Language: Acquisition and Loss

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Abstract

An understanding of the reasons for language acquisition and loss is useful for those who wish to learn or teach languages. Studies of language acquisition and loss have been manifest in at least two major disciplines: Cognitive Neuropsychology (Psychology and Medicine) and Applied Linguistics (Language Studies). These studies are made more complex by the inability to plan and perform controlled experiments, in the case of pathologic aphasias (Medical studies) and by the acquisition of second or even more additional languages (Linguistics) with the interfering factors of multiple language skills. There can be interference from the first language (L1) with the second (L2) and likewise the loss of L1 or L2 can be decreased or accelerated by exposure to the surrounding languages.

Both Medical studies and Linguistic studies recognize the normal development of language skills. In fact, deviation from "normal" may be the first sign of developmental delay or disease processes. The latter field of inquiry, Linguistics, has examined language acquisition and attrition for purposes of education and skills in languages. With respect to Linguistics, language acquisition and loss are attributed to naturally occurring phenomena. These can be measured, assessed and influenced by the educational process.

Medical and Linguistic research and literature have sought to identify factors involved in acquisition, attrition and aphasia of language. This paper seeks to review and discuss some of the more important research and factors involved in language acquisition, attrition and aphasia.

Key words: *attrition, aphasia, applied linguistics, cognition, Neuropsychology*

1. Introduction

In 1719, the English writer, Daniel Defoe published ***Robinson Crusoe***, a novel about a shipwrecked sailor's isolated existence on a deserted island. Defoe's manuscript had its basis in the actual fate of an 18th century Scottish sailor, Alexander Selkirk, marooned in 1705 for 4 years on the island of Juan Fernandez, west of Chile in the Pacific Ocean. Selkirk's isolation came to an end when he was found by a passing British ship in 1709. The crew noted that he seemed to understand but he spoke with great difficulty:

"*It is difficult to understand what he is saying. He speaks slowly, dragging out his words and dividing them into halves as though he has been losing the power of speech during his long period of isolation*." (Severin 8). During his 4 years on the island, Selkirk had no one with whom to speak and he had not used English.

In 1869, the American writer Mark Twain published ***The Innocents Abroad***, a summary of his travel adventures in Europe, Egypt and the Mediterranean. His reference to Venice included descriptions of the Bridge of Sighs and prisoners held in the subterranean cells:

"Down below the level of the water, by the light of smoking torches, we were shown the damp, thick-walled cells where many a proud patrician's life was eaten away by the long-drawn miseries of solitary imprisonment---without light, air, books; naked, unshaven, uncombed, covered with vermin; ***his useless tongue forgetting its office, with none to speak to….****"* (Twain 140)

Mark Twain's observation provides a further anecdotal example of the loss of language due to lack of use.

These anecdotes illustrate the phenomenon generally recognized as language attrition. In these cases the attrition was of the native language or first language (L1). But attrition of the second language (L2) is perhaps of even greater interest, since the acquisition and attrition of human languages affect the work of educators, research scientists and medical professionals. In addition to attrition, which is relatively slow, the ability to speak and/or comprehend language can be lost abruptly. This is termed "aphasia" and is of particular interest in medicine.

The interest in language acquisition and loss has been manifest in at least two major disciplines: Neuropsychology (Psychology and Medicine) and Applied Linguistics (Language Studies). These studies are made more complex by the acquisition of one or more additional languages and the potential interferences posed by multiple languages. For example, basic well learned pronunciation skills in the first language (L1) may interfere with the acquisition of correct

pronunciation in the second language (L2). On the other hand, it is also recognized that high level literacy skills (the ability to read, write) in the first language greatly improve the ability to develop literacy in the second language.

The medical concerns with language acquisition and attrition are well established, dating to papers by Broca in 1861 and Wernicke in 1874. The attention of physicians to these topics has been directly related to the pathologic states which have disrupted language. The sphere of the former, the medical sciences, is in the realm of injuries, disease processes, and the so called phenomenon of "natural aging". The disease processes include embolic or hemorrhagic infarction (cerebrovascular accidents, strokes), tumors (both benign and invasive/metastatic), infections and other less acute conditions such as multiple sclerosis and dementias.

The specific anatomic locations responsible for language have been determined during decades of observation and scientific inquiry of individual patients presenting with specific language deficits. But in recent years, the use of more advanced technology has improved the understanding of the specific sites within the brain which correlate with function, including language acquisition and loss.

