Linguistic Development

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1 Introduction

This report is a general overview of current knowledge on linguistic development. It covers four main aspects of the subject. It begins by briefly covering the history of methodologies for studying development, with references to diary studies, large sample studies , and linguistic studies .

Following the historical perspective there is a section on language apparatus, which discusses the idea of the *"language chain"*. On page 9 I discuss the areas of the brain that have been linked to language, as well as the difficulties of linking any part of the brain to a specific function. I then discuss the neurological encoding that gets information from the brain to the body during speech. I then discuss on page 14 in more detail the physiology of speech and hearing.

After the discussion of what it is that has to be developed are a series of sections that cover the main developmental stages of language. They are the prelinguistic period (page 17), the holophrastic period (page 19), the telegraphic period (page 20), the complex period (page 22), and the intuitive linguistic period (page 25). This discussion is then followed by a discussion (page 26)of some of the theoretical contributions that have been made over the years. In particular I discuss the differences between the ideas of the behaviorists such as B.F.Skinner and the Linguistic theorists such as N. Chomsky. In that section I also discuss some of the ideas of the developmental psychologists Piaget and Vygotsky.

The section on developmental theories is followed by a glossary on page 32 and then an extensive bibliography on page 37

The notation which I have used to represent an age in years and months is $yy;mm$. All phonological symbols used are from the International Phonetic Alphabet. For more information on the font see [var]. For a more detailed description of what the characters signify see the glossary and Fig. 24 p. 104 of [Cry80]

2 Language Acquisition

This section is intended to give a brief overview of the kind of issues that linguists and psychologists consider when studying language development. If any of the terminology is new, refer to the glossary on page 32 for explanations. In the rest of the report the terms will be explained in more detail.

The process of language acquisition has a number of features which have intrigued researchers for over a hundred years. For example when children learn a set of words or ways to pronounce words they are making forward process in the language development process.They then pass through a new phase and all of a sudden they can no longer use the words properly. It appears that the child has made a retrograde step in their development, but in the opinion of linguists the child has made a forward leap, since they are now using general rules instead of memorized cases.

What causes this "*U-turn*" effect? There are many explanations, and in recent years the use of neural network models has made it possible to simulate the learning of irregular verbs and past tense markers. The results of these experiments are promising.

In the early stages of development children start by distinguishing the major types of vowel and consonant. Later on they acquire distinctions between the elements of those classes. By age 1 the child is able to utter single word utterances, and by the end of the second year they are able to speak 2 to 3 word utterances. This phenomenal ease and speed with which children are able to pick up something so absurdly complicated, makes the subject all the more interesting and challenging.

The meanings expressed in the sentences produced by children in their early years varies between

statements of possession, requests for more of something or statements with relations of the form (Agent/Action/Object). Sometime after the "*telegraphic*" stage children will begin to use tense markers, number, possession and the progressive aspect of verb "-ing". They are thus starting to use the appropriate grammatical forms.

In the early part of the telegraphic stage the child might say "baby eat cookie". The utterances when they have passed into the early complex stage might be more like "baby eating cookies". This marking system will continue to develop for some time to come. The order in which such grammatical markers are acquired is very orderly. For instance by age 3 most children will start to produce a variety of sentence types that follow identifiable rules.

The child, in producing *wh*-questions, might simply append the question word onto the beginning of the sentence as in *"what you buy"*, leaving the rest unchanged. Later on the auxiliary forms begin to emerge so that the utterance might be *"what did you buyed?"* but before long the child progresses to the final adult form *"what did you buy?"*

In examples such as that shown above the past tense marker is placed on the auxiliary only. So the long process of learning grammatical rules is one of learning the general rule and then learning the exceptions to that rule. Chomsky said in 1978 :

> *Language seems to me to grow in the mind, rather in the way familiar physical systems of the body grow. We begin our interchange with the world with our minds in a certain genetically determined state, and through interaction with an environment, with experience, this state changes until it reaches a fairly steady mature state, in which we possess what we call knowledge of language. The structure of the mind, in this mature state (and indeed in intermediate states as well), incorporates a complex system of mental representations and principles of computation on those mental representations.*
>
> *This sequence of changes from the genetically determined initial state to the final steady state seems to me in many respects analogous to the growth of our organs. In fact I think it is not inappropriate to regard the mind as a system of mental organs – the language facility being one. Each of which has a structure determined by our genetic endowment. These organs grow as a result of the triggering effect of experience, which shapes and articulates them as they develop in the individual through the relevant period of his life.* *[Cho78]*

On all of the levels of description that we have for the language process, it has been argued that development follows a single process. That process is one of *generalization, differentiation, categorization and hierarchical organization.* It is often enlightening to examine the typical errors that children make in the early stages of using a grammatical rule. For instance ***"I seed him brooming"*** (I saw him sweeping)

In this error the past tense rule (suffix */-ed/* has been applied to an irregular verb, even though the child has never heard anyone use the word like that. In that case the child has over-generalized the use of the past tense marker.

During development children will initially use the correct form of the past tense marker for irregular verbs. When the general rule of past tense formation has been learnt, they will use irregular verbs wrongly. Such behavior indicates a rejection of previously learnt forms (listemes) in favour of more general morphological rules. This is very common, even when the result is inappropriate or gives a meaning that was not intended.

Another example from the sentence is the word *"brooming"* which is an overextension of the progressive formation rule (suffix */-ing/* as in hammer → hammering or comb → combing) where the base of the progressive formation is not a verb as in sweep → sweeping but a noun which has been characterized by its use. The error made is very similar in form and cause to that made with the verb *"seed"* in the sentence.

The errors are also very similar to the naming errors that children make in the holophrastic and telegraphic stages of development. The child might use a word to indicate some specific feature of the object to which they are refering. For instance *"ball"* might be used to refer to anything that is round such as a clock face or the moon or anything that bounces. This error is known as *"semantic overextension."*

The removal of such over- or under-generalization of rule is an application of the process of *differentiation* described above. In the process that will require modifications to semantic or syntactic categories and eventually to the hierarchical organization these rules are a part of.

Children create approximations to grammatical adult sentences, and such approximations can reveal similar rules being applied at other levels.

2.1 Social Influences On Development

As we saw above children make and test hypotheses about the meaning of words and the organization of morphemes in a sentence. But how would the child test such hypotheses? The solution is in the social context of language formation. There can be identified three aspects to the social influence on children.

1. establishing the communicative functions of language.
2. providing models of the form and use of language.
3. placing demands on children to communicate effectively.

It is during the very early part of development in the pre-linguistic stage (see section 6 on page 17) that the interactions of parent and child establish vocal noise-making as the *primary* vehicle of communication. That is done through crying, babbling, cooing, whining etc.

The models of form and use of language are provided throughout the developmental process. The use of *"Baby Talk Register"* (often known as "Motherese" or "Child Directed Speech") serves this purpose very well. It does so by providing examples of short, well articulated and grammatically complete sentences which closely approximate to the complexity of the child's own speech.

Parents also play word games that give access to vocabulary and sentence structure. They also repeat the sentences back to children in expanded grammatical form. This practice serves two purposes. First, it acts as a model for sentence structure rather than as a correction of any imprecise usage. secondly it indicates to the child that the parent has understood what the child has said, thus giving encouragement.

Although it is clear that the exposure to language that children receive from their parents is not of the bulk that might be required in the behaviorist model. It is also clear that the language which *is* shown to them is well suited to the task of providing archetypal examples of sentence structure.

In teaching their children parents very seldom set out with the intention of providing formal instruction. They use language to communicate, to play and to maintain social, mental and emotional contact with the child. In doing so they are inadvertently providing what current research indicated is the best kind of schooling in speech.

It is also evident that parents are inadvertently using their communication with the child to train the child in language use. They display modified and highly specific behavior in the choice of sentence, syntax, complexity, tense and cognitive payload that they utter. Such sentence structure is not present in any other social context, and could not be produced by a voluntary act of will.

Importantly, parents very seldom correct any errors in the grammar and pronunciation of a child's utterance. The child itself must perform the discrimination. It is not clear whether constant correction would serve any useful purpose. Children, when corrected, seldom pay any attention to the correction – the continue as before. What the parents do is provide enough input for the discriminative/categorical process to take place in the child. It is also clear that the reason the child ignores the admonishments of the parent is that the child is probably being told not to over-extend a grammatical rule to a certain situation. But children favour general rules over listemes, in the early stages of using a rule.

3 History

3.1 Diary Studies: till 1930

From 1877 until 1930 the main way that linguists could study the development of language was through the diary study. the observer, who was typically a parent, recorded daily the speech of the child. The techniques is still used, although in recent years the child was recorded on a tape recorder. Although several excellent diaries were kept during this period, there were none for the English language. There were a few sporadic reports produced which were incomplete and sketchy in their coverage. (see [Hil14, Hum80, Leo47, Smi73])

Most of the diary studies were of syntax, and little research was made on phonological development. The main benefit which has been accrued from studies of this sort is simply the raw data that they provide. No diary studies have ever been performed on phonologically disabled children.

3.2 Large Sample Studies: 1930 - 1957

The second period of study began with the advent of Dorothea MacCarthy's book *Language Development Of The Preschool Child* (see [McC30]). In this study the practice of collecting large bodies of data on the abilities of children at a certain age. Instead of data on a single child, short samples of speech from large numbers of children across different ages were taken. Such methods were the first systematic attempts to study development, although such claims had been made during the diary period.

Three major studies in the area of phonological development were [WIMB31], [Poo34] and [Tem57].

During the period of large sample studies there was a methodology known as *"taxonomic phonemics* that was concerned with the way that languages use contrast to distinguish meanings in language. For example English uses the sounds /*p*/ and /*b*/ to distinguish the difference between the words *pit* and *bit*. Relying on this principle the area of taxonomic phonemics developed a number of assumptions about the nature of language and its analysis.

3.3 Linguistic Studies: 1957 onwards

Since 1957 there has been a marked change in the approach to the study of children's language. The change was toward linguistic analysis. Instead of just looking at the utterances of the child, the attempt is made to understand what the rules were that produced the output.

The reason for the change in emphasis in developmental linguistics is the advent of the work on transformational grammar by Noam Chomsky (see [Cho57]). People were trying to find out what the rules were and how they changed with time. There was interest before Chomsky on the idea of

phonological substitution, but in the period of linguistic studies, researchers tried to find the rules that governed substitutions. They were not content merely to catalogue the substitutions.

With the advent of transformational grammar in the 50s a new approach to phonetics was developed. It came to be known as *"generative phonology"*. It differs from taxonomic phonemics in many ways. Language is described in terms of features. Sounds are broken down into their various parts. For example the sound /*b*/ is not treated as a single unit but of a series of features [+ stop],[+labial], [+ voiced] and so on. Another way in which there is a difference in the method of generative phonology is in the use of *formal devices* to describe the sound patterns of language. These include restrictions on the way rules are written and the way they can be joined together. The formal devices are encountered more in recent times in speech journals and in speech generation research.

4 What Is It That Develops?

The purpose of this report is not to examine the physiological or neurological architecture of the language chain in any great detail. What I hope to do is cover the developmental aspects of language with reference to these features of the language apparatus. In many cases it is not known how the various physical parts of the apparatus develop. I will on occasion speculate on what might be happening, but speculation is all that I shall do.

This section is therefore a brief overview of the physical endowment which we use to make language. It is intended solely to put the developmental discussions in context and to explain the terminology.

There are four kinds of linguistic knowledge:

1. phonology
2. semantics
3. syntax
4. pragmatics

phonology refers to the set of basic units of speech: *phonemes*. They have no meaning on their own, but they can be chained together to form words, that do. English has around 45 phonemes, other languages have up to 60 (but no more).

semantics is the stage at which the individually meaningless phonemes are assembled to produce meaningful portions of language, called *morphemes*. Morphemes are either words or grammatical markers such as prefixes or suffixes to indicate for instance tense or plurality. The meanings are arbitrarily assigned and bear no inherent relationship to the sound which they are denoted by. Children go through a stage when they recognize that words are used to convey meaning. This is no mean task when considered in detail. One of the primary problems of semantics is knowing exactly how children go about deducing the meaning of words, and how they generalize or specialize concepts. (How can you know what a child means by a word, if what they mean is different from what you mean?)

syntax refers to the form or structure of the language, and deals with the rules that specify how words are combined in order to express meanings. It deals with how to interpret the meaning of a sentence depending upon the word order. For example, consider the following two sentences:

John hit Jim
Jim hit John

In English in an active sentence the noun which precedes the verb names the doer of the action. The noun which follows it names the object of that action. The sentence:

* Jim John hit

violates the rules of word ordering for English and consequently is deemed ungrammatical, although it would not be so in France. The interactions between the rules of syntax for a language and the meanings of the morphemes of the language that are in the sentence help the language user to deduce the combined meaning of the sentence.

pragmatics is the knowledge, independent of semantics and syntax etc, of what kind of response would be appropriate in a given social situation. For example one would not communicate very well if one covered ones mouth with ones hand. Similarly if one preceded a sentence with "now listen here my man..." one would have the same effect, thus pragmatics is the knowledge of the social complications of communication.

4.1 The Communication Chain

The idea of the communication chain comes from Information theory. The communication chain contains the following links: transmitter, encoder, transmission medium, decoder, and receiver. There are parallels between each of these mathematical models and physical counterparts in the human body. We can see that human speech makes more than a little use of the ideas from cybernetics and information theory. For instance, when we speak we rely heavily on cybernetic feedback in order to communicate effectively. If we don't know where our tongues are we tend not to be able to articulate effectively (as anyone whose been to the dentist lately will know!)

Similarly, we need feedback on the progress of our speech through bone conduction through the skull. Researchers have found that if they use a delay mechanism to relay speech to the ear later than normal (so called *delayed auditory feedback*) we begin to stutter, and slur our speech and final end up stopping altogether.

The same principles apply to all parts of the speech apparatus. The Cerebellum and Basal Ganglia need tactile feedback and the auditory system needs vocal feedback, we also need pragmatic feedback too. If we were speaking to someone on the telephone and they made no sound we would begin to falter and stop, hence the "mhm", "I see" and "yes" used so often in conversation. We need pragmatic feedback to see whether the speech is having the desired effect on the listener as well.

4.1.1 The Brain

When trying to understand language development we are faced with a number of problems that would tax the ingenuity even of Hercules. Language by virtue of its fluidity is almost impenetrable to introspection. Everything happens so smoothly and quickly, we have no way of knowing what goes on when we speak. And children, aside from being fairly unreliable witnesses are fundamentally incapable of linguistic introspection of any kind until the developmental process is nearly over. Therefore the kinds of experiments which are required to gain some insight into language development have to be either superficial, as with the diary studies, or must be roundabout in their approach. If an experiment is not direct there may be a number of different explanations for its results. That is the case in developmental linguistics.

The majority of work is descriptive, and it is only latterly with the aid of Nuclear Magnetic Resonance, Computer Aided Tomography and Positron Emission Tomography scanners that we are learning anything of the neural architecture involved with language. Such scanners are still not able

to tell us anything about the developmental processes in the areas that they scan. Many of the discussions in this section will thus be either rather imprecise or the result of inference.

The key questions of this section are about the parts of the brain that are used in language, and how they relate to other cognitive process. It also discusses the difficulties of trying to pin functionality down to one area. For instance, Broca's area, has been long associated with the muscular control of speech processes. But before the turn of this century it was also said that if Broca's region was damaged all that we could conclude was that speech articulation was lost. It did not mean that Broca's region was doing the control, but only that Broca's region was critical to the process of articulation.

Our understanding of the distributed representation scheme used by neural networks only confirms the above caution. If a single line of code is removed from a speech recognition program the whole thing is likely to crash, but that does not mean that *that line alone* was responsible for speech recognition, only that it was involved in the process.

How is the relationship defined between the complex symbolic system of language and the even more complex biological structure of the brain? Most evidence for the relationship has been inferred from language disorders caused by focal lesions on the brain, and other experimental techniques such as brain scanning and dichotic listening tests. The bulk of the data is still gained from pathological clinical cases to this day. The cautionary note raised above applies to such diagnostic techniques.

The study of the relationship assumes some knowledge of both the brain and language. How do we define an adequate level of description for the knowledge that we have gained? Language implies a complex set of mental processes such as the following:

1. Extraction of meaning from words and sentences.
2. Recalling verbal symbols from memory.
3. Associating verbal symbols with referents.
4. Organizing sentences that convey specific meaning and that follow prescribed syntactic orders, and precise phonological rules etc.

In all of the processes the brain is equally engaged, but not necessarily in the same way. Brain scans showing blood flow in an area, shows that there is more blood flow in the left hemisphere of the brain during the execution of speech acts. Moreover the resolution is such that areas such as Broca's and Wernicke's have been shown at work. The scanners do not show what part in the process each patch plays.

The knowledge and functionality in the brain is often smeared out across a large patch of neurons. Although neurons are located in different areas of the brain, their excision may cause equal damage to a specific language function. Thus it is not necessarily possible to say that the functionality is located in any one place. Given that there is no logical necessity for there to be any direct physical counterpart to such grammatical rules as might be found in the formal description of grammar, it is not necessary that the rules have direct psycho-biological reality.

For example, in Chomsky's analysis of grammar, a *speaker* and *hearer* are mirror images of each other. Generative grammar is the logical inverse of the comprehension process. Within the biological reality there are distinctly different requirements of the systems. Thus there can be *no* biological symmetry. The high degree of redundancy in spoken language allows for a certain amount of imprecision within the decoding process. Such guesswork and filling-in does not prevent successful comprehension. More precision is required in the production of sentences. It is necessary for us to draw a distinction between the central cognitive processes behind the formulation of utterances and the mode and method of communication whereby they get expressed and decoded.

Is it reasonable to assume that evolution has totally decomposed the brain's language facilities into tidy subsystems of neural machinery? Given that certain types of focal brain lesion have been observed to selectively disrupt language - it is not unreasonable. (c.f. anomia though for the other side to the argument) Lateralisation of the severity of the effect of such lesions points to at least *some* localization.

The following working assumption can be used in the analysis of brain-language functionality:

1. The medium of natural language is dominantly and originally acoustic.
2. The anatomic sub-strata for speech function are for the most part concentrated in a particular region of the left hemisphere.
3. It is possible to recognize in language performance acoustic-phonetic afferent systems as well as articulatory effectors.

The two poles of the language system are fairly well circumscribed in the cerebral cortex. They appear to be connected via a fibre tract. That is - there is a set of nerve fibres carrying information between the two regions. The receptor/affector polarity constitutes a familiar pattern of neural organization for many functions and is reminiscent of the *"reflex arc"*, which in various forms serves as the basic building block of the nervous system.

The temptation to draw a parallel between language and other sensori-motor functions should be resisted. Such a model does not leave room for a description of comprehension or of spontaneous production of utterances, nor of any of the motivations which we serve by speaking.

While a reflex arc can be demonstrated for the speech mechanism as elsewhere in the nervous system, its function with respect to language appears to be limited to repetition and auditory feedback. There is little direct coupling between speech production and speech comprehension. This is an important point since it distinguishes between language as cognitive process and speech as a mechanism of performance of communication which is *coincidentally* acoustic/vocal in form.

Can it be assumed that although in some cases there are anatomical territories for language function, there are such territories for all language functions? It is much easier, for example, to find the anatomical locus for phonological aphasias than for anomia. Anomia is often associated with diffuse cortical disorder such as senile dementia.

Some studies of echolalia indicate that there is a short-term auditory/verbal memory that is separate from a long-term semantic counterpart. In other studies it has been demonstrated that the lack or damage of such a short term memory does not hinder comprehension or paraphrasing.

What are the origins of language asymmetry in the brain? Of some of the most elaborate communication systems in the animal kingdom, the majority are organized equally across both brain hemispheres. There is a small set of animals that do display hemispheric dominance in communication tasks. For instance, canaries and macaque monkeys. In most cases the songs and calls are preferentially processed in the left hemisphere rather than the right.

These findings indicate that the left hemisphere is preferentially disposed towards communication. It might also be argued that for a computationally intensive tasks such as speech, more efficiency would be gained through processing in just one hemisphere. That would reduce the chance of confusion between the hemispheres in handling the sensory motor processes that underpin comprehension and production of language. It could also be argued that if language becomes a major survival advantage, then it must be protected from accidental damage. If abscesses, strokes or other internal damages strike with equal probability in either hemisphere, then the chances of a stroke damaging language are halved by concentrating it in one place. Lack of communication in any member is a blow to the whole tribe, not just to one individual.

