group could be based on racial identity, or it could be a familiar person they know. So, extending this, if they know the person, they will focus their attention more on that person. Now, if you take it a little, you know, take a long shot, there is also this study by Kuhl's group. So, they found out that children tend to attend more to a real human being than to an inanimate object. So, it is easier to learn from a human than from, let us say, a robot or something of that sort. So, this is because the attention level is higher when they are talking to or interacting with a human. So the degree to which humans interact and engage infants socially with the tutor in the social language learning situation correlates with learning. So if you are attending, you will be learning more; that is a simple thing, but for children, this also has epistemic trust and other factors embedded, and at the root of all of these is attention as a mechanism. That is the most important part of this theory.

So, social interaction may activate brain mechanisms that invoke a sense of relationship that is at its core, and then between self and others. So, in the constant interaction with a person, knowing them and getting familiar with them, a sense of relationship forms, which is what we call in-group relation, and at the same time, the brain mechanisms will also be tuned in, so to say. So, social understanding systems that link perception action and that will immediately also get co-activated. So, your interaction, underlying which is this attention in line, also activates the brain mechanisms, and then you can connect perception and action together. So, this is a kind of network that Patricia Kuhl's theory proposes and that others have also supported.

Now comes the role of brain. Now the human brain is the seat of all actions, or let us say all planning. So the role of the brain in the language domain has also been studied extensively for a long period of time. So this is given. Both sides, or let us say all the sides, of the theoretical divides in linguistics agree that the brain is one of the most important players in this entire game. So, the brain's role in language acquisition refers to the biological foundation of the language faculty. When Chomsky says that we are bioprogrammed, what he means is that the brain has a component or some sort of software that enables us to learn language, and from there the idea of the biological foundation of the language faculty emerged. So, of course, Chomsky was not the first

person to say this. We know that Paul Broca discovered that language is localized in the left hemisphere. So, this has been pretty old; we have a long tradition here of understanding that the brain is the seat of language. So Chomsky's theory on the brain basis of language popularized the idea of modularity as well.
So not only does language have a biological basis in the sense that it has a brain basis, meaning it has a localized domain within the human brain, there is a specialized area in the brain which is called the language area, and that is also the idea of Chomskyan theories—that is the idea that it is modular. What does it mean? that the brain has specific areas that are designed for using language, producing language, understanding language, and so on. So, it is a modular structure that does not have much give and take with the other mental functions. So, each function is kind of segregated; that is the idea of modularity. So Chomsky popularized these two things: the biological foundation of the language faculty and the notion of modularity.

Chomsky, Fodor, and others are on this side. On the other side, the empiricists believe in a distributed representation of language knowledge; basically, it is kind of a network of systems, so it is not one area in the brain; it is not a modular structure. But it is a distributed structure in which various areas in the brain need to work together for us to be able to use language. And so they call it some sort of network of systems rather than a simple module in the brain. Thus, irrespective of the theoretical position, brain's role in language acquisition has been undisputed. Up to this point, there is not much of a problem. The only debate is whether it is one domain or a distributed domain, but it is all in the brain. Along comes Lenneberg; Lenneberg's 1967 work was a pioneer in some sense in pointing out the biological and maturational components of language acquisition. The brain structure he mentioned indicates that brain structure at birth does not necessarily point towards left hemisphere dominance in language. So, as the brain develops as the child grows up, the brain also matures at the same time; this is common knowledge that the human brain continues to grow after birth. So, during that time, my brain maturation happens, and as a result, he says that left hemisphere dominance is not necessarily present in the very beginning.

So, this feature grows from the age 2 onward and this is exactly the idea the logic on which the critical period hypothesis is based on. Because the organization, or reorganization, of the brain happens during this phase, from age 2 to puberty, that is also the time given for language acquisition. So, the left hemispheric dominance builds during this time. And this is the theory called the equipotentiality hypothesis. Equipotentiality, as the name suggests, indicates that both hemispheres of the brain are equally responsible

for language function. So, they start out, you know, in some sort of an equal fashion; they start out similarly, but over a period of time, during brain maturation, the left hemisphere takes over the job of doing the language-related processes. So, the idea here is that both hemispheres of the human brain start out similarly. So, these are the keywords for us. Then get specialized for certain functions; this is the idea of the equipotentiality hypothesis. Later findings, however, do not agree with Lenneberg's idea , and we now know that this theory is not exactly tenable.

Why is it not tenable? So, infants show anatomical and functional asymmetry from a very young age. So, what we are talking about is that anatomical and functional basically refer to the structure and the function. So, the brain's two hemispheres are not exactly the same; that is what we are talking about: anatomic asymmetry and functional asymmetry, of course we already know. Different areas in the brain do different things, and not everything is equally distributed, and that is evident even in very young infants.

Hence, Lenneberg's theory is probably incorrect. For example, studies have been carried out on infants as young as 4 days old. They have shown a right ear advantage for syllables and a left ear advantage for musical sounds. In humans, the brain's control system is contralateral. What it means is that the right brain controls the left side of the body, and the left brain controls the right side of the body. So, if something is presented to your right ear or to the right eye's visual field, then it gets processed better in the domain of language; that is what they found out.

So, right ear advantage means that in a dichotic listening task, when the two ears receive two different signals, the chances are higher that you will be able to say what was played in the right ear better than in the left ear because the sensory input from the right ear is processed in the left hemisphere and vice versa. So, they found in 4-day-old children that there is the same right ear advantage that we already know about. So, right ear advantage means left hemisphere advantage for language-related tasks. So, there is a right ear advantage for syllables and a left ear advantage for musical sounds. So, all non-linguistic sounds are processed in the right hemisphere; hence, the left ear advantage.

Five to six-day-old children are capable of connecting the production of sounds with their auditory perception, and they do so in a left hemispheric dominant way. Remember our Leiberman's idea of the motor hypothesis. This is what they are talking about: that they could connect the production with the perception. The study was like this:. So, the infants were presented with videos of women articulating certain sounds like /ba/ and

/ma/, you know, something like this: some simple sounds.

The video was played; in some cases, the video was played with audio, and in some cases, they were played without audio. And among these cases, the audio matched the video; in some cases, the audio did not match the video. The videos were presented either to the right or the left visual fields. The infants looked for a longer duration at the video in the matched condition, and they did so predominantly when the video was presented on the right. This is what we are calling the right visual field advantage or the right ear advantage.

Meaning anything that is presented to the right side of your sensory input system will be processed in the left hemisphere. So, because children did better in those stimuli that were presented to the right visual field, it means that left hemispheric dominance are already in place. And when there was a mismatch, the visual input indicated that she was producing /ma/ or /ba/, but the sound came out as /ga/. So, that is when this is a mismatch condition. But when you see /ma/ and hear /ma/, this is a match condition. So, this is how the experiment went. So, very small children also show left hemisphere dominance in the case of processing language. Hence, Lenneberg's theory may not be tenable. So, as a result, over a period of time, a lot of such studies have been carried out after an adequate amount of evidence has shown that the equipotentiality hypothesis is not tenable. Now, we have something called the new Lenneberg hypothesis, which is kind of a softer version of the same theory.

So, the softer version basically talks about how language-relevant aspects of cerebral organization are dependent on language experience. So, it is not entirely that you know everything is starting from the beginning, and everything is similar. They say that language experience has a role to play with respect to the cerebral organization. So, this hypothesis looks at language-specific grammatical functions and their localization in the brain, which might be different from one language to another.

So, that is the new Lenneberg Hypothesis. In any case, we now know that the brain anatomically has the language area already in place. Now, we have to look at how the language area and how the brain interacts with the outside world and society, and that is where the idea of the social brain comes in. So, the social brain has been studied in various domains, starting not only with neuroscience but also with linguistics, anthropology, and even evolutionary sciences. So, the idea is that how the brain developed and how it evolved has a role to play with respect to how humans evolved. Because this is the same thing, humans evolved so that during the evolution of the human species, the change into a social brain has a lot to do with how we are today.

So, the social brain is the key component that allows humans to do what other primates cannot do. We are very similar to our other close cousins. However, we do certain things that they cannot do, and that is where, apparently, the idea of the social brain comes in. The main cognitive abilities of the great apes are primarily dependent on the management of social worlds. The same can be said about humans. Creativity and flexibility are considered a form of adaptation to the challenges imposed by the social environment. So, we are dependent on the kind of environment we are in; we adapt very quickly. That is something that is common to humans; there is nothing called a habitat for humans. Humans can be anywhere because we adapt very quickly; that is what we are talking about. So, this kind of flexibility and creativity with respect to the brain's adaptation to the environment is the domain of the social brain. So, the management of social relationships has led humans to develop a brain that is kind of unique in the animal world. Now, this nervous system's role in the management of relations with other individuals emerges in these domains. As it is assigned to predict the future, anticipate, connected to predicting and anticipating the consequences of one's own, or other people's actions, and to buy time; this is famously called "to buy time." Basically, when we are engaging in any kind of social interaction, we are not only talking about the here and now, but we can also predict, remember our theory of mind? So, that makes us capable of predicting what is going to happen, not predicting in the sense of Nostradamus, but predicting in the immediate future.

If I do this, there is a consequence like this. So, that cause and effect relationship we immediately understand and at a bigger level as well. So, not only one's own actions but also those of others. So, this is the entire gamut of things that the social brain is engaged in. So, the human brain's adaptation works at two levels: finding solutions to problems imposed by the physical environment. First and foremost, you have to find a solution to the problem you are in. Secondly, what is very interesting is the competition with the other competing individuals for the solution to the same problem. Basically, the competition we have with other people. That is how society functions. We want to beat the other person to that same position.

