Analyzing Language Acquisition by a Child's Brain

Subhadip Roy

Department of Basic Science and Humanities (BSH)

Institute of Engineering and Management (IEM), Kolkata

Oct. 11, 2020

Abstract

This paper tries to reflect on theories and experimental findings examining language learning, comprehension, and genesis by children. It peeks into child psychology probing innate linguistic intelligence: how infants find the words within the acoustic stream that serves as input to language learning. This paper also investigates how children acquire the ability to interpret the relationships between chunks of speech and their meanings and sometimes, in a rare case, even create a new language when none of the existing ones are compatible. This paper digs deep into the budding stages of a child's brain when it just begins responding to stimuli from nervous triggers. Finally, it analyses how children map grammatical structure onto their perceived input, providing useful insights into how children extract, manipulate, and build up the complex structures existing within natural languages.

***Key words**:* language acquisition, synapses, parentese, mother tongue, natural language, child psychology

Analyzing Language Acquisition by a Child's Brain

Communication is by far one of the most fundamental, yet intricate systems humans have ever relied upon: be it for exchange of information, thoughts, ideas or emotions. The evolution of communication through language is an instinctive process. Language is the most common medium of interacting with one another and this ability blooms naturally in children. In the words of neurobiologist Dr. Lise Eliot, "the reason language is instinctive is because it is, to a large extent, hard-wired in the brain. Just as we evolve neural circuits to eat and see, so has our brain, along with a sophisticated vocal apparatus, evolved a complex neural circuit for rapidly perceiving, analyzing, composing and producing language" (Eliot, 1999). Provided the complexity of this system, it is seemingly quite improbable that a child can discover its underlying structure and use it for communication. However, most children do so eagerly, all within the first few years of life.

Nascence of the Idea of Language

The concept of language is not at all an easy meal to digest for a budding brain that has just started exploring all the five senses. At this stage of life, the most significant contribution comes from the ears that capture sounds and help to interpret them. The second most vital contributors are the eyes. A child tries to relate an experience, rather a stimulus, with all his/her senses - the blend of which creates a perception of the input, that gets stacked in the memory. The next time when similar stimuli are encountered, the brain recognizes it and the child tries to respond to it with some spontaneous movements of hands and legs or, may be just a giggle or a cry as a natural instinct. This is just the embryonic stage of communication with the environment. But communicating with human beings is a much more complicated process. Here comes the role of the parents, to be specific, the mother of the child.

Parental Role

In a general scenario, the first living entity with whom a child communicates is his/her mother. Researchers have found that an infant is able to respond to sound around 10 weeks before birth, learning the mother's voice and the sound pattern of her language prenatally through bone conduction. A baby takes comfort in hearing his/her mother's voice after birth, so a mother's lullaby can be very calming, especially if the mother sang to the baby during pregnancy. While a newborn does not use words, he/she is definitely able to communicate. He/She can look into his/her father's or mother's face in a way implying his/her want to hear their voices. Crying of a baby preludes discomfiture due to hunger, cold, pain or any needs to be met. An infant's brain responds best to a type of speech called 'parentese', (Elaine Shiver, M.S.S.W., 2001) which adults naturally use while speaking to babies. Parentese include short, simple sentences with prolonged vowel sounds having more inflection in the voice and a characteristic higher pitch than usual. Studies have shown that when parents spoke parentese, the baby was able to connect words quicker to the objects they represent. This helps in building a good coordination between the sounds and the objects they refer to.

Parents, as well as professionals working with young children, watch with anticipation the developmental milestones where a child picks up the skills expected at a certain age. In the very first year of life the focus is typically on motor skills, and in the second year, attention shifts to language development. Before a child starts mapping words onto objects they see all around, he/she must determine which sound sequences are words. To do so, he/she must unveil at least some of the units that belong to his/her native language from a largely continuous stream of sounds in which words are seldom surrounded by pauses. In spite of the difficulty of this reverse-

engineering problem, infants are seen successfully segmenting words from fluent speech from about 7 months of age.

