Neuroscience of Multilingualism

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***Abstract*—**This paper focuses on structures of the brain in multilinguals. It pays particular attention to parts of the brain related to language, and how these may differ in multilinguals from monolinguals. This paper will try to see if there are any set correlations between areas and functions of the brain and language.

***Keywords*—** neuroscience, multilingualism, language learning and acquisition.

I. Introduction

Multilingualism basically refers to the ability to use two or more languages. Some linguists and psychologists use the term bilingualism as the ability to use two languages and multilingualism for more than two, but this paper will refer to multilingualism as the use of two or more. It is estimated that multilingual speakers now outnumber the world's monolingual speakers, with more than half the world's population being able to use two or more languages (Tucker, 1999). Research on how language affects the brain has been carried out since the nineteenth century, and this includes research on the neuroscience of multilingualism also. Over the years, there have been huge breakthroughs in this area, with particular attention being paid to the effects of multilingualism on the brain's structural plasticity, aphasia in multilingual individuals, bimodal multilinguals, and which areas of the brain languages may be stored. These areas of research have had a major impact on how we view language, and in particular, multilingualism and new information on the structure of the brain has changed the way we now think about second language learning and acquisition.

II. Language Acquisition And Language Learning. What's The Difference?

It must be noted that there are two ways in which we obtain the ability to learn language; through *learning* or through *acquisition*. The two are very different from one another. The former being a conscious process of accumulating knowledge of the features, such as vocabulary or grammar, of a language. The latter, acquisition, refers to an unconscious process, developed much more gradually, by using the language naturally. It is vital to differentiate here.

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III. Techniques Used to Examine the Brain during First Language Acquisition

Due to the fact that first language acquisition happens in infants, the study of neuroscience in this field is a relatively new concept. Over the last decade, there have been advances in noninvasive techniques that can examine the brain, particularly language processing, in infants. Prior to this, any techniques used for examining language processing in the brains of infants would have been unethical. Magnetoencephalography (MEG) is a brain imaging technique that allows us to measure brain activity extremely accurately. Sensors located within the MEG helmet measure tiny electrical currents that are produced in the brain when it's performing tasks. This has been used with infants to monitor multiple brain areas as infants listen to speech (Imada, Zhang, Cheour, Taulu, Ahonen, Kuhi. 2006). In modern research, Electroencephalography (EEP) is also widely used to study speech and first language acquisition in infants and young children. This type of technique looks for electrical activity that is time locked to the presentation of a specific sensory stimulus (for example, syllables or words) or a cognitive process (recognition of a semantic error within a sentence of phrase). By placing sensors on a child's head, the activity of neural networks firing in a coordinated way can be measured and neural activity can be detected. This technique is specifically well suited to studying the high-speed structure of human speech.

IV. Techniques Used to Examine How the Brain Organizes Languages

The study of the brain of how the brain organizes languages has been around for decades. Techniques have changed drastically over the years as new technology surfaces; however, versions of methods dating back from the conception of this field are still widely used. In some studies, learners are presented with stimuli from different languages to the right versus left visual or auditory fields to investigate which side of the brain is most involved in processing each language. As visual and auditory paths are crossed, meaning stimuli which are seen and heard from the left side of the body are sent to the opposite hemisphere of the brain, we can see which hemisphere responds faster. Another technique still used is mapping the brain surface during surgery by using electrical stimulation at precise points and recording which areas are involved in which aspects of speech, and in which language. Finally, as mentioned, with new technology comes new

techniques. Positron Emission Tomography (PET-scans), as well as other non-invasive imaging techniques such as MEP and EEP scans, allow direct observations to areas of the brain that are activated by different language stimuli and tasks.

V. Multilingualism

It is important to know the relevance of factors and stages of multilingualism. There are two main types of multilingualism; simultaneous multilingualism, and sequential multilingualism. In the former, a learner will develop the use of two or more languages simultaneously. The reason for this is likely to be growing up in a multilingual household or society and actually acquiring both languages at the same time. This factor is of paramount importance as acquiring a language goes through totally different stages to that of an individual learning a language. On the other hand, sequential multilingualism is developing a first language through acquisition as a child and then, after that is complete, developing the use of a new language. The second language may also be acquired depending on the situation of the subject, such as if they were immersed in the new language and picked it up naturally and subconsciously, however, in sequential learning, it is regularly the case that the new language is learned. This learning is a conscious decision which puts the language through a different set of stages than that of an acquired language.

VI. Conclusion

Throughout this paper, one can see just how big of a role language has, and the brain's capacity to deal with it really is astounding. The fact that brain allows individuals to learn a language right into adulthood is truly amazing. The way a brain can repair itself with treatment after damage, and aphasic patients can get back their lost information is fascinating.

Chompsky believes that humans have an innate capability for learning language. He describes his theory of Universal Grammar as "*the sum total of all the immutable principles that heredity builds into the language organ. These principles cover grammar, speech sounds, and meaning. Put differently, universal grammar is the inherited genetic endowment that makes it possible for us to speak and learn human languages"*. If this is to be true, then the brains capacity to learn and acquire language is one of the greatest feats of human evolution.

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