Little is yet known about how the brain is able to encode grammatical structure within the brain. It has been found though that it encodes sentences as clauses.

> *The clause has emerged as a unit of speech which is more readily identified than any other as being phonologically 'shaped' by such features as pause and intonation (speech melody). We are much more likely to pause between clauses than within them, for instance.* [Cry80]

Other indications confirm this. For instance spoonerisms never occur across clause boundaries.

The structure of the brain is involved in the process of language development in other ways than by learning alone. The language development process is determined by what the brain *cannot* learn. In the early stages of language development the child is still growing nerve cells and the brain is also still wiring itself up. As David Crystal says:

> *Moreover, nerves develop their myelin sheaths (or become 'myelinated') at different periods of human development. All fibres are unmyelinated to begin with; the process of myelination continues until well after birth, and proves to be an important factor in the extent to which the nervous system is capable of transmitting efficiently several of the more complex voluntary movements. For example, it is possible that the relatively late appearance of certain types of sound in speech production (high frequency sounds such as /s/) may be due to the degree of myelination of the auditory nerve and the cortical areas to which it connects.* [Cry80]

4.1.2 Neurological Encoding

There are many things which a child must learn if they are to produce speech effectively. It is not enough for the child to just know grammar, and morphology. A complete control over the speech organs is also required. The organs used in speech are:

- Tongue
- Pharynx
- Epiglottis
- Vocal Chords
- Larynx
- Trachea
- Clavicle
- Sternum
- Lungs
- Thoracic Cavity
- Diaphragm
- Nasal Cavity
- Hard and Soft Palate

- Teeth
- Lips

These are really just the tip of the iceberg when speech is involved. There are many muscles in the tongue, which are able to move it in all directions. The control of the tongue requires the control of all of its constituents. The same is also true for the rest of the anatomy involved.

Such control is an awesome task, and has been the downfall of many artificial Intelligence projects. The fine motor control of the speech apparatus is performed by the cerebellum. Arising dorsally from the brain-stem, the cerebellum is responsible for the maintenance of body posture and the smooth coordination of all movements, including walking and *speaking*.

The Basal Ganglia, which are buried deep within the hemispheres, are also involved in coordination, as well as the motor cortex which is situated immediately anterior to the Rolandic Fissure.

The regions located in the region around the junction of parietal, frontal and temporal lobes are proposed for language skills. As described above in section 4.1.1 there are many complicated feedback mechanisms that are integral to the production of speech. Unless the brain knows where all of the speech organs are located and how they are moving, then it has great difficulty producing speech. The brain uses a cybernetic feedback mechanism to control speech. Studies have shown that if the feedback process is interfered with, the subject will begin to produce, slurred speech, stuttering and will eventually stop speaking at all.

Too much reference to Broca's and Wernicke's areas can lead the reader to think that that is all there is to the language comprehension and production processes. In fact there are many areas of the brain which are involved in language. The Thalamus and the Hippocampus are strongly involved. The thalamus relays and helps to analyze sensory information, while the hippocampus is involve in the control of memory. Without a perceptual system and a memory there would not be any chance of speech developing.

It can be shown that lesions to the left hemisphere produce:

- Disorders of reading and writing
- Loss of verbal memory
- Defects in left right orientation
- Oversimplification and lack of detail in drawings
- Inability to perform certain kinds of movements

Lesions to the right hemisphere produce disorders in:

- Spatial orientation
- Facial recognition
- Certain emotional responses
- Grossly distorted drawing

Although these observations seem to indicate that there is significant differences between the hemispheres, it has been found in recent years that there is less of a correlation between language dominance and handedness than was originally thought.

4.1.3 Anatomical-Physiological Encoding

There are several processes at work in the production of speech. The Diaphragm, ribs, clavicle and the other thoracic organs involved in speech are used to create a flow of air. They are the power supply. They provide the *"pulmonic"* air flow. The pulmonic is used to create the vowel sounds as well as most of the consonantal sounds. They are not used in the production of *"velaric"* air flows. Velaric air streams are used in some languages such as the *"!kung"* of the Kalahari desert. The "!" is the *clicking* sound that one is able to make by placing the tongue against the hard palate and velum then moving it quickly towards the bottom of the mouth.

Our breathing patterns change as we speak. The normal breathing pattern is around 20 breaths per minute. Which speaking we change to a pattern of around 10 breaths per minute.

Speech is superimposed on the air flow by the rest of the speech apparatus. The air stream is normally inaudible, and it can be made audible by interfering with it in several ways. The molecules of air are made to vibrate. The first point at which this vibration can be created is at the larynx. The vocal cords, which are encased in a "voice box" about 8cm by 5cm (the Adam's Apple). The larynx is able to close off the lungs during exertion, or to prevent foreign bodies entering the lungs during swallowing. It can close the trachea intermittently or partially.

The cartilages in the larynx (known as "arytenoids")are articulated by a series of joints and controlled by several muscles and ligaments. As a consequence there are a wide variety of sound effects that can be produced by the different positions of the cartilages. Situated within the thyroid cartilages are the vocal cords which are around 2cm in length.

The operation of the vocal cords is the subject of some controversy and is still not fully understood. The vocal cords are used for *"phonation"* or voicing. If they are held closed and then opened quickly the effect is known as the glottal stop (as in the cockney pronunciation of "bottle" $/bl/$. If the vocal cords remain open then we are able to hear audible friction as in whispering or the $/h/$ sound. Various other sounds can be produced, by changing the frequency and amplitude of the vibration.

Above the larynx the sound is changed again by the shape of the vocal tract. Three cavities are involved in this process: the*Pharyngeal cavity*, the *Oral cavity* and the *nasal cavity*. The name for the physiological movements of the above is *"articulation"*. Sounds are classified by the place and manner of the articulation. The The main consonantal divisions according to place of articulation, can be read from front to back of mouth as follows:

labial both lips involved — $/p/$ $/b/$ $/m/$
labi-dental lip against teeth — $/f/$ $/v/$
dental tongue against teeth — // //
alveolar tongue against teeth ridge — $/t/$ $/d/$
palatal tongue against hard palate — $/ç/$ $/j/$
velar tongue against velum — $/k/$ $/g/$
uvular tongue against uvula — $/q/$
pharyngeal constriction in the pharynx — //
glottal constriction in glottis — glottal stop, whisper

Table 1: The main consonantal divisions according to the place of articulation, read from back to front of mouth.

The tongue is the organ of articulation most involved in the production of speech sounds. It is involved with the production of all of the vowel sounds, and the majority of the consonants. The great mobility of the tongue is due to the arrangement of muscles in all three planes, to allow great control, of size, shape, movement and position. Seven basic types of tongue movement are possible allowing the tip, edges and center a fair degree of independent movement.

The soft palate (or *velum* or *velo-pharyngeal sphincter*) is the extension of the hard palate, at the back of the mouth. Muscles allow it to be raised and lowered during speech. It determines whether air is allowed to pass through the nasal cavity and is thus involved in the production of many sounds such as /*n*/ and /*m*/.

4.1.4 Auditory Reception

The first step in the reception and decoding of signals is in the ear. The ear is nominally divided into three sections: the *inner, middle* and *outer* ear.

The outer, visible part of the ear known as the *"auricle"* or *"pinna"*, and the narrow passage that leads to the ear drum known as the *"external auditory canal"* is non-mobile and consists mostly of cartilage. It plays a minor part in the language process, mainly being involved in the focusing of sound waves into the ear, and assisting in the localization of sound waves. It is about 2.5 cm long and ends at the eardrum. It contains hairs and glands that secrete wax. It also acts as an amplifier for frequencies between 3000 and 4000 Hz.

The outer ear is separated from the middle ear by the eardrum (or *timpanic membrane*) It lies at an angle of 55 degrees across the canal, and is thus roughly circular in shape. It is made of a tough, fibrous, elastic tissue that is able to resonate in response to sound waves reaching it. The shape of the membrane forces the vibrations to be focused on a prominence near its middle. The prominence passes the vibrations on to the first of the small bones in the middle ear, attached to the other side of the membrane.

The cavity behind the eardrum, known as the timpanic cavity is filled with air. It has a direct passage to the nose and throat via the Eustachian tube. The middle ear turns sound vibrations into mechanical movement of the three bones of the middle ear known as *"ossicles"*. The purpose of having such bones in the middle ear is that the leverage system employed by the bones amplifies the vibrations by 35 times. Such amplification is necessary because the inner ear is filled with a viscous fluid that would be insensitive to lesser vibrations.

The inner ear is a small series of interconnected cavities – the *"Aural Labyrinth"*. It has two parts - the semicircular canals (*"Vestibular Canals"*) that are organized so that the loops are set at angles to each other. These are used to control the sense of balance. They are filled with fluid and hairs to detect the movement of the fluid in response to the motion of the head.

The other part of the inner ear known as the *"Cochlea"* is a coiled cavity resembling a shell. It is 35mm in length and coiled $2\frac{3}{4}$ times. Its primary function is to turn mechanical vibrations in the middle ear into nerve impulses capable of being transmitted to the brain. The Cochlea tapers during is spiral, thus allowing responsiveness to different frequencies, over the course of the taper. Within the cochlea lies a highly sensitive organ of hearing based upon similar principles to that of the vestibular canals. It contains an arrangement of cells with very fine hairs distributed in rows and layers along a membrane. These hair cells are able to pick up the pressure movements of the fluid in the inner ear. The cells connect to nerve cells which carry impulses along the cranial (auditory) nerve. the messages thus are carried to the brain.

5 Normal And Deviant Development

There are several reasons why deviant development is an important area of study within linguistics. A full appreciation of normality requires an understanding of abnormality. in the case of language development we are able to understand the processes that are at work within the language development cycle by being able to look at situations in which those processes have been damaged or have not occurred. Likewise, the study of normal development enables us to diagnose and often to treat cases of abnormality.

The study of development provides linguists with a framework within which they are able to study language as a whole. It is possible to see that the stages of development of phonology, morphology, syntax and pragmatics creates a natural academic division. Maybe the localization of brain function makes it possible to study one area of development without having to make recourse to knowledge from other areas.

There are several debates going on within linguistics about language development. They relate to the idea of progress within language. Is it that there are general stages of development that are independent of each other? Is phonological development able to progress along its own schedule regardless of the status of development of syntax? Is linguistic development entirely divorced from cognitive development. In other sections I have discussed possible ways in which this is false. it is known that in the majority of cases retarded linguistic development is associated with cognitive retardation. It still remains in doubt because the cause for the two deficits might be another region that is itself critical for both. Damage to this region might cause retardation in language and cognition, but the possibility still remains that language and cognition are capable of separate development and retardation.