The latter field of inquiry, linguistics, has examined language acquisition and attrition for purposes of education and skills in languages. With respect to linguistics, language acquisition and loss are attributed to naturally occurring phenomenon. These can be measured and assessed as natural occurrences, which can be influenced by the educational process.

2. Objectives

This paper constitutes a review of the literature with regard to the origins of language, language learning and the acquisition/loss of language attributable to medical conditions and interfering factors (2nd learning acquisition). The objective is to apply this background to current education formats in order to facilitate language learning and prevent loss of acquired language skills.

3. Discussion

Origins of Language. The Connection of Motor Function (Praxia) and Language (Phasia)

Neuropsychological studies have found a strong relationship between the origin of language and praxis, the development of motor skills with the use of tools (Roby-Brami). Likewise, there is clearly a strong relationship between aphasia, the loss of language and apraxia, the loss of fine motor movements. The systems within the brain that support language and fine motor function are located predominantly in the left hemisphere in the vast majority (90%) of human populations.

A paper by Roby-Brami et al. in 2012 suggests a common evolutionary pathway between the development of tool use and language. The use of tools began in the distant past, as long ago as 2.5 million years, as determined by the record of archeology. Language may have developed concurrently with increasing social interactions, and imitation or instruction in tool use (Steele). In the human species, an asymmetric brain pattern for both language and motor skills has emerged, with the left hemisphere responsible for language and motor function in approximately 90% of all individuals. This phenomenon is present in all human cultures.

Figure 1. Illustration of cave drawings

Handedness

The left hemisphere is also dominant for "handedness", with a preference for the use of the right hand/arm by the majority (90%) of human populations. This is a natural occurrence and

unrelated to cerebral pathology (Knecht). Genetic models for the prediction of handedness have been proposed by Annett and MacManus (Annett; MacManus).

Based on the occurrence of handedness and the models which accurately predict its occurrence, handedness is best explained by a single gene which codes for right-handedness. In addition, one allele causes the distribution to be favored for right-handedness, with an additional allele which leaves handedness to chance (Corballis).

Figure 2. Human handprints, outline blown onto cave surface

Handedness is also affected by culture. Worldwide, culturally imposed constraints have altered the choice of hand use in certain locations. Researchers have found that eastern cultures have a strong preference for right handedness, rooted in the belief systems and society norms. In contrast, comparisons with western cultures (Canada) show a higher number of left handed individuals, believed to be a reflection of less stringent cultural mandates to assume right handedness (Ida; Mandal). Although it would appear that language centers in the left hemisphere are strongly related to right-handedness, the association of language with motor skills is much more strongly related than the association of language with right handedness.

Left Hemisphere Dominance in Language

A left sided cerebral dominance is also present in other vertebrates. Experimental research with monkeys has shown that the left cerebrum is the site of the essential neurologic network for the use of tools and simple motor function (Umilta). However, the more advanced and complex usage of tools and language are unique to humans. Such higher level usage and complexity require accumulated knowledge of the meaning (semantics) of particular tools and their variety of uses.

Further evidence for the importance of the left hemisphere for language and motor function has been acquired by investigation of medical cases. For a century and a half, information on particular patient cases and their neurologic deficits has been collected. These case studies have shown that lesions in the left hemisphere interfere with both language production (aphasia) and complex motor function (apraxia) (Roby-Brami). The anatomic areas wherein lesions can cause such disruption in language and motor function are located in the left hemisphere, in the homologue of area F5, the caudal part of the inferior frontal gyrus, also corresponding to Broca's area in the left hemisphere (Fadiga; Kotz).

Medical Sciences. Language Attrition and Aphasia

Over the centuries, many individuals have suffered from acute language loss, known as aphasia. Dating back to the era of Dr. Paul Broca (published findings,1861), it has been observed that the ability to learn and communicate with language relies on the normal functioning of the left cerebral hemisphere.

Paul Broca (1824-1880) was a French surgeon and anatomist, who had a series of patients with a similar problem: they seemed to comprehend speech, but they had developed an inability to speak. One in particular could only utter the word "tan". At autopsy, Broca found that 9 similarly afflicted patients had lesions in the left frontal lobe. This led him to conclude that this area in the left hemisphere was responsible for the formation of speech. Thus came his famous statement, "*We speak with the left hemisphere*".

Thirteen years later, in 1874, the German physician, Carl Wernicke (1848-1904) published an article "*The Aphasic Symptom-Complex*". He found that an area in the left posterior portion of

the left temporal lobe was associated with an inability to comprehend speech. Such affected patients could speak relatively fluently, but with somewhat disordered and incoherent speech. Wernicke diagrammed what he believed to be the locations and relative relationships of the anterior site of the frontal lobe (Broca) and the posterior site of the left temporal lobe (Wernicke). Today, "Wernicke's Area" in the left hemisphere is identified as areas 22 (secondary auditory) and 39 (angular gyrus). In fact more modern studies have confirmed that the major anatomical sites for language and semantics are located in these areas of the left hemisphere.

Background Models for Language

Based on these observations, models of how the acquisition (learning) of language occurs have been developed for over a century. Of these, the most widely known and understood is the Wernicke 1874 – Lichtheim 1885 model (Graves; Martin). By this model, the particular word sounds essential for language are registered and understood in the left posterior hemisphere in a region named "Wernicke's area". In contrast, the motor functions necessary for the production of sounds forming words and language are located in the left anterior hemisphere, in "Broca's" area. Both of these areas are also connected through fibers known as the "arcuate fasiculus". This connection is essential for the ability to repeat new words (as well as "non-words") and to learn pronunciation.

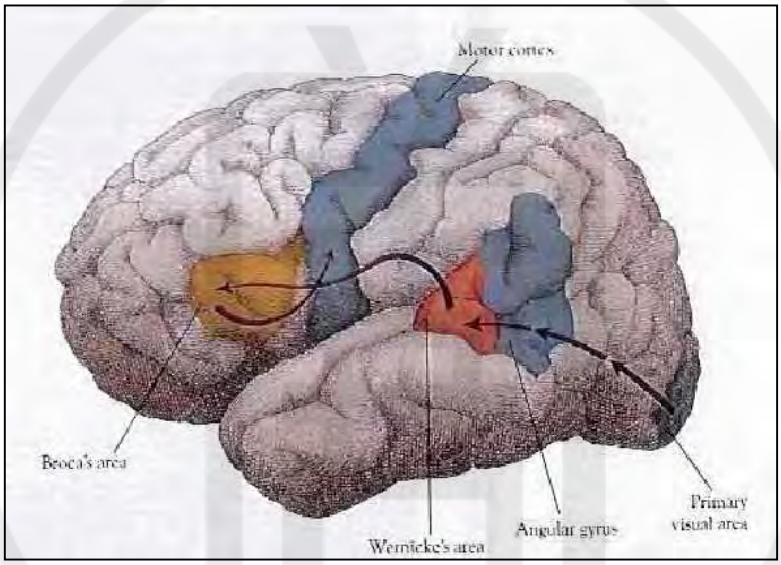

Figure 3. Left cerebrum, sites of Broca's/ Wernicke's

The association of the left hemisphere with language ability has been determined by observation of individuals who have suffered damage to specific areas in the brain. For example, damage by stroke, (cerebro-vascular accident by infarct, hemorrhage or tumor) limited to Wernicke's area will result in a *receptive aphasia*, or an inability to comprehend the meaning of spoken words. Such patients retain the ability to speak, but their fluent, often grammatically correct, speech is not meaningful. For example, a person affected with a receptive aphasia might produce the following:

"*When we are going but not today in the cabinet gives them the easy way unlike most"*.

These individuals are unaware that their speech has a problem, since they are unable to distinguish meaning.

In contrast to Wernicke's aphasia, damage to Broca's area (further anterior in the frontal lobe of the left hemisphere) results in an *expressive aphasia*, that is the inability to form and articulate meaningful speech. Individuals with expressive aphasia have great difficulty in producing words and speech, even though the motor mechanisms for speech remain intact. If they are able to produce some words, they are often short, limited in number, or they may lack all the words needed for a grammatically correct sentence. For example, after a struggle to speak the affected individual may produce the words "go car". The meaning of this may be "I want to go in the car". Such persons have a good understanding of the meaning of speech produced by others and by themselves, so they may become extremely frustrated in their inability to produce the speech needed to express their thoughts. Individuals with Broca's aphasia may have an associated paralysis of the contra-lateral

motor function (right hand, arm), since the motor function in the brain is located in the left hemisphere, near Broca's area.

There are therefore striking differences in the speech of patients with anterior damage (Broca's area) as opposed to posterior damage (Wernicke's area). There are many variations and degrees of the aphasias, since there may be a great variability in the sites and extent of damage to particular brain areas.

Although the Wernicke-Lichthim model is generally effective in explaining the association of left hemisphere damage with a distinct aphasic disorder and a loss of fine motor control, it has certain limitations to fully explain the more precise deficits in speech found in particular individuals. Those with Broca's aphasia tend to have speech that is "agrammatic", that is, speech with a simplified grammar which retains content words, but fails to keep function words, such as determiners, prepositions and auxiliary verbs. Furthermore, the writing of both types of aphasics (Broca's and Wernicke's) shows similar defects, with agrammatic features.

Research in the 1970's and 1980's by Berndt and Caramazza led to a more refined model, a syndrome based approach. In this model, those suffering from a Broca's aphasia are defined as having speech patterns with disrupted syntax. This would better explain the agrammatic speaking and writing (Berndt and Caramazza). With regard to Wernicke's area, Caramassa and Berndt proposed that patients with damage to the left posterior hemisphere had a problem with semantic images, which affect both the comprehension and production of words (Caramazza and Berndt).

Other studies have suggested that limited damage to Broca's area causes short term interference in motor speech and language. Damage to one particular region could be quickly compensated for by other regions, thereby explaining the short-term nature of some aphasias. To have a more permanent expressive aphasia would require damage to a larger area, beyond the proposed limits of Broca's area (Mohr).

Studies in the 1990s and early 21st century (Wise) also showed that the anatomic location of Wernicke's area is less defined than Broca's. If the common defect for Wernicke's is used (the posterior third of the superior temporal gyrus), damage restricted to only this area does not result in the more permanent findings of Wernicke's aphasia. A much larger area of involvement is required to explain the longer lasting or permanent lack of speech comprehension found in Wernicke's aphasics (Selnes).

Neuroimaging Studies and Correlates with Language

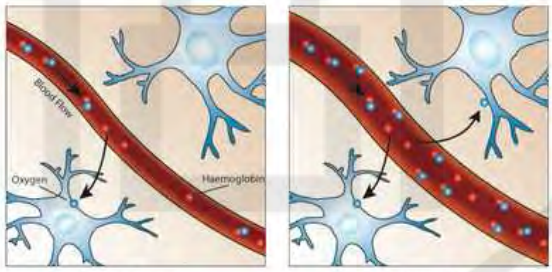

Figure 4. Illustration of arterial dilation

Broca and Wernicke relied on careful observations of symptoms and anatomic correlation to determine the cerebral sites responsible for speech loss. Such studies were therefore limited to those individuals presenting with particular deficits in language abilities, basically natural observational studies. In this sense, controlled experimental studies were not possible, since the studies were based on individuals with naturally occurring physical and pathological deficits.

But in recent decades, sites within the brain responsible for specific deficits in language have been more precisely determined by functional neurological studies, without the requirement for correlation by autopsy. These include fMRI (functional magnetic resonance imaging) and PET (positron electron emission). Such studies can measure localized changes in blood flow when neural activity occurs. Thus, when specific words, groups of words, or activities are presented, the brain responds by "activations" of the particular neural sites affected by such stimuli. This increase in neural activity causes an increase in blood flow to the area, which can be observed by imaging studies, fMRI or PET. However following the neurologic stimulus, there is a delay of 1 to 1.5 seconds before the blood flow increases. This delay causes some limitation in the accuracy of the scans to reflect the actual neural activity.

Nevertheless, researchers have been able to conduct many experiments using these new technologies. These generally involve posing a stimulus and recording the observed changes in blood flow, pre and post stimulus. A second method is to measure differences in observed blood flow when two different sets of neurologic stimuli are introduced. For example, a perfectly normal sentence could be read to a subject to establish a baseline scan. Then a similar but anomalous sentence (one with errors in grammar or syntax) could be read to an attentive subject while a second scan is recorded. By subtraction of the observed response in the latter stimulus from the former, it could be concluded that a particular area of the brain was involved in processing the language of the sentence.

Evidence from such experimental studies has identified more specific correlations of the locations for the reception and processing of language, beyond those determined by Broca and Wernicke. These include more precise evaluations of the components of language such as phonology, semantics and syntax. *Phonology* refers to the sounds used in language. Each language has a different phonology; some sounds are similar and present in different language, while other sounds are lacking. *Semantics* refers to the meaning of words and the meaning of language components such as phrases and sentence level information. *Syntax* encompasses the specific rules and principles for constructing lengthier language units beyond the word level, for example phrases, clauses and sentences. There can also be an emotional content to words and sentences, manifest by voice modulation. This is termed "*prosody*" and is primarily evaluated by activation in the right hemisphere as opposed to the left hemisphere. A summary of research findings based in neuro-imaging studies has been produced by Gernsbacher et al. in "*Neuroimaging studies of language production and comprehension*" in 2003. Newer techniques may provide even more precise information for the anatomic sites of language. Magnetoencephalography (MEG) studies surpass fMRIs and PETs, with even better spatial and temporal resolution.

