The brain and brocas area psychology essay

The brain is said to be one of the most complex things in the universe. It has an estimated 100 billion neurons and countless synaptic connections between these. These neurons are highly complex in structure, each with the potential of having over a thousand dendrites branching to communicate and connect to other neurons. Evolution, however, has allowed for the development of a functional order from what would appear as random chaos. Throughout the ages, the study of the brain has answered many questions and raised many more about the way the brain works. The dedication of countless researchers has allowed for the creation and advancement of the field of neuroscience. Research has allowed scientists to identify brain areas that serve a specific purpose or have explicit functionality. One of these areas is Broca’s area. Broca’s area is the name given to the area of the brain that is mostly responsible for the production and processing of speech. It also aids in the control of neurons responsible for facial movement and is to an extent, responsible for allowing humans to understand complex language structure. The functionality of Broca’s area in the matters of language processing goes without a doubt, but new research is shedding light on the possibility that this region of the brain contributes to more than just basic verbal language skills.

Broca’s area was discovered by Pierre Paul Broca, a French surgeon researching speech. The discovