

Fundamentals of language Acquisition

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Lecture 045

Lec 45: Social brain contd.

Hello, welcome back. Today we will complete the module with a lecture; this is lecture 5, the last lecture of the module. We have been discussing the role of nurture in language acquisition among children, and we have already looked at various environmental factors, starting with child-directed speech, BTR (baby talk register), and then we went on to the socio-cultural environment and various kinds of factors that might be present in the exosystem of the child. So, we looked at various factors, including the microsystem and exosystem from BTR to the geographical location and socio-cultural factors, and how they probably impact. Then we moved on to discussing the brain and how it does not really remain a mute spectator; it interacts with social realities, and as a result, there is a lot of give and take between society and the brain.

So, we embarked on the idea of the social brain or ecological brain, focusing on how various kinds of experiences in the outer world affect a child's development, especially during the first few years when the brain grows rapidly at first and then slows down, although some growth continues. So, during that time, the child is also interacting with the world, and we have seen some of the factors or variables that might be interacting with the brain and then having an impact. So, let us move on to other parameters within this domain of the social brain, the brain's reaction to the environment. So, the interaction of the brain with the environment can be seen in many other domains as well.

So, many other aspects of the environmental factors in terms of their effect on brain and language development have also been explored. Most importantly, the impact of noise and that of music is significant. These two have been studied in terms of how environmental noise or the existence or non-existence of music in the environment can impact the brain and, in turn, can impact language acquisition; that is what we are

interested in. So, this is a three-way kind of interaction environment, whether it be noise, music, or whatever, how it impacts the brain, and then how those structural changes in the brain impact language acquisition. So, let us start with noise: environmental noise.

So, increased exposure to excessive noise places a lot of demand on auditory processing. Anybody who has been to places where they play loud music will realize that you have to strain to hear your friend talking to you. So, this is a very simplistic example, but this need not always be a loud noise; even a less loud noise, let us say a kind of loud music, has also been studied. So, this kind of difficulty with auditory processing may influence the development of neural circuitry associated with language development. So, that is the crucial connection we are looking for. So, the development of the neural circuitry that is responsible for language development is important because we already know we have seen that the brain has domains and areas that are directly connected to language processing. Processing in language development acquisition as well as the use of language. So, there are certain areas. So, those areas, if they are affected by external stimuli, will have an impact on language development. So, this process is contingent on being able to hear and parse phonemes and syllables.

Very interesting work was done in 2015. So, we will be using certain domains while looking at certain cortical areas which are the main variables in this case of certain important areas in the brain. So, the left inferior frontal gyrus and the left superior temporal gyrus have been associated with concurrent and future language and reading abilities. So, the gyrus is a large area. When we talk about the brain, the gyrus and sulcus are how we look at the top part of the brain; however, they are quite large areas, and today we know that with state-of-the-art techniques we can look at even smaller regions, but largely we will focus on these two domains. Additionally, the morphometric qualities, like cortical thickness and surface area, are important variables in terms of their efficacy for the processes for which they are dedicated. So, the critical cortical thickness and surface area of these regions are associated with environmental factors more broadly. So, with language input specifically. So, cortical thickness is one of the most important variables in terms of its efficacy, and it can be affected by the environment, which in turn will affect language processing. So that is the idea.

So, excessive noise exposure and increased cortical thickness has been found out by many researchers who are looking at this kind of a connection. So, increased noise exposure may place a high demand that we have already seen. The left IFG is responsible for language production and processing, as well as phonological processing abilities. Now, decreased cortical thickness in this region during childhood will reflect in less grey matter formation early in development. So, if your cortical thickness is decreased, then it

will be reflected in less gray matter and may be indicative of otherwise altered neurodevelopmental trajectories.

So, if you have less gray matter, if the cortical thickness is not up to the mark and has not developed properly as a result of certain kinds of environmental impact, then it will have a serious impact on the entire neurodevelopmental trajectory, including language. So, structural differences in language-related brain regions have been linked to reading problems. For example, one particular group has looked at this. Differences in the home language environment, including the number of words children hear and the number of conversations they engage in, have been associated with cortical thickness. This was a very interesting study, actually.