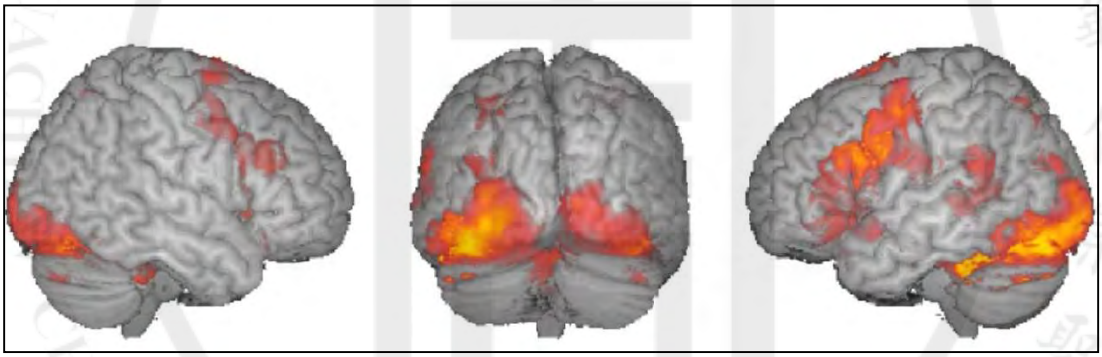

Figure 5. Sites of activation, Right, Posterior and Left cerebral views

Language Acquisition

Both medical specialists and linguists recognize well defined milestones for the individual development of language. The developmental stages are similar in all languages, though many of the studies have evaluated the natural development of the English language. The normal milestones for native language

(L1) acquisition have long been recognized, and these are part of the physical/psychological assessment provided for babies and children. These include normal basic anatomy and auditory function, without which normal audition, speech and language functions are not acquired. Notable exceptions are the deaf and blind whose language skills may be acquired by alternative routes, by signing and the symbols of written language. However, the language acquired in these individuals is still based in the language sites of the left hemisphere. Such developmental milestones are accepted and they are basically identical for both medical practitioners and linguistic specialists.

Language Development, Listening.

In the natural course of language development the earliest experience of language occurs prior to birth. The auditory system has already become well developed by 24 weeks of gestation, and the fetus is capable of showing responsiveness to sounds.

Several studies in the 1970s and 1980s found that the auditory system in the fetus is able to hear and discriminate the mother's voice prior to birth (Mehler). The fetal familiarity with the mother's voice has its origins prior to birth, as suggested by studies of newborns reported by De

Casper and Fifer in 1980. A listening preference for stories read while intrauterine has also been found by DeCasper and Spence, 1986.

Furthermore, in research published in the Jusczyk Lab Final Reports, infants from age 2 months to 24 months have had several experimental studies of syllable and word recognition, better defining the age correlation of a gradually expanding facility in language (Houston). Discrimination of specific syllables is age related: infants at 6 months could not distinguish syllables to which they were frequently exposed; by 9 months, they could discriminate between frequently exposed and infrequently exposed syllables (Santelmann).

Language Development, Speaking.

Verbalizing behavior begins within 3 months of birth, when children spontaneously make laughing and cooing sounds. These are elongated into vowel sounds and by the 6th month they have entered the "babbling stage". During these states the 12 most common speech sounds of all languages are found, and they make up 95% of the productive babbling. By 1 year of age, normal infants produce fewer speech sounds which do not occur in the language spoken in the home, and they lose the ability to distinguish sounds not heard in the home.

Young children do not acquire new vocabulary words at a steady rate, but they do have a remarkable expansion of words. The vocabulary may double or triple between 18 and 24 months, possibly due to impulses for naming surroundings. This is called "referential learning", the acquisition of words which refer to concrete objects in the environment. Children may also accelerate the learning of language by an intrinsic understanding of word categories, for example "animals".

These single word utterances have a logical progression, so that even a single word has a sentence like intent. For example, "daddy" may mean I want daddy to come; "milk" may mean "I want to eat". By 24 months, 2 word combinations are common, with meanings suggestive of complete thoughts, as in sentences. These two word structures have been analyzed and placed into categories of meaning. Although the studies were accomplished in English, further comparisons with other languages show that the semantic relationships appear in a variety of different languages. Between 24 and 36 months the "language" of the child becomes more similar to adult speech, with longer groupings of words and with the inclusion of more defined grammatical structures, as subject, verb, object (Kennison).