Another issue that is important for linguists is exactly at what ages should we regard linguistic development to be occurring? The majority of significant developments occur between the ages of 2 and 5. Other believe that the period from 0 to 16 years of age is a more significant duration.

It has been shown in other sections that the child's linguistic development begins from the very first days after birth. At that time the discriminatory capacities are developing. The myelination of nerve cells within the cortex is also still going on. Linguistic development continues after the age of 5 in the development of more complicated structures. Further development of cognitive capacities is also observed into puberty. Introspection about the structure of language is not possible until after the age of 5.

If language is not independent of cognitive development then it could be argued that one of the areas of study in linguistic development is cognitive development itself. Consequently the duration of linguistic development will be from birth till puberty, and beyond. It has thus been argued that a suitably loose scheme for the classification of development in general is that of Piaget. The scheme is shown below in table 2.

As a contrast to table 2 listed in table 3 is a scheme for the linguistic stages that have been observed. Many of the major insights which enable further development in children are visible by comparing the changes that must have occurred to pass from one cognitive stage to another.

The development of phonology in table 4 illustrates the development still further. The recognition of the object concept heralds the development of noun words and the foundation for a morphological system is laid.

Sensori-Motor Stage:$(0;0$ **-** $1;6)$ Development of systems of movement and perception. Child achieves notion of object permanence.

Concrete Operations Stage:$(1;6$ **-** $12;0)$ preconcept subperiod $(1;6$ - $4;0)$ The onset of symbolic representation. Child can now refer to past and future, although most activity is in the here and now. Predominance of symbolic play.

Intuitional Sub-Period:$(4;0$ **-** $7;0)$ Child relies on immediate perception to solve various tasks. Begins to develop the concept of reversibility. Child begins to be involved in social games.

Concrete Operations Sub-Period:$(7;0$ **-** $12;0)$ Child learns the notion of reversibility. Can solve tasks dealing with the conservation of mass, weight and volume.

Formal Operations Period:$(12;0$ **-** $16;0)$ Child learns the ability to use abstract thought. Can solve problems through reflection.

Taken from Ingram (1976)[Ing76]

Table 2: **Piaget's stages of cognitive development.**

Prelinguistic communication through gestures and crying.

Holophrastic Stage Use of one word utterances.

Telegraphic Stage Child begins to use words in combinations. These increases to point between 3 and 4 when most sentences become close to well formed, simple sentences.

Early Complex Sentences The child begins to use complements on verbs and some relative clauses. These early complex, however appear to be the result of juxtaposition.

Complex Sentences Child acquires the transformational rules that embed one sentence into another. Coordination of sentences decreases, v. the increase of complex sentences.

Linguistic Intuitions Child can now reflect upon grammaticality of his speech and arrive at linguistic intuitions.

Table 3: **General stages of Linguistic development.**

6 The Prelinguistic Period

When spoken to, neonates will often open their eyes and gaze at the speaker, and after 3 days they are able to recognize their mother's voice. They then prefer the sound of their mother to that of a female stranger. In the first few days of life, speech already elicits more activity in the left hemisphere than in the right. With music the reverse is true. This pattern persists into adulthood, and suggests that hemispheric specialization for processing different types of acoustical stimuli occurs before birth and may be innate (although left handers are less hemispherically dominant than right handers.)

Young infants will suck faster in order to be able to hear sounds of recorded speech, in preference to instrumental or rhythmical sounds. In short, babies are able to discriminate speech from other sounds from the moment of birth. They pay close attention to speech and will listen to speech in preference to other kinds of auditory stimulation.

By 2 days of age babies are able to discriminate between the vowel sounds of $/a/$ and $/i/$. It is unlikely that different samples of speech seem all alike to a newborn. By $0;1$ infants are as able

Prelinguistic	vocalization and perception.(*0*; *0* - *1*; *0*)
Phonology of the first 50 words	.(*1*; *0* - *1*; *6*)
Phonology of single morphemes	The child begins to expand inventory of speech sounds. Phonological processes that result in incorrect productions predominate until around age 4 when most words of simple morphological structure are correctly spoken.
Completion of the phonetic inventory	The child acquires production of troublesome sounds by age 7. Good production of simple words. Beginning of use of simple words.
Morphophonemic development	Child learns elaborate derivational structure of the language; acquires morphophonemic rules of the language.
Spelling	Child masters ability to spell.

Table 4: **General stages of phonological development.**

as adults in distinguishing between the consonant sounds /*ba*/ and /*pa*/ and /*da*/ and /*ta*/, even though the children have never been able to produce the sounds. The ability to discriminate speech and non-speech sounds is probably innate, or learned in the first few days of life.

From birth to about 1 month the child produces sounds which are stimulated by their physical state. They are still able to convey several different kinds of information. It would seem that temporal characteristics of crying patterns are able to convey info that enables babies to make their needs known.

Psychologists have managed to distinguish 3 different types of crying:

Hunger cries The cry starts as a quiet and intermittent cry which gradually becomes louder and more rhythmical.

Angry cry the angry cry follows the same sequence as the basic crying pattern, but which is characterized by different lengths of sound and pause.

Pained cry The cry of pain is sudden and loud from the start and consists of a long cry followed by a long silence, then a series of short gasping sounds.

From *0*; *1* onwards babies are able to make a cooing sound that seems to be produced in response to pleasurable sociable interactions. They occur particularly in dialogues - arising between mother and child, such as in nappy changing or bathing.

Although many conversations between mother and child appear to be completely one sided, video recordings show that the baby will stare fixedly at the face of the adult and display signs of enjoyment. It has been argued that early interactions between mother and child of this sort form the basis for language learning at a later period.

From *0*; *6* to *0*; *9* the baby enters the babbling or echolalia stage, in which the baby reproduces vowels and some consonants. The baby is therefore no longer confined to the simple vocal patterns of the first few months.

Echolalia is the frequent repetition of syllabic sounds such as /*adadadadada*/ or /*mamamamama*/ in which the baby engages. During this period the baby spends a lot of the time making noises while alone. Perhaps this is a stage in which the child is rehearsing its linguistic skills.

The child is also at this time learning other types of behavior which they use only with familiar people. Initially during this period the parent expends a lot of effort in interpreting the baby's

utterances. She is creating or providing a social frame work for the child, or is integrating the child into a social system. This process is often known as scaffolding.

At the age of *0*; *9* a new pattern of behavior appears. The baby produces strings of utterances which have the intonations of language, even though they do not contain meaningful sounds. This period is often called the *Jargon* period. By this stage the baby appears to understand what is being said to it since it is able to obey simple instructions such as *"COME here"* or *"STOP it!"* During this stage babies also learn another useful skill - turn taking.

Studies have shown that in the interaction between parent and child from the ages *0*; *3* to *1*; *6*, one of the main characteristics is that the interaction is of a conversational nature. The parent alternately gives data and tries to elicit it. The pattern thus emerges of two way conversations. Beyond *0*; *7* this process increases when the baby starts to produce more meaningful output. By *1*; *0* mother and child have a repertoire of shared activities which can last for several minutes. When in this stage the mother will begin to expand and rephrase the babble that the baby produces *as if they were words.*

From around *1*; *0* babies begin to use words consistently to refer to things that they want, or to name people or objects. At this time they often condense the meaning of words so that they mean different things in different social of psychological states. They are able to create variations in the meaning of the word by intonation, context, gesture and volume to produce a richer form of expression. For this reason the single words are often known as holophrases because they are used to represent a whole idea.

7 The Holophrastic Period

The word *"Holophrastic"* is used to mean the *single word phrase* stage. It starts at around the age *1*; *0* and ends at about *1*; *6*. As its name suggests the only verbal means that the baby has of communicating is through the use of single word sentences. These words are not as basic as the meaning of just that single word. The child is able to imbue the word with a set of other meanings which are expressed using intonation patterns and gestures as well as volume. It is the fact that the child is able to express more than one meaning with a single word, that the linguists say that the words are holo-*phrases*.

At the age around *1*; *6* the child's vocabulary begins to grow at a phenomenal rate. The words are accumulated at a rate of around 15 words per day for around the next 15 years!!(See [SC91] and [Pin94]). This rate and duration may seem preposterous, but the latest estimates for the size of our vocabularies is vastly larger than was originally thought. Indeed, given that we learn generative morphological rules as part of our linguistic development, we have the capacity to use an infinitely large set of words in our language.

Pronunciation improves during the Holophrastic stage and the vocabulary consists of a large proportion of person and object words. There are some relational words but they do not form a large part of the language of a child until the telegraphic period. The kinds of relational words which are used are normally like *'up', 'no',* or *'more'.*

It seems from much research that has been done recently in the computer modeling of language development that there is a critical mass of knowledge that the child must accumulate before he can start to make connections between the items of knowledge. Hence the vocabulary must be of a certain size and consistency before the syntactic development of the telegraphic stage can commence. Likewise the the increased comprehension that the child has of adult speech means that he can start to deduce many more facts about the content of sentences and the meanings of words.

This critical mass is very important and gives us an insight into the reason for such simplistic grammatical formulations in motherese. If a child has reached the end of the *50 word* stage, but does not yet know anything about syntax then they can have an easier job of comprehending a two word sentence than a three word one. There are two possibilities to the meaning of a two word sentence, and thus it is easier to decode. For a three word sentence, there are six alternative meanings. With a four word sentence, there are 24 alternatives, and 120 for a five word sentence. By concentrative the efforts on a Subject/Object model of language the scaffolding can be put in place for further development.

A child is able to understand very simple instructions and questions, during this period. Examples are *"DON'T do that!"* or *"STOP that!"*.

From *1*; *6* to *1*; *9* a child's vocabulary will expand from around 20 words to 200 words. These words will include action names, state names and the odd functional word which refer to kinds of events. Most of the vocabulary at this stage will consist of naming words (nouns) particularly of objects in the child's environment that it can manipulate, such as toys clothes, food or people.

8 The Telegraphic Period

The telegraphic period is so called because of its terseness and lack of function words such as tense endings, verb endings, prepositions, conjunctions and articles. It occurs between the ages of *1*; *6* to *3*; *0* and is thought of as the period during which function words are added to the multi-word sentences. Consequently it is the most thoroughly studied of all of the periods of linguistic development.