So, the home language environment is associated with cortical thickness, and we have just said that cortical thickness is associated with the efficacy with which certain neural functions are carried out. So, the surface area of these brain regions has been connected to the home language environment. Further, differences in the home language environment have also been associated with the integrity of the underlying white matter tracts supporting language abilities and language-related brain function of the IFG. So, depending on the home language environment or the noise environment, all of these interact at the structural and anatomical levels of the cortical part of the human brain. As a result, the thickness of the grey matter or the white matter changes, which might impact language development.

So, higher everyday noise exposure would be associated with poorer language skills and differences in language-related cortical structures. So, there have been studies; for example, a socio-economically diverse sample of children was studied, and they used MRI—specifically, T1-weighted magnetic resonance imaging—to measure the surface area and cortical thickness of the left inferior frontal gyrus (IFG), which is what we are talking about. Imaging of the IFG and superior dorsal gyrus (SDG) were extracted. So, MRI, and with that, they have taken out this information and used LENA, which is Language Environmental Analysis, to measure the levels of exposure to excessive environmental noise over the course of a typical day. Results: what did they find out? Results indicated that children exposed to excessive levels of noise exhibited reduced cortical thickness in the left IFG.

So this is what they found: this study proved that home environmental factors, such as environmental noise, are associated with neurobiological development related to language development in children. Then we look at music and how it impacts language development. This is Patricia Kuhl's group again. They studied infants with respect to music and the exposure to music. So, they were socialized in an environment playing a variety of music; first, they were all in these studies, which typically have that kind of training phase and the test phase.

So, in the training phase of the first phase of familiarization, they were socialized with a variety of music while engaged in playing the drums. Parents help them keep the rhythm by tapping their feet. So, a large number of sensory inputs is present in the child's environment. There is music playing; they are playing with drums while tapping their feet to keep the rhythm. So, in this way, a highly variable social stimulation scenario was created, and a control group had all the similar elements except for the music in the background.

So, one group had various kinds of music continuously playing in the background while they were playing with drums and keeping rhythm; the other group, the control group, had everything except the background music. The test phase was the training phase; the test phase used MEG again, music was played, and MEG is the machine that they used; the music was played with a slightly mistimed rhythm. The first group of children showed a very high degree of neural activation in a wider area, including the prefrontal cortex. The prefrontal cortex is often referred to as the area that is dependent on activation for executive function mechanisms and various other higher mental functions. So, that is an area that was found to be activated in the test phase when they heard mistimed rhythm. So, there was music played, a waltz was played, and there was a mistimed rhythm, and their brain activation showed that they had actually identified it and were trying to work on it; the brain was working on it. They are also made to listen to a novel language where, again, they mistime the rhyme. Here, two target groups showed a higher activation in the region known for attention control. So, attention control, executive mechanisms, and cognitive control are all governed by our prefrontal cortex in the brain. The children who were exposed to the background music were doing better in this kind of task because the music was already there.

So, now they could find out the mistiming in the rhythm, whether it is a language or music; that is what the finding talked about. Thus, experiencing patterned signals is what music is; patterned signals help children establish their ability to detect and predict

patterns in the world in different domains. This is the finding of this very influential study: if children are socialized with different kinds of patterned signals, this will help them find patterns in other domains as well. So, even if you have been exposed to music, you can use the same knowledge; the brain can use the same knowledge for finding rhythm in language as well; that is the idea. So, pattern detection and pattern prediction abilities are crucial for optimizing brain resources.

So, music has a very important role, which is, of course, out there in the socio-cultural environment, and that has an impact on your brain and the way the brain gets activated. Now, based on all these different kinds of theories, what are the different kinds of theories? We have seen Kuhl's theory of social gating, and we have looked at various other ideas that suggest the environment does not play much of a role, as well as findings that say the environment does play some role. So, because of all these different kinds of ideas, a new theory has been proposed based on the different kinds of data; it is called the ecological theory of language acquisition. Now, this idea is very interesting. This idea is based on certain kinds of steps the children take; you know there are different stages.