Why is this review of language acquisition important? A major model for attrition (language loss) envisions a mirror image relationship, suggesting that the ultimate loss of language occurs similarly to acquisition, but in the opposite direction.

Applied Linguistics. Development and Loss of Language Skills.

In the mirror image model, language loss is the ***mirror image*** of language acquisition, In this model the complexities of sentence structure and grammar would be lost first, declining into an inability to communicate with language. This is also termed the model of "***Last learned-First forgotten***". However, others have suggested that the best learned aspects of a language are the most likely to be retained, regardless of the time frame. This is the "***Best learned-Last forgotten***" model of language loss. These are two of the major theoretical models developed by linguists to explain how language is lost.

There are certainly relationships between the first, or native language (L1) and the second language (L2), with respect to their acquisition and loss. In fact, solid and extensive competence in the first language improves the ability to learn a second language. It seems that an extensive familiarity with the grammatical structures and ability to write well in the L1 provides a structural basis for overlap of the L2, making it easier to extend the grammatical rules and formation of the first language to the second language. However, depending on the age that the second language is acquired, the first language can also act as a filter, blocking some aspects of acquiring the L2, for instance native-like pronunciation of L2.

Figure 6. Mirror image

Figure 7. Rapid attrition (loss)

First Language Attrition

Attrition of the first language occurs due to non-use and interference from the process of learning the second language. Complete non-use of language, as in the introductory anecdotes, may cause attrition, though this may more likely be due to temporary difficulty with retrieval of words and language. Studies of 1st language attrition are most commonly carried out in individuals who are migrants, in situations where the 1st language is no longer used. In certain migrant situations, the use of the first language is even discouraged by the surrounding general population. For example, immigrant German Jewish children in England were surrounded by a community of English speakers, who were at war with Germany. The use of German in these children was strongly discouraged.

First language (L1) attrition is therefore identified as the gradual decline in the ability to use the first language in a migrant population. Schmid & Köpke in 2007 viewed this attrition as due to declining use and lack of exposure to the 1st language, along with an increasing usage and proficiency in the 2nd language. Some of the same factors (less use and lack of exposure) may be at work in both first language attrition and second language acquisition. The factors which affect L1 attrition and L2 acquisition may also include the amount of exposure in daily usage, attitude and motivation (Ben-Rafael and Schmid). L1 attrition is first noted in the lexicon, the catalogue of words in a given language, as noted by Schmid and Köpke in 2008. The L1 is influenced by the L2, by which some terms in the first language have changed their meaning, due to expansion from the L2 to the L1.

The Correlation of Linguistics and the Neurologic Basis of Language

Linguistic studies have found several characteristic features of language learning and loss. These are supported and to some degree explained by neurobiological research. In 1992 Yoshitomi developed a model of language attrition focused on the L2 (second language attrition) which included the basic manifestations of language attrition. He also identified the neurologic findings which supported the major features which were pragmatically found by linguistic studies as the following:

1] Mirror image/reverse order of acquisition: the last items learned are the first forgotten
2] Inverse relationship: better learned, better retained
3] There is a critical threshold for language learning: once the learner has reached a certain proficiency, language loss is less likely.
4] In the beginning of the incubation period, learning continues. This is termed residual learning.
5] There is an initial plateau before the onset of language loss.
6] Frequently used expressions are stored and not lost, even if there is no further language learning.