Underlying Science

Neuroscientists tell us that a baby is born with millions of brain cells, more than he or she will ever require. Each brain cell has branching prolongations, called dendrites, connecting it with other brain cells at junctions termed 'synapses'. When electrical signals pass from one brain cell to another, they cross the synapse. Repeated exposure to similar stimuli triggers signals to cross the synapses over and over again, and these tracks get registered in the brain. With time, these patterns develop and strengthen. In this way, an efficient, permanent pathway is established allowing signals to be transmitted quickly and accurately. In recent years, advances in brain-imaging technology have confirmed this process. Besides, good nutrition and deep sleep should not be neglected as they play an essential role in the proper growth of a child's brain. Brain cells are covered with an insulating layer of proteins and fats called myelin enabling efficient signal transfer. Infants must receive sufficient fat in their diets provided by breast milk or an equivalent formula prepared in the proper proportions.

Critical Aspects of Language Assimilation

In the initial stages of a child's growth, the brain is active in forming connections for specific abilities. Critical periods in brain development comprise the acquisition of specific skills, one of them being language. This is the prime time for the blossoming of specific intrinsic neural synapses. Arguably, this is the reason why a skill learned at this phase takes much less effort and time to acquire than those learned later. It is also during these critical periods that the lack of

stimulation or negative experiences can have the most significant impact. Hence, this phase of a child's life must be delicately taken care of.

Advancements in medical sciences have shown us that there are physical differences between a child's brain that has been appropriately stimulated and one that suffered lack of stimulation (Elaine Shiver, M.S.S.W., 2001). The restructuring of the connections between brain cells after birth is highly impacted by experiences provided by the child's environment. Parents play an invaluable role in influencing the child's cognitive, language, motor, and socio-emotional development. It is by means of catering repeated, positive experiences for their child that parents have a lasting impact on his or her child's brain development.

Evolving Child Psychology

Researches in child psychology reveal that the key differences between infants and adults lie in their varying levels of imagination and curiosity. It's the curiosity of a child that drives him/her to explore new stimuli and keeps them thoughtfully proactive. At this stage, parents can trigger their child's urge for language learning by providing experiences that allow the child to comprehend what is being spoken to him/her, engaging him/her in face-to-face interaction without undue stress or overstimulation. Infants grasp more meaning from expressions, gestures and emotions than by words. It is always a good practice to use facial expressions while interacting with children as they learn to derive the meaning of the words from the expressions used while using them during conversation. In this way a child will quickly get to infer meaning from chunks of speech. Besides picking up the sounds of speech, in the course of the first six months, a child's brain begins to learn which mouth movements go with the sounds. Therefore, it is crucial to have lots of face-to-face conversations with the baby as the parent interprets the world around him.

Cooing and then babbling are considered milestones in language acquisition. Babies like mimicking what they hear. By speaking to the child and imitating the child's sounds, a parent not only teaches the child sound patterns but also encourages taking turns, a process necessary for conversation. Studies have shown that children whose parents spoke to them more often know many more words by age two and performed better on standardized tests by age three than those whose parents did not (Elaine Shiver, M.S.S.W., 2001). In the first year, it is advisable to talk, sing, and read to the baby often so he/she can imbibe the sounds of his/her native language. In the second year of life, the brain organizes auditory signals and integrates them with visual inputs. For instance, the connections for language starts building up when the child sees pictures in a book and hears the parent giving names to the pictures simultaneously, or sees him/her reciting nursery rhymes, lullabies and concurrently using visual imagery to deduce the implications. Between 24 and 35 months of age the brain gets better at forming mental symbols for objects, people, and events. This has a direct relation with the growing ability to use many more words and short sentences.

The Acquisition of Language: An Intricate Process

Discovering the words of a language and knowing what they mean, is only the first step for the language learner. Children must also fathom how the distribution of these elements, including grammatical endings (-s, -ed, -ing) and function words (of, to, the) convey the further combinatorial meaning of an utterance. The conceptions regarding syntax or grammar grow during the preschool years and may close as early as five or six years of age, while that for adding new words never closes completely. They evidently own certain additional language-learning abilities that enable them to organize their language without explicit guidance. These abilities diminish

with age and may pertain to biology (Jenny R. et al., 2001). Efforts made by researchers to isolate them experimentally, encountered a methodological complication: provided today's languages were acquired by children in the past, language fed to children already comprises products of inborn biases. It is therefore not so easy to determine whether any particular linguistic element observed in a child's language is inborn or derived.