Remember, we talked about another stage-wise difference between emergent theory. See, this theory is similar to the emergent theory; some properties of this theory do correlate with the other one. So, based on the findings from previous studies, the ecological theory of language acquisition was proposed. This theory explains the initial steps of the language acquisition process as unintended. So, there are two initial stages and a later stage.

In the initial stage, the child's processing is unintended; it is not voluntary, but rather involuntary—an inevitable consequence of the infant's multisensory interaction with the environment. This is the most crucial part of the theory that there is an interaction between all the different kinds of sensory input the child is getting at that time, and as a result, the child is trying to find some sort of pattern there, right? The early language acquisition is, I quote, an emergent consequence of the multi-sensorial embodiment of the information available in ecological adult-infant interaction settings. So, when there is an adult, there is a child, there is an interaction happening, there are objects in the environment, there are mappings of the word on the object, and so on and so forth. So, there is a multitude of sensory input that the child is exposed to, and that is the time when the structures begin to emerge; that is the idea of the beginning stage, the first stage. So, this model proposes a speech interaction scene where correlated external information in terms of sensory dimensions gets together.

Correlated, as in you have speech, you have sound, the word form, you have the object, and you have various other experiences. All of them are working within what this theory calls a speech interaction scene. So, they collate; they get together, sort of. This general sensory processing and memory mechanism worked with the sensory regularities in the typical use of language. So, the regularities we talked about are statistical patterns, with the children figuring out the relative frequencies.

So, they are talking about the same thing in a different way. So, the sensory processing involves multiple types of general sensory processing as well as the memory mechanisms that work on sensory regularity. So, the regular pattern of the mapping is similar and so on. So, this is how they typically use language. Then, working through the recurrent nature of this co-occurrence, the input stimuli lead to clustering in the representation space. So, interaction space to representation space. So, first they interact, they connect the dots, so to say, and then they find out what represents what. So, the word means this particular object, something like that. So, the sensory relationships implicit in these clusters can subsequently be used in cognitive and exploratory processes. So, this is the time when it is a voluntary process to some extent; this is something that the child is doing actively. In the beginning, it is unintended; it is just there in the environment, so many things are happening, sensory inputs are taken in, and they are mapped onto each other, which is then tracked across contexts based on their co-occurrence, how often these things co-occur, and then they come into a scenario where the references are finalized, and then clustering is possible; subsequently, they are used in cognitive and exploratory processes. The infant is not just a passive learner but an interactive one in this model. So, in this way, this theory is similar to what we have seen in constructivism. Where the child interacts with the world, based on the information they receive from the mappings they create, they learn, and what they learn becomes an input for their output and so on. So, this is a continuous process; this model is also similarly talking about the same idea.

So, this model draws a parallel between the original evolution of language and language acquisition by children. While giving the theory, this group, the people who proposed this idea, say that child language acquisition and the original evolution of language actually have a lot of parallels. Though there are differences, of course, there are a lot of parallels. So, they stress that emerging linguistic structures must necessarily rely on the very essence of the speech communication process. So, language emerged as a tool for

communication.

So, the process is embedded in the social scenario and social setting. So, it has to be taken into consideration that is the idea, and that might have also been one of the key motivators for the evolution of language in the first place. So, that is why he draws a parallel and says that on many grounds these two things are similar, as a result of which he discusses the link between the acoustic nature of speech and other sensory dimensions. Thereby, he theorizes that this might be a domain-general process. So, language is not just in the modular reality, but it is a domain-general process that is part of the normal socializing practices of humans.

So, in sum, this model starts off with a crude associative process in the beginning, which is the acoustic signal on the referent that is the association, and then it can rapidly evolve towards an active exploration and crystallization of linguistic regularities. Now applied to actual language acquisition settings, this model suggests that the infant quickly becomes an active component of the language discovery process; that is how they talk about it. So, starting with association and then using cognitive exploration, eventually they get to something like a discovery science. They discover what is out there through this kind of interconnected process. So, in this module, we have discussed various perspectives on the possible role of nurture through topics like child-directed speech, both natural and cultural environments, and the brain's interaction with this environment, as well as how these types of interactions have an impact on language learning by children.

So, with this, we are at the end of this module. Thank you.