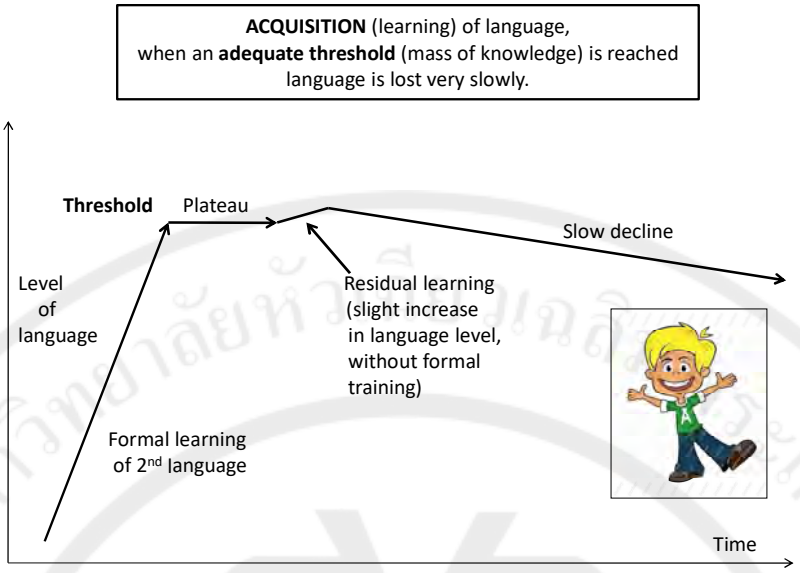

Figure 8. Acquisition and loss of language, high threshold of learning

7] The loss of language is gradual, beginning with difficulty in retrieval and progressing to total loss.
8] Around puberty (age 8-9) there is a critical period of language attrition
9] The amount of use of the language is more important than the length of exposure to the language in the development of language proficiency and resistance to loss.
10] Affect, meaning attention and motivation, indirectly alters the language use and degree of attrition.

It appears that animals, including humans have an adaptive capacity within the neurological system for new learning. This means that the neurological structures involved with memory and language have the ability to absorb new knowledge, and in turn this activity can affect the actual size and strength of neural connections. They can increase in both volume and connectivity. As a result, the neurological capacity to acquire, process and store new items of language changes and improves. It becomes better able to acquire, process, store and recall more information. The neurons are interconnected and learning language causes anatomical changes which increase and enhance the connections, leading to increased synaptic activity. This is the essential element for memory (Squire 1985). Prenatally, the basic neural connections in humans are directed and determined genetically. Thereafter, the environment and life experiences influence neurological development.

The idea of storage of memory over time as initially suggested by Burnham (1903) has been termed "memory consolidation" by Squire, in "*Memory: Neural organization and behavior*". For long term memory, two divisions are postulated: "intermediate memory" which can be easily affected and "permanent memory" which is more resistant to loss. Storage areas are the medial temporal lobe for intermediate memory and the cortex on the external brain surface for permanent memory (Squire, *Mechanisms of memory*).

The cerebral cortex is the layer found on the outer part of the cerebrum. It is present in humans and some vertebrates. The cortex is involved in memory, thought, language and consciousness. In humans and primates, this is also termed the "neo-cortex", which derives from Latin, "new bark". Humans have a distinctly larger neo-cortex, leading to their remarkably advanced abilities in memory, thought and language. In a sense, the neo-cortex in humans is similar to adding extra memory to a computer.

The time periods required for "memory consolidation" correspond to the observed findings by linguistic studies, that learning a language follows a pattern of increasing acquisition to a plateau stage, which is then followed by slower attrition if no further exposure occurs.

Critical periods for learning a language and critical periods for loss of language have also been identified by linguists. For language acquisition, there are several important periods, believed related to the maturational level of the brain and nervous system (Johnson and Newport). In 1990, Long published a review of the literature, which seems to indicate that the ability to acquire "native"

capabilities for speech and hearing (phonology) needs to be accomplished by about age 5. Yet the ability to learn a language with native like characteristics (syntactic knowledge) extends up to about 15 years of age. Above puberty it becomes extremely difficult to acquire native language ability (Hyltenstam and Abrahamsson).

Early exposure to language is essential to acquiring language. Studies done on children raised in isolation show that children with no language exposure, who were found after age 8 to 10 had no language skills. Such children could be taught only with great difficulty. One example seemed to develop semantics (understanding of words) but never acquired correct grammar and syntax (Curtiss).

On the other hand, children who have established a solid basis of language by the age of 9 also have very little attrition of language (Berman & Olshtain; Cohen). These studies showed that children from age 5 to 8 developed significant loss of irregular noun plurals and verbal past forms in comparison to older children (Olshtain). Reports by other investigators have shown similar results. The children over 8 years had better vocabulary and usage of language and better retention of oral language skills than the younger age groups (Cohen).

Neurologic Basis of Language

On a neurologic basis, language input is initially brought together, processed and stored in working memory, which seems to be a short term holding area, located in the medial temporal lobe. Items more frequently heard and experienced transfer into intermediate memory, which is also located in the medial temporal region. Those items to which the person is frequently exposed or items learned earlier undergo a process of consolidation. These are retained in permanent memory, found in the neo-cortex. So the process of acquiring language skills advances from temporary to short term memory located in the medial temporal area, with transfer to permanent storage in the neo-cortex if there is sufficient exposure and repetition. Once items are stored in permanent memory, they are less susceptible to loss by attrition. This neurologic model would explain the linguistic models and findings in acquisition and loss of language (Yoshitomi 304-305).

Language attrition may be attributed to the degradation or loss of previously found neural connections. This attrition is initially manifest by a difficulty in retrieving information (search for words, unable to quickly recall and use words). This is considered a weakening of the neural connections, which can be modified and reformed, or “re-strengthened” by re-exposure to language input.