We want to score higher marks than our competitors and so on. So, the adaptation of the human brain is based on these two factors. Not only must we find a solution ourselves, but we need to find a solution before the other person does. And this results in the social brain's ability to obtain information related to the intentional states of an individual and to identify the causes of his actions before he acts effectively. So, this helps us understand, you know, this makes us capable of cueing, or let us say tuning in to the very subtle cues in the environment, be it humans or other things. So, many studies have also pointed out

that it is not just the social brain that understands others' perspectives that is important, but it is also the ecological brain.

So, ecological brain refers to the way the brain interacts with the immediate environment as well as the culture. So, the environment comes in here since we are talking about the nurture factor; let us not lose sight of what we are actually doing. So, for one, a lot of brain development happens after birth until puberty; beyond this, the development of the brain stops, but the development of the mind continues. The hardware is in place, and software keeps growing; depending on whether you want it to grow, you can grow with the software as long as you are alive. Secondly, this makes the environmental impact a reality. Now, the environmental impact is seen in various domains. Let us quickly go over to them. There are two kinds: the natural environment and the cultural environment. Natural environment, let us talk about the human visual system.

Now human visual system is designed for doing various things. One is, of course, when you see something it is not one function; it is a multitude of functions built into one. We are good at depth perception, back-and-forth transitions between 2D images and 3D representations, binocular vision, mental rotation of imagery, and coordination between sight, sound, touch, and so on. However, seeing and perceiving are not the same things. If anybody has read Oliver Sacks's books, you will know what we are talking about here. So, you might see that seeing refers to the collection of input through the sensory organs of your eyes, that's all.

You are collecting the information that is seeing, but perceiving is the second layer output of that information. So, you have taken the information; now you do all these things that you are talking about. So, the depth perception and various other factors allow you to perceive the scene. There might actually be a divorce between the two, as I was just talking about Oliver Sacks; he talks about many patients who have a break between these two. Sensory input is present, but the perception is missing. that is possible So, people who are born blind and have gained their sight through medical intervention may see things immediately because the machine is now working, but to truly perceive what they see, they need a certain amount of experience. So, the brain needs experience in the real world in order to function. The machine is in place, but experience is what makes it see things as they are. So, in terms of coordinating between the object and what it is like from various sensory inputs.

Similarly, to give you a small example, The Gods Must Be Crazy is a very famous film. So, there you have it; you see the Bushmen, the people who are very different from us. They have no sense of, you know, possession. They do not know what money is or what it means to own something because everything is for everybody in that kind of society. Now, if you let us imagine you meet somebody you know who has never seen something called a photograph. Now, when we look at a photograph, we look at a 2D thing, a 2D object, but we are able to mentally simulate the 3Dness of the entire thing.

The depth, the background, and foreground calculations—all happen because this is the way we are experienced. We know photographs; we know how they work. But for people who do not, it will take some amount of getting used-to to map the 2D onto the 3D representation. So, that is what we mean by experiences helping you perceive things even though you might see them immediately. Similarly, toddlers learn to walk and stand through training, and then all that happens. Now, in terms of cultural environment, we know that from cross-cultural studies, even basic aspects of perception are often colored by the way the experience is modeled in a particular given scenario. So, a culture that is not familiar with two-dimensional representation, as I just said, may need to learn. Similarly, this is also a very well-known finding that people who are used to a carpentered environment, that is, most of us, experience less complexity in their surroundings. So, you have solid lines, clear contours, clear surfaces, and regular angles. They are more prone to be fooled by certain kinds of optical illusions as opposed to people who live in more natural environments.

So, in the natural environment, you are exposed to various kinds of permutations and combinations of sensory input that are not present in the carpentered environment. So, the overall experience has been found to impact brain plasticity modulation as well as the structure of the brain in terms of physical and cognitive growth. So, it is dependent upon the interaction of the agent with the environment rather than just being a passive experiencer. So, depending on how the agent interacts with the environment, we have various kinds of understanding that we generate. Within this idea, there is a very well-known concept in psychology called affordances. Basically, affordances mean that there is a complementary relationship between animals and their environment. So, what you can do is the action potential of a thing. For example, a famous example is that a tree is climb-up-able; not necessarily will we climb every tree that you see, but it is an action potential with respect to trees.

This is what is called "affordance" in psychology. Now this can be understood in cultural

terms as well. So culture is a collection of practices that are inter-individual. It is a collective process made up of generations of practices, values, and related behaviors. So the brain is the site that collects all this information and all these experiences, and as a result, neural connectivity might get modified, and it does get modified, as some studies have already shown through sustained engagement with such practices. As a result, we create cultural models, and those cultural models have a direct connection to the neural activity.

So, this is how you can understand affordance in cultural terms with respect to our social brains. So this is where we complete Lecture 4, where we started talking about the social brain. Thank you.