Language acquisition involves structures, rules and representation. The ability to successfully use language requires one to acquire a range of tools including phonology, morphology, syntax, semantics, and an extensive vocabulary (Wikipedia). Researchers are working on a variety of methodologies to uncover the mechanisms underlying language acquisition. Months before infants utter their first word, their early language-learning mechanisms can be scrutinized by recording tenuous responses to new mixture of sounds. Once children begin to link words together, experiments using real-time measures of language processing can disclose the ways linguistic and non-linguistic information are blended while listening. Natural experiments in which children are faced with minimal exposure to language, can reveal the extent of inborn language-learning capacities and their impact on language creation and change. As these techniques and others exploring the child's mind are developed and their findings summarized, they will reveal the child's solution to the puzzle of learning a language.

A Rare Scenario: Hearing-Impaired Children Built a Native Language

Here we examine one of those rare situations in which the language environment is impoverished. This is a reaffirmation of the quote "Necessity is the Mother of Invention", an example of children who are deprived of a holistic exposure to a language, yet quite astonishingly

build a structured native language for themselves: a community of deaf children in Nicaragua. The Nicaraguan Sign Language originated just two decades ago among deaf children attending new schools for special education in Managua, Nicaragua. Their language environment offered an incompatible medium for communication: they could not hear the Spanish words spoken around them, and there was no existing sign language available. The creative children responded by producing gestures that contained grammatical regularities not found in the language offered to them (Spanish), and in the process created a new, natural sign language. The language continues to develop and modify as new generations of children enter school and learn the sign language from their experienced peers.

Thus, there is a measurable dissimilarity between the inputs exposed to each batch of children and the language they acquired, which is much evident in comparisons between the first batch of children (now adults in their 20s) and the second batch of children (now adolescents) (Senghas,2001, p. 323–328 as cited in Jenny R. et al., 2001). One such development is observed in their expression of semantic roles. The first batch of children invented unique signs for the things they needed to talk about (like girl, boy, push, give, fall, etc.) and quickly invented ways to order them together into sentences. For instance, they would name each participant followed by its role to comprehend the occurrence of an event such as “boy push girl fall” or “girl give boy receive”. The next batch of children made better modifications to the existing structure. In just a few years, not only the order of the signs but also where the signs were produced had a different meaning. Once a girl and boy had been stated, push produced to one side or the other would indicate whether the boy was pushed or the girl was pushed. Besides, it was discovered that the children had devised some spatial means for denoting semantic roles, a characteristic of typical sign languages. (Supalla, 1982 as cited in Jenny R. et al., 2001) These findings indicate that

children can implement their own organizational biases to input that is not richly structured. Even when cues are absent from their environment, children apply their inborn learning capabilities to invent a new common language for their community.

Conclusion

These examples of language learning, processing and genesis represent just a few of the many developments between birth and linguistic maturity. During this phase, children discover the crude components in the sounds and gestures of their mother tongue (mother language), learn how they are ordered into longer strings, and map these combinations onto meaning. These challenges unveil simultaneously, requiring children to blend their skills as they learn, to crack the code of communication surrounding them. Notwithstanding layers of complexity even beyond the reach of present modern computers, young children readily solve the linguistic puzzles facing them, even outstanding their input when it lacks the expected framework. Although distributional analyses enable children to grasp the words and phrases of a language, many higher linguistic functions cannot be acquired with statistics alone (Jenny R. et al., 2001). Children, when faced with higher challenges, discover the rules that generate an infinite set, with only a finite sample. The accurate reason justifying a child's innate abilities pertaining to linguistic maturity and perception still remains undiscovered. After all, we can't undermine the fact that the experiences provided in a child's environment are critical for the development of language. Although the process of learning language begins with how the brain is structured, it is this interplay of nature and nurture that results in our ability to communicate.

References

Elaine Shiver, M.S.S.W. Brain Development and Mastery of Language in the Early Childhood Years. IDRA Newsletter, April 2001. https://www.idra.org/resource-center/brain-development-and-mastery-of-language-in-the-early-childhood-years/

Jenny R. Saffran, Ann Senghas, and John C. Trueswell. The acquisition of language by children. PNAS November 6, 2001 98 (23) 12874-12875. https://doi.org/10.1073/pnas.231498898

Senghas, A. & Coppola, M. E. V. (2001) Psychol. Sci. 12, 323–328.

Supalla, T. (1982) Ph.D. thesis (University of California, San Diego).

Wikipedia - Language acquisition https://en.wikipedia.org/wiki/Language_acquisition