This neurobiological model correlates well with the “inverse relation hypothesis” as suggested by linguists based on empiric observations. Greater proficiency in a language suggests that a critical threshold of language acquisition has been reached. Biologically, this means that a greater number of neurological connections have been established and that the language acquired has been moved to long-term storage, or “permanent memory”. This increase in the number and strengthening of neurologic connections enables a rapid recall of information and language. In fact, this also suggests “efficiency” in memory recall and processing. Studies of brain activity using positive emission tomography (PET) indicated less active brain metabolism in the most proficient individuals, suggesting that very proficient L2 learners have a greater efficiency in processing, recall and storage of information (Haier).

4. Conclusions

In summary, the origins of human language are closely linked to the development of gestures, tool recognition, tool use and the gradual development of the fine motor skills needed for tool use. For the majority of humans, the location of language and motor skills is in the left hemisphere, in the area identified as Broca’s, located in the inferior frontal gyrus of the left cerebral hemisphere and Wernicke’s area, in the left posterior hemisphere. However, specified storage areas have some variability, and the ultimate storage and use of language is dependent on a network of neurologic connections. The acute loss of language skills, termed aphasia, is closely linked with the acute loss of fine motor skills, apraxia.

The acquisition of language has fundamental stages which are time related and language learning begins prenatally. The stages of language acquisition have been established by empiric observation, and they are supported by neurobiological research. These models suggest an initial period of learning, in working or short term memory, followed by an intermediate stage of memory. If language repetition and exposure continue and are sufficient, the retained information is moved to long term, or permanent memory, located in the neo-cortex. This process is dependent on the achievement of a sufficient threshold of language exposure to cause consolidation into permanent

memory. Once established in permanent memory, the language skills are resistant to attrition. In this process of acquiring and losing language, there are critical time periods. The establishment of language with native like phonology (pronunciation and absence of syntactical errors) requires exposure to the language, for both L1 and L2 by the age of 5. The period of puberty, about age 10 to 11, is also recognized as an important milestone for language retention. Some studies have shown that individuals placed in a new language environment, with no further exposure to the L1 prior to about age 9-10, can have complete loss of L1, with a replacement by the new language, L2. For individuals who are no longer exposed to L1 after age 10-11, the L1 is retained, and may continue to act as a filter, blocking some of the ability to acquire L2.

Figure 9. Students dancing and singing

The ability to communicate with language is unique to humans. The varieties of language expression by different cultures and over time are extensive and impressive. But the mechanisms by which language is learned and lost are universally the same. The unique ability to communicate through language has contributed to all social and scientific advances in the human species. The search to self-examine and identify the principles and biologic processes which make language possible is also a uniquely human endeavor.

The future holds great promise for identifying even more precise correlates of language location and function within the brain. Linguistic studies on the acquisition and loss of languages continue to elucidate the processes and factors involved. With such knowledge, alteration of the course of language acquisition and attrition may be possible, both in terms of acute medical intervention and by furthering innovative educational techniques.

5. Recommendations

Based on the studies done in Neuropsychology and Applied Linguistics, certain recommendations for teaching and learning of languages can be made.

1. In order to acquire native-like fluency and pronunciation, the L2 (second language) should be taught and initial learning begun before about age 5.
2. The continued use of the native language, L1, interferes with or blocks the attempts to acquire proficiency in the L2, second language. For this reason, the language to be learned should be taught in the target language, not in the native language. Likewise, day to day conversations in the learning situation should be conducted in the L2. The findings also explain why immersion programs in language, in which all surrounding input is in the L2, are the most effective method in language learning.
3. In order to attain long term retention of a second language, it is essential to teach/learn to a high threshold level. When an individual becomes highly proficient in the L2, language decline/loss will occur slowly. Likewise, limited learning of a target language (L2) will result in a relatively rapid loss, if it is not reinforced by regular exposure and use.

4. The exclusive use of the second language (L2) negatively affects the retention of the native language (L1). When an individual is moved into an exclusively L2 environment prior to puberty, it is highly likely that the L1 will be lost or forgotten. If it is desirable to learn and

retain both L1 and L2, then it is essential to continue some use of L1 in periods of time while training and exposure to L2 occurs.

5. In a classroom setting, methods to stimulate affect (attention in class) are very important. These may include appropriate break times, active participation of all students in the classroom activities and innovative classroom methods, such as videos, role-playing, song/dance activities with the L2 used as the language of choice during in class.

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