The essence of telegraphic speech is economy. The words that are used are the absolute minimum required to convey the meaning. The kind of words that are likely to be omitted are article, prepositions, pronouns and auxiliary verbs. Young children tend to follow the same strategy, even in their imitations of adult speech. It was thus thought, initially, that the reason for such economy were limitations in memory capacity. this view was rejected once researchers noticed that children were capable of producing 3,4 or even 5 word telegraphic sentences.

Presumably a child that can only generate short sentences will choose to omit those that do not contribute so much towards the content of the utterance. They therefore allow more effective communication through the omission of redundant(ish) verbiage.

Surprisingly children from very different culture produce similarly structured sentences even though they have been exposed to strikingly different language structures during their first few years. Telegraphic speech thus represents a universal child language.

To analyze child language just on syntax would not convey the meaning the child learned to express in the holophrastic stage using intonation, stress and pitch etc.

Brown (1973) analyzed the telegraphic speech of children of several countries and produced a semantic grammar (see table 5 below). A semantic grammar is an analysis of the semantic relationships (meanings) expressed in the earliest sentences. the most common of these relationships are shown below. (c.f. p.p. 373 [Sha93]

It is presumed that given the rules described in table 5 the next task in the developmental cycle is to combine them into longer telegraphic utterances. For example, an agent/action relationship such as "mommy drink" can be added to an agent/object relation such as "drink milk" to yield an agent/action/object rule for "mommy drink milk".

if such a milestone is passed then we could concluded that the child is ready to acquire the rules of syntax. The child would be ready to produce the grammar that more closely resembles the language

Semantic Relation	Examples
Agent + Action	mommy come; daddy sit
Action + Object	drive car; eat grape
Agent + Object	mommy sock; baby book
Action+ Location	go park; sit chair
Entity + Location	cup table; toy floor
Possessor + Possessed	my Teddy; mommy dress
Entity + Attribute	box shiny; crayon big
Demonstrative + Entity	dat money; dis telephone

Table 5: **Common categories of meaning (semantic relations) expressed in children's earliest sentences**

they are learning. The semantic rules which it is born with can be combined in a variety of ways which can reflect the language community in which it is born.

In the prelinguistic stage prior to the development of intelligent speech babies have still developed a means of communicating with their care-givers. e.g. crying, cooing, laughing, whining and particularly pointing. Perhaps by pointing at an object the mother is prompted to give a name to that object. So the use of pointing and other gestures may serve the purpose of increasing the linguistic input that the child receives.

The babies will also be using other gestures to disambiguate telegraphic sentences. By 2 to *2*; *6* children have also learnt that there are other keys to effective communication, such as hearing others properly by placing yourself near them and making yourself heard by speaking up.

The order order of development is fairly predictable and is the same for all languages that share the same system of noun and verb suffixes. Until children have learnt suffixes that make word order flexible they have no way to produce unambiguous word orderings.

Towards age 3 the child is able to determine the subject and object of a sentence without having to make reference to the word ordering. They are able to do this by examining the relationships between the verb and the other sentence parts. As is described in other parts of this report the cognitively simplest grammatical morphemes are learnt first. For instance the present tense third person singular */-s/* as in *"he goes"*m develops before the past tense endings such as *"he goed"*. There are also less variations in the structure of the present tense third person singular forms of verbs than there are in the past tense forms.

From *1*; *6* onwards the child is already beginning to produce two word sentences, even though single word sentences continue to be used for some time. At *1*; *6* the baby is becoming skilled at monitoring and comprehending the responses of others, even though they have not really mastered the grammatical rules of language.

At *1*; *9* to *2*; *0* the child is able to adapt their form of communication if they are not able to make themselves understood (repair). By introducing flexibility to find some means of communicating the child is actively seeking out a rudimentary syntactic/semantic system.

By *2*; *0* they are regularly producing 3 to 4 word sentences, often ungrammatical by adult standards but certainly obeying *some* rules of grammar. The rules are fewer and simpler but that have been shown to exist. Their understanding of the grammatical rules of language used by adults is expanding very quickly. They will start to reorder the words in sentences in accordance with syntactic rules for the conversion of declarative sentences to questions or negations etc. The children will at this stage start to practice dialogue when they are alone. It seems that they are practicing new words and grammar forms and playing with sounds and rhymes. They are trying to make sense of the world

by ordering events in a systematic way.

R. Brown in 1970 distinguished two types of semantic relationship used in telegraphic speech.:

1. Those expressed by combining a single constant term or *pivot word* (e.g. "more", "all gone") with another word which refers to an object, action or attribute.
2. Those which do *not* involve the use of pivot words.

The acquisition of telegraphic speech was thus attributed to the acquisition of two kinds of combinatorial rule, namely pivotal or categorical rules. Children vary widely in the amount that they use the two types of rules.

It has been argued that the use of rules in language must reflect some underlying understanding. Children form *schemas* to understand the world and *then* talk about them. Thus the child must form the idea of object permanence before it can begin to use words for naming purposes. If the child has not made such connections then the first strings of words are likely to be random collections of words. Such a view of language development is consistence with Piaget's view of cognitive development.

9 The Complex Period

During the early complex period the first example of grammatical markers appear. It should be noted that different commentators use different schemes of development, and some regard the development of grammatical markers as one of the features of the telegraphic period. See [Mos0s] and [BS84].

Between the ages of *2; 6* and 5 the Mean Length of Utterance (MLU) increases dramatically. Sentences become considerably more sophisticated. Brown (1973) kept records of three children and noted their progress in the acquisition of 14 semantic markers that frequently occur in English sentences. he found much variation in the age at which they learnt to use the markers and in the time that it took them to learn all 14.

He also found that in all of the subjects studied the morphemes were learnt in precisely the same order. See table 6 below.

These findings were confirmed by de Villiers and de Villiers (1973) of an additional 21 children. In order to find an explanation Brown rejected the idea that this ordering represented a frequency of occurrence of a certain type of morpheme. rather, he found that the morphemes learnt first required less cognitive sophistication. The morphemes occur in language with roughly equal frequency.

For example the first morpheme to arrive is the */-ing/* present progressive form. this describes ongoing action which appears before the past regular */-ed/* that describes action and a sense of an earlier time. */-ed/* conveys two semantic features and is thus acquired earlier then the uncontractible forms of the verb *to be* such as*is, are,was, were.* these specify 3 semantic relationships: number (*was v. were*), tense (*is v. was*) and action.

It also seems that children in the post-telegraphic phase employ processing strategies that are designed to maximize their chances of finding the new grammatical morphemes. They will pay more attention to the ending of words. Thus they find suffixes easier to learn than prefixes. they will also tend to look for regularities in the language that they hear, and avoid or discount any exceptions to the rules that they discover. Even if it seems that they have learnt the exception already. Hence the characteristic U-turn in the child's performance.

There are in addition to grammatical morphemes, certain of the transformational rules that children use to convert declarative statements into questions. In English, people learn to transform declaratives into *wh*-questions by placing a *wh*-word such as *who, what, when, where, why* and *how* at the

Morpheme	Example
Present Progressive: -ing	he is sitt*ing* down
Preposition: *in*	the mouse is *in* the box
Preposition: *on*	the book is *on* the table
Plural: *-s*	the dog*s* ran away
Past Irregular: e.g. *went*	the boy *went* home
Possessive: *-'s*	the girl*'s* dog is big
Uncontractible Copula *be*: e.g. *are, was*	*Are* they boys or girls
	was that a dog?
Articles: *the, a*	he has *a* book
Past Regular: *-ed*	he jump*ed* the stream
Third Person Regular: *-s*	she run*s* fast
Third Person Irregular: e.g. *has, does*	*does* the dog bite?
Uncontractible Auxiliary *be*: e.g. *is, were*	*is* he running?
	were they at home?
Contractible Copula *be*: e.g. *-'s, -'re*	that*'s* a spaniel
Contractible Auxiliary *be*: e.g. *-'s, -'re*	they*'re* running very slowly

Table 6: **Order of acquisition of English grammatical morphemes.**

beginning of the sentence, then inverting the order of the subject and the auxiliary verb. by applying such rules we could change the statement *"I was eating pizza"* into *"why was I eating pizza?"*.

Other transformational rules allow us to generate negations (see below in table 7) imperatives, relative clauses, and compound sentences.

"I was not eating pizza"
"eat the pizza!"
"I who hates cheese, was eating pizza"
"I was eating pizza and john was eating spaghetti"

As the child's mean length of utterance rises above 2.5 they will begin to produce variations in the declarative model. However, young children acquire the transformational rules in a step by step fashion. If, in order to produce a certain kind of sentence such as a negated question *("why was john not eating pizza?")*, one had to employ both the *wh*-transformation and the negation-transformation. But if one only knew the correct form of the *wh*-transformation then the result might seem a bit strange.

"why not was I eating pizza?
"not why was I eating pizza?"

There are two main kinds of question; those which yield a yes/no answer, questions which ask whether a declarative statement is true or false. In contrast *wh*-questions are asking respondents to provide information other than a simple yes/no.

I early stages of the telegraphic phase the child will issue interrogatives by using a declarative sentence with a raised inflection. *wh*-words are occasionally placed at the beginning of the telegraphic sentences generating simple *wh*-questions such as *"where doggy?" or "where doggy go?"*. Later on the children will use auxiliaries.

In an interesting parallel to the way in which grammatical morphemes develop in the simplest first order, the kind of questions which children ask are generally those which contain similar concepts to the grammatical morphemes. For instance the first questions usually contain the *wh*-words *what where* and *who*. Only later on are they followed by the *why, when* and *how*.

The *what where* and *who* have concrete referents. (objects, locations and persons) Such words can be easily understood by a cognitively immature child, whereas *when, why* and *how* require an appreciation of the more abstract concepts of time and causality. Their onset must wait for the appropriate insights in the child's non-linguistic learning.

The strategy for producing negations is very similar to the rule for *wh*-questions. the initial strategy is to simply place a negating word such as */no/* or */not/* at the beginning of the sentence e.g. "no sit there." the negation has been placed at the beginning of a positive declaration.

The children pass through a second stage in which the negative markers are placed within the sentence next to the word stem to be modified, so that sentences of the form "i no want milk" or "I not am going home". Eventually at the third stage the child will combine negative markers with auxiliary verbs to negate affirmative sentences in much the same way as adults do.

1st Rule : to negate add *"no"* or *"not"* to the front. Or if forgotten at the beginning : add to the end. But never in the middle.

2nd Rule : 1st rule plus
"no", *"not"*, *"can't"* and *"don't"* can appear after the subject but before the verb. Some imperatives begin with *"don't"* instead of "rule 1s".
"can't" and *"don't"* are unanalyzed forms of negative. Therefore they are interchangeable with no.

3rd Rule : Many more features added.
concorded pronouns are not added yet. Thus the progression might be as follows

- * I didn't see somebody today
- * I didn't see nobody today.
- I didn't see anybody today.

Telegraphic speech is still evident at this stage.

Or use of pitch to indicate negation from *2*; *0* to *2*; *4* because adults raise the pitch during negation.

Table 7: **Progressive acquisition of the negation-transformation rules**

When the child's MLU reaches 3.5 to 4 at around the age of 2 or *3*; *6* the child will begin to produce more complex sentences. the first complex constructions generally tend to be embedded sentences in which a noun phrase or *wh*-clause serves as the object of a verb. For example "I remember *where it is*" (a *wh*-clause is the object).

Within weeks of passing this milestone children will start to produce relative clauses that modify nouns. For example "that's the box *that they put it in*". they also learn to join simple sentences with conjunctions such as *and, or , because* or *so*. "he was stuck *and* I got him out." or "I want some milk *'cause* I've got a cold."

By the age of 5 or 6 the language is very much like that of an adult. the children have acquired a working knowledge of the principles of grammar. It is thought that a pre-schooler's language

Stage 1	**Stage 2**	**Stage 3**
No . . . wipe finger	I can't catch you	we can't make another b-
No a boy bed	I can't see you	room
no singing song	we can't talk	I don't want cover on it
no the sun shining	you can't dance	I gave him some so he wont
no money	I don't want it	cry
no sit there	I don't like him	no, I don't have a book
no play that	no pinch me	I am not a doctor
no fall!	book say no	it's not cold
not . . . fit	touch the snow no	don't put the two wings on
not a Teddy bear	this a radiator no	I didn't did it
more . . . no	no square . . . is clown	you didn't caught me
wear mitten no.	don't bite me yet	I not hurt him
	don't leave me	ask me if I not made mis-
	don't wake me up . . . again	take
	he not little, he big	because I don't want some-
	that no fish school	body to wake me up
	that no mommy	I didn't see something
	there no squirrels	I isn't . . . I not sad
	he no bite you	this not ice cream
	I no want envelope	this no good
	I no taste them	I not crying
		that not turning
		he not taking the walls
		down.

Table 8: **Examples of negative sentences showing the three developmental stages of negative sentences. By Ursula Bellugi and Edward S. Klima. They observed that in the first stage almost all negative sentences appear to be formulated according to the rule: Attach "not" or "no" to the beginning of the sentence to make it negative. In the second stage additional rules are postulated that allow the formation of sentences in which "no", "not", "can't" and "don't" appear after the subject and before the verb. In the third stage several issues remain to be worked out, in particular the agreement of pronouns in negative sentences (third part), the inclusion of the forms of the verb "to be" (bottom part) and the correct use of the auxiliary "do" (second part). In adult speech the auxiliary "do" often carries tense and other functional markings such as the negative; children in the third stage may replace it by "not" or use it redundantly to mark the tense that is already marked in the main verb.**

becomes more complex at that stage because the child has started to appreciate relational contrasts such as *big/little, tall/short, in/on, before/after, here/there* and *I/you.*

naturally the application of such relations follows a very similar path to that of the application of the transformational rules or the semantic morphemes. If a child learns that there is a certain characteristic such as height is normally associated with size then the child will initially overextend such a characteristic so that short and fat blocks are deemed smaller than tall thin blocks even if they are heavier and have more volume.

10 The Intuitive Linguistic Period

Although most of the language has been learned in the period up to age 5 there are still many linguistic skills to be learnt in the years from 6 to 14. Children will be using larger words and longer and more complex sentences. They will also develop the capacity to think about language itself in

a way which was previously impossible. This is the so called *"linguistic intuitive"* period.

There is later syntactic development after age 5, personal pronouns are still not used properly and they are refined from the years 5 to 8. After age 6 children will tend to produce *"tag"* questions. tag questions are placed at the end of declarative sentences, e.g. "he will come, *won't he?*" or "You like Brighton *don't you?"*. Such sentences have a more complex grammatical structure than the other kinds of question structure described in section 9.

From 7 until 9 the child is beginning to understand passive sentences involving mental state verbs such as *like* or *know*. this occurs at the age at which a child's speech for the self becomes internalized. Perhaps the the internalization of speech for the self is also associated with a heightened ability for introspection.

The period from 5 to 12 is evidently on of linguistic refinement. The language that a child employs is perfectly capable of enabling communication with others. It lacks the subtlety, ambiguity and expressive power of adult speech.

The understanding of semantics grows throughout the period, by 6 the child is likely to understand between 8000 and 14,000 words, their *"productive capacities continue to grow at the rate of 15 words per day for many years to come"*!! Children are also becoming more proficient at drawing inferences about the meaning of what they hear. they are able to contemplate propositions as hypotheses. Surprisingly those that are able to draw inferences from statements often do not realize in retrospect that what they inferred from the sentence was not actually included in the sentence itself.

By 10 it is likely that the child will have managed to recognize the fact of their making inferences, and they are more affective at make=ing these inferences. the reasons that children are able to go beyond the information that is contained in the sentences is that they are developing a *"Meta-linguistic Awareness."*

A meta-linguistic awareness is a knowledge of language and its properties, an understanding that it can be used for purposes other than communication. This reflective ability has been present to some degree since around the age of 6. We are able to display more phonemic awareness during this stage as well.

There appears to be a distinct correlation between early meta-linguistic awareness, especially around 5 or 6, and reading proficiency at a later age. Why? Various opinions are held on all sides but the results show that reading instruction and other literary experiences promote meta-linguistic awareness, whereas a certain amount of meta-linguistic awareness make reading easier.

11 Developmental Theories

In 1957 Skinner argued that children acquire language due to reinforcing of correct usage. By the process of conditioning the baby's babbles and coos are progressively shaped into words. The adults reward those which are most word-like. Later word combinations are enforced so that syntactic expressions are produced.

He put forward the idea that a process of successive approximations, being rewarded until the child's language became similar to the adult's, takes place during development. He also thought that imitation played a large part in the process.

Initially the behaviorist theory held much sway, till the early 1960's when it became increasingly implausible. It was thought that the environment must be responsible for differences in learning one language or another. How else could we explain why one person speaks Russian and another Japanese? If they were born with language innate then we might find natural born Japanese grammar in English speakers.

Empirical evidence from tape recordings of interactions between mother and child showed something altogether different taking place. It was found that mothers did not shape their children's grammar. In actual fact they seldom even corrected ungrammatical speech. They also made no attempt to reward grammatical speech.

What parents did respond to in a child's speech was truth and falsehood. Falsehoods were refuted and truths were agreed with. Such findings thus gave no support to reinforcement or conditioning in the process of syntactic acquisition. Still less for phonological and morphological acquisition.

Having said that – such pressures are present (enough) to shape the child's language. It must be there to some extent otherwise there would be no pressure for the child to develop anything more than was required to have their needs attended to by mother.

It should be said that mere imitation of a parent's speech is not enough to account for the endless creativity of a child. A simple mathematical calculation would illustrate the probabilities of ever reproducing a sentence twice in conversation as microscopic. If an average sentence is 15 words long, and if there were 20 words which would make sense at each point, then the number of possible sentences that could be uttered in a given situation are $15^{20} = 332525673000000000000000$, i.e. VERY large. It was also demonstrated that the babies could not be imitating the adults since more often than not they were using languages that followed different grammatical rules to those of adults.

11.1 Baby Talk Register

It was found that the mean length of utterance (MLU) was shorter between mother and child than between adults. The pitch of the utterance was also higher and key words were also emphasized more often. the length and complexity of the utterance was adjusted to the development of the child.

From the age of 2 onwards (at the end of the telegraphic stage) the complexity of parental speech increases. But even by age 5 there are still differences between Baby Talk Register (BTR) speech and and inter-adult speech. It has also been noticed that children of age 4 are similarly able to modify their speech for younger siblings.

The *Motherese Hypothesis* states that the special properties of the mother's speech play a *causal* role in the child's acquisition of language. One of the main controversies that arose was on the exact nature of how BTR is able to catalyse Language acquisition.

Useful data have not yet been gathered to settle the dispute over whether the MLU has any significant effect on the development. Many studies contradict each other. Several theories argue about the optimum MLU. It is thought by one that an MLU from the parent which is slightly longer than the child, but not too long, is best for development. Several results seem to indicate that particular word orderings accelerate language acquisition. For instance the use of *auxiliaries* at the *beginning* of sentences. e.g. "*have* you finished?"

Other apparently beneficial techniques involve the expanding and recasting of a baby's utterance.

Baby	Expansion	Recasting
doggy eat	doggy is eating	what is doggy eating?
daddy gone	daddy has gone	where has daddy gone?

Table 9: **Expansion and Recasting – do they accelerate development?**

After Chomsky's critique of the behaviorist account of language acquisition (LA) the tide turned

towards a *biological basis theory* in which it was held that there are specific biological mechanisms underlying language acquisition. Consequently there is a critical period for the learning of language.

Lenneburg (1967) argued that the lower limit for LA was the development of motor control of the speech organs and the upper limit was puberty. the justification for this opinion was that language has universal properties. It has been shown that the sequences of LA are broadly similar across world languages. All languages have certain features in common. One of them is the learning of language at an early age.

Chomsky therefore argued that humans have an innate LA device (LAD) without which language cannot develop. The structure of the LAD was such that it was able to perceive any regularities in the utterances that children hear.

Such an explanation was hoped to account for the way Language developed *despite* the poverty of input. that is – it could account for the way that children produce complex and unique utterances even though they have never been exposed to complex utterances. they were, after all, the recipients of Baby Talk register Speech.

The LAD could acquire any language, or faced with the utterances of any language could find the grammar for that language. An assumption of this theory was that to do so one must assume that all languages must share some common universal constraints. These constraints limited the types of languages that could occur.

It was thus believed that a description of the universal constraints on language was a description of the internal structure of the LAD. The primary question thus became one of characterizing these universal constraints on language.

Plainly the phonological aspects of language must be covered, Every language has consonants, vowels and a syllabic structure. Such a set of characteristics must also be able to apply to syntax. All languages have sentences, noun phrases, verb phrases and a grammatical structure that puts them together.

Chomsky argued in 1965 that there are *deep structures* (d-structures) and *surface structures*(s-structures) in language. To convert the deep structures to surface structures in speech we use a set of *transformational rules*. The surface structure is the, almost coincidental, ordering of words in a sentence. The surface structure can vary but is still able to reflect the underlying deep structure, the meaning. Two equivalent sentences such as :

> *"the dog bit the man"* and
> *"the man was bitten by the dog"*

have different surface structures but share the same deep structure. The relationship between the d- and s- structures is achieved using the rules of transformation. These rules are there to make the connection between meaning and sound.

The worth of the Chomskian argument lies in the assertion that the relationship between speech sounds and meaning is not the simple one of association through conditioning. He successfully falsified the behaviorist view of language acquisition. instead we need to distinguish the s-structure and d-structure and find the rules of transformation that link them. The ability to infer such transformational rules from surface structure must lie in the LAD.

Chomsky's arguments prompted a lot of research into LA. His own work was involved in the production of spoken language from a d-structure using transformational rules. This is known as a generative grammar, because the rules are used in the inverse generative role to comprehension. Chomsky felt that the comprehension and generation processes were logical inverses of each other.

that is the reason why we find him producing such generative grammars. The discussion in section 4.1.1 demonstrates that there the physical difficulties of perception and decoding and attention versus the problems of controlling the many parts of the speech apparatus make such an ideal state of affairs rather unlikely.

It was felt that if the multilevel approach was correct then a child should possess from an early age the transformational rules embedded in the LAD. The child could thus begin to infer the structure of language. This would enable them to understand utterances from an early age. Some research might suggest that children have a d-structure since they are able at *1*; *6* to form three overloaded meanings on a single word.

Studies performed in 1969, tested the hypothesis that even within the holophrastic stage words could be made to have different meanings. The words did not serve the simple task of naming objects or events. recordings were made of children aged between *1*; *6* and *1*; *8* and it was found that children could produce words with intonations that indicated either *declaration, imperative or questioning.* It was concluded that *"although the data are extremely limited there appear to be indications that the child's single utterances are not simply names of objects and events. the child uses prosodic features of language generatively, productively or creatively according to the rules to create sentence types"* [see p.218 Menyuk and Bernholtz (1969)].

Such results seem to support the theory that quite young children are using generative rules at the holophrastic stage. On closer inspection the conclusion only states that adults can use prosodic features to comprehend the child's utterances, and that children themselves may not actually use these features generatively to signal these distinctions.

Other research was done on telegraphic speech the conclusion of which was that utterances could be classified as grammatical sentences from which certain words had been omitted. It was also found at that stage that the ordering of words was important. For instance children are very likely to use words with a structure like *"me want coat"*, but are very unlikely to use sentences like *"want coat me"*.

Other researchers have concluded that children have an innate propensity to use rules. Such a propensity would lead them to make such striking over-generalization errors, from which linguists could infer the structure of the grammar being used. The structure of the sentences that children were using did not come from adult models, but it did seem that children had produced them themselves on the basis of simple grammatical hypotheses. If this was true it would be consistent with an LAD theory.

It is interesting to note in passing that at the age of 18 months children have started using different modes of speech. One should find it suggestive that the children even have such modes at that age, regardless of whether they are able to use them consistently. Another suggestive finding is that from an early age children act as if they expect language to be governed by rules.

Recent results have contradicted the assumption that there is a critical age at which language learning can take place. It was shown to be an unfounded assumption of the early proponents of the language instinct. It has been suggested that the LAD did not arise before birth, but from the prelinguistic knowledge. It was felt that in the pre-linguistic period children are still developing perceptual systems and some ability to categorize the world. Also they are learning to differentiate sound and other perceptual stimuli. these faculties are developed prior to any ability to express it. As other research has shown there may be numerous precursors to a linguistic skill. For example it is believed that the prelinguistic precursor of the noun is the tendency to point at things. Nouns and pointing serve the same purpose of fixating the attention on a thing. Labeling would thus come later as a pragmatic development of that tendency when the child realizes the role of sound as a medium of communication.

This emphasis on stimuli which occur in the pre-linguistic period that give rise language acquisition, such as gestures, facial expressions etc was known as the "interactionist approach." The interactionist approach moves the emphasis away grammatical competence to the study of understanding and communication. Much research was performed on the relationship between language and cognition and between language and social interaction.

11.2 Social Theories Of Development

Lev Vygotsky's theory of the relation between language and thought states that during the prelinguistic period (up to *2*; *0*) language and thought are not linked in any way. The forms of expression used by the child are Crying, Cooing, Babbling, and Echolalia and are devoid of thought. Likewise there is thought which is not mediated via language, which is to say that it is pre-verbal. Examples include sensori-motor intelligence, perception and emotion. Vygotsky said that at age 2 there is a crucial moment when prelinguistic thought and pre-intellectual language *"meet and join to initiate a new kind of behavior . . . thought becomes verbal and speech rational"* [Vyg62]

He was of the opinion that between the ages of 2 and 7 language serves two purposes. First to monitor and guide thought and second to express the results of thought. He also said that at that age a child is not able to distinguish the difference between these two functions. Consequently the child is unable to distinguish between speech for the self and speech for others.

Piaget called speech for the self *autistic speech* and speech for others *socialized*. He felt that about the age of 7 when concrete operational thought begins to be used, the child is able to restrict its overt language to the purposes of communication. At that point the function of language is internalized as verbal thought and speech. Piaget thought that prior to age 7 external speech is egocentric in that it is like a running commentary on the behavior of the child. When that stops at 7 he felt that the language was now more socially oriented or socialized, since it now serves the purpose of communicating concepts and thought to others.

Vygotsky differed on this point. He thought that at the stage when egocentric speech seemed to disappearing it was becoming very unlike social speech. He therefore concluded that it was not being eradicated or suppressed at all, it serves a similar purpose to internal speech. It does not merely accompany the child's activity, but orients and guides their thoughts. It also helps them to overcome difficulties. It is speech for oneself and is intimately and usefully connected with thought. In the end it becomes *internalized* (not suppressed). Adults at times can be heard "thinking out loud" when their purposes have been thwarted or they face a difficult problem. They might use phrases such as:

> "Now where did I put that hammer?" or
> "Now what do I do?"

They might do this when they are alone in particular.

The difference in emphasis between Piaget and Vygotsky is summarized below:

Piaget Autistic speech → egocentric speech → socialized speech

Vygotsky Social origin of speech → egocentric speech →

1. speech for the self (inner speech or verbal thought)
2. speech for others (external or communicative speech)

By 1962 Piaget had come to agree with Vygotsky. It was found that inner or egocentric speech differs from speech for other since it does not have to satisfy the grammatical conventions or any pragmatic rules. Inner speech is often abbreviated since it is concerned with the underlying meaning of speech and is seldom concerned with the abstracts of expressing it to others in a comprehensible way. It is interesting to note that as we become more familiar with others our communication becomes more like inner speech since we may share common vocabulary and context. The more shared experiences we have in common the less explicit our speech is required to be. Consequently such conversations can become more like inner speech.

12 Glossary

Aphasia The loss or impairment of language abilities following brain damage.

Anomia An aphasia that causes the inability to access dictionary items. Often associated with diffuse cortical damage, as with senile dementia.

ASL American Sign Language. The primary sign language of the deaf in the US.

Behaviorism A school of psychology, influential from the 1920s to the 1960s, that rejected the study of the mind as unscientific, and sought to explain the behavior of organisms (including humans) with laws of stimulus-response conditioning.

Bottom-Up Perceptual processing that relies on extracting information directly from the sensory signal(e.g. loudness, pitch or frequency of a signal), as opposed to *top-down* processing, which uses knowledge and expectancies to guess, predict or fill in the perceived event or message.

Clause a kind of phrase that is generally the same thing as a sentence, except that some kinds of clause can never occur on their own but only inside a bigger sentence: *THE CAT IS ON THE MAT; John arranged FOR MARY TO GO; The spy WHO LOVED ME disappeared; He said THAT SHE LEFT*

Cognitive Science the study of intelligence (reasoning, perception, memory, language, control of movement), embracing parts of several academic disciplines: experimental psychology, linguistics, computer science, philosophy and neuroscience

Consonant a phoneme produced by a blockage or constriction of the vocal tract

Content Word Nouns, Verbs, Adjectives, adverbs and some prepositions which typically express concepts particular to a given sentence. This is opposed to *function words* that are used to express information, such as tense or case, that is relevant to many different sentences.

Cortex The thin surface of the cerebral matter containing the neurons used for many of the 'higher' functions of the human brain such as language.

Deep-Structure (often d-structure) The tree structure, formed from *phrase structure* rules, into which word can be placed so as to fulfill the demands of words in neighboring phrases.

Derivational Morphology the component of grammar containing the rules for the creation of new words from old words. For example: *break* + *-able* → *breakable*; *sing* + *-er* → *singer*; *super* + *woman* → *super-woman*

Diphthong a vowel consisting of two vowels pronounced in quick succession. e.g. bIte (pronounces /*ba-eet*/); loUd; mAke.

Echolalia The phase that a child goes through during the Holophrastic period, when it starts to repeat syllables. For example: *dadadadada* or *Mamamama*.

Focal Lesion A visible area of damage to an area of the brain. Often caused by cysts, hemorrhages, embolisms and such things as shrapnel or bullet wounds. One of the primary sources of information on localization of brain function in language and other cognitive skills.

Function Word see content word.

Grammar A **generative grammar** is a set of rules that determines the form and meaning of words and sentences in a particular language. A **mental grammar** is the hypothetical generative grammar stored unconsciously in a person's brain. Neither should be confused with a **prescriptive** or **stylistic grammar** taught in schools, which attempt to give guidelines on how we 'ought' to speak.

Gyrus plural of *gyri*. the visible part of a wrinkle on the surface of the cortex.

Handedness The situation where one hand (or foot or eye etc) has better control then the other. Handedness is thought to be due to the contralateral control of limbs, and the consequent control by brain hemispheres that have different functionality. For example most humans are right handed, with their right hand being controlled by the left hemisphere, the language dominant hemisphere.

Larynx a valve at the top of the windpipe that is used to seal the lungs during exertion and in the production of voiced sounds. It contains the vocal chords.

lexicon a dictionary, especially a *mental dictionary* that would contain all of a person's intuitive knowledge of words and their meanings.

Listeme A kind of "word" that refers to an element of language that must be memorized because its sound or meaning does not conform to some general rule of structure. All word roots, irregular verbs and idioms are listemes.

Mentalese The hypothetical *"Language Of Thought"* or representation of concepts and propositions in the brain in which ideas including the meanings of words and sentences are couched.

Morpheme the smallest meaningful pieces into which words can be cut. e.g.*un-micro-wave-abil-ity*

Morphology the component of a grammar that builds words out of morphemes.

Neurons the information processing cells of the brain.

Perisylvian the regions of the brain lining both sides and the end of the Sylvian fissure, the cleft between the temporal lobe and the rest of the brain. Language functionality is thought to be concentrated on the left Perisylvian fissure.

Phoneme One of the units of sound that are strung together to form a morpheme. See International Phonetic Alphabet.

Phonetics How the sounds of language are produced and perceived.

Phonetic symbols used in this report

p as in *p*at	l as in *l*et
t as in *t*en	j as in *y*es
k as in *k*in	i as in b*ea*d
b as in *b*at	i as in b*i*d
d as in *d*en	e as in b*e*d
g as in *g*o	a as in b*a*d
t as in *ch*in	as in b*ar*d
as in *g*in	as in b*o*dy
f as in *f*at	as in b*aw*dy
as in *th*in	u as in b*oo*k
s as in *s*in	u as in b*oo*t
as in *sh*in	as in b*u*d
h as in *h*at	as in b*ir*d
v as in *v*at	as in *a*bove
as in *th*at	i.e. as in d*ay*
z as in *z*oo	ou as in b*oa*t
as in mea*s*ure	ai as in b*uy*
m as in *m*at	au as in c*ow*
n as in *n*o	i as in b*oy*
as in si*ng*	i as in b*ee*r
w as in *w*et	as in b*ea*r
r as in *r*ed	

Phonology The component of a grammar that determines the sound pattern of a language, including its inventory of phonemes, how they may be combined, how they must be adjusted in the presence of their neighbors as well as patterns of intonation, timing and stress.

Plosive Any sound articulated with an abruptly released closure, e.g. */p,t, k/* in English

preposition one of the major syntactic categories, comprising words that typically refer to a spatial or temporal relationship: *in, on, at, near, by, for, under, before, after*

Root the most basic morpheme in a word or family of related words, consisting of an irreducible, arbitrary sound-meaning pairing: ELECTR*icity,* ELECTR*ical,* ELECTR*ic,* ELECTR*ify,* ELECTR*on*

Stem The main portion of a word, the one that prefixes and suffixes are stuck onto: WALK*s,* BREAK*able, en*SLAVE

Syntax the component of grammar that arranges words into phrases and sentences.

Universal Grammar The basic design underlying the grammars of all human languages; also refers to the circuitry of children's brains that allows them to learn the grammar of their parent's language.

Voicing vibrating of the vocal folds in the larynx, simultaneous with the articulation of a consonant; the different between *b,d,g,z,v* (voiced) and *p,t,k,s,f* (unvoiced).

Vowel A phoneme pronounced without any constriction of the airway.

X-bar The smallest kind of phrase, consisting of a head and its non-subject arguments (role-players): The Roman's DESTRUCTION OF THE CITY; she WENT TO SCHOOL on foot; he is very PROUD OF HIS SON.

X-bar theory The particular kind of phrase structure rules thought to be used in human languages, according to which all the phrases in all languages conform to a single plan. In that plan, the

properties of the whole phrase are determined by the properties of a single element, the head, inside the phrase.

References

[AHKea87] Jonathan Allen, M.Sharon Hunnicutt, Dennis Klatt, and et al. *From Text To Speech: The MITalk System*. Cambridge Studies In Speech Science And Communication. Cambridge University Press, 1987.

[Akh71] Olga Akhmanova. *Phonology, Morphonology, Morphology*. Janua Linguarum. Studia Memoriae Nicolai van Wijk Dedicata (Series Minor, 101). Mouton, The Hague, 1971. Translated from the Russian.

[Bee95] H. Bee. *The Developing Child*. Harper Collins, 7th edition, 1995.

[BH94] George Butterworth and Margaret Harris. *Principle Of Developmental Psychology*. Principles Of Psychology. 1994.

[BL81] Lynn Bindman and Olaf Lippold. *The Neurophysiology Of The Cerebral Cortex*. Dept of Physiology, University College London, 1981.

[BS84] George Brannigan and William Stakes. *A sketch of Language Development*, chapter 1, pages 5 – 13. Croom Helm in association with The Open University, 1984. A reader for the cognitive development course at the OU.

[Cho57] Noam Chomsky. *Syntactic Structures*. Mouton, the Hague, 1957.

[Cho69] Noam Chomsky. *The Acquisition Of Syntax In Children From Five To Ten.* MIT Press, Cambridge Mass., 1969.

[Cho78] Noam Chomsky. untitled. Broadcast as part of an interview on Brian Magee's BBC television series – Men of Ideas. Also included in a book of the same name, 1978. p.p. 205 -206 in book.

[Cry80] David Crystal. *Introduction To Language Pathology*. 1980.

[D.G95] D.G.Myers. *Psychology*. Worth Publishers, 4th edition, 1995.

[Gre94] Simon Green. *Principles of Biopsychology*. Principles Of Psychology. 1994.

[Hay94] Nicky Hayes. *Foundations Of Psychology: An Introductory Text*. Routledge, 1994.

[Hil14] E.C. Hills. The speech of a child of two years of age. *Dialect Notes*, 4:84–100, 1914.

[HSL76] Steven R. Harnad, Horst B. Steklis, and Jane Lancaster, editors. *Origins And Evolution Of Language And Speech*, volume 280 of *Annals Of The New York Academy Of Sciences*. New York Academy of Sciences, WPC, October 28th 1976. This series of papers is the result of a conference ... on September 22, 23, 24, and 25, 1975.

[Hum80] M.W. Humphreys. A contribution to infantile linguistics. *Transactions Of The American Philological Association*, 11:5–17, 1880.

[Ing76] David Ingram. *Phonological Disability In Children*. Number 2 in Studies In Language Disability And Remediation. Edward Arnold, 1976.

[Jak68] R. Jakobson. *Child Language, Aphasia, And Phonological Universals.* Mouton, The Hague, 1968. highly influential work.

[Lee81] Geoffrey Leech. *Semantics: The Study Of Meaning.* Penguin, 2nd edition, 1981.

[Leo47] W. Leopold. Speech development of a bilingual child: A linguists record. In *Sound-Learning In The First Two Years*, number 2. Northwestern University Press, Evanston, Ill., 1947.

[Mar76] Oscar S. M. Marin. Neurobiology of language: An overview. In Harnad et al. [HSL76], pages 900 – 912. This series of papers is the result of a conference ... on September 22, 23, 24, and 25, 1975.

[McC30] Dorothea McCarthy. *The Language Development Of The Preschool Child*, volume 4 of *Monograph Series.* University Of Minnesota Press, Institute Of Child Welfare, 1930.

[Mos0s] Breyne Arlene Moskowitz. The acquisition of language. *Scientific American*, pages 82 – 96, circa 1980s.

[NH93] F. Newman and L. Holzman. *Lev Vygotsky.* Routledge, 1993.

[Pin94] Steven Pinker. *The Language Instinct.* Penguin, 1994.

[Poo34] E. Poole. Genetic development of articulation of consonant sounds in speech. volume 11 of *Elementary english review*, pages 159–61. 1934.

[Rei83] Tanya Reinhart. *Anaphora And Semantic Representation.* Croom Helm, 1983.

[RW86] Henk van Riemsdijk and Edwin Williams. *Theory of Grammar.* MIT press, 1986.

[SC91] Peter K. Smith and Helen Cowie. *Understanding Children's Development.* Blackwell, 2nd edition, 1991.

[Sha93] David R. Shaffer. *Developmental Psychology: Childhood And Adolescence.* Brooks/Cole Publishing Company, 3rd edition, 1993.

[Smi73] N. Smith. *The acquisition of phonology: a case study.* Cambridge University Press, 1973.

[SW79] N Smith and D Wilson. *Modern Linguistics:The Results Of Chomsky's Revolution.* Pelican, 1979.

[Tem57] M. Templin. *Certain Language Skills In Children: Their Development And Interrelationships*, volume 26 of *Institute Of Child Welfare Monograph Series.* University of Minnesota Press, Minneapolis, 1957. study of 480 children.

[var] various. *Washington State University International Phonetic Alphabet Font Manual.* Washington State University. Part of the standard TEX installation. Usually found in `/usr/lib/texmf/tex/symbol/ipaman.dvi`.

[var83] various. *Current Surgical Diagnosis And Treatment.* Lange Medical Publications, 6th (j. englebert dunphy memorial edition) edition, 1983. Distributed By Van Nostrand Reinhold. c.f. Section 40 On Neurosurgery And Surgery Of The Pituitary.

[var84a] various. *Computational Models Of Natural Language Processing.* Number 9 in Fundamental Studies In Computer Science. North Holland, 1984.

[var84b] various. *Language Development*. Croom Helm and the Open University, 1984. For the Cognitive Development course at the Open University.

[var85a] various. *Cognition, Education And Deafness: Directions For Research And Instruction*. Gallaudet University Press, Washington D.C., 1985. c.f. sections 3 and 6.

[var85b] various. *The Collins Dictionary Of The English Language*. William Collins Sons & Co. Ltd., the 1985 edition edition, 1985. c.f. pages i - xxxv.

[var87] various. *The Oxford Companion To The Mind*. 1987.

[Vyg62] L.S. Vygotsky. *Thought And Language*. MIT Press, Cambridge, Massachusetts, 1962. (original work published 1934.).

[WIMB31] B.L. Wellman, Case. I.M., I.G. Mengert, and D.E. Bradbury. *Speech Sounds Of Young Children*, volume 5 of *University Of Iowa Studies In Child Welfare*. ?, University of Iowa, 1931.

[Wol73] B.B. Wolman. *Dictionary Of Behavioural Psychology*. van Nostrand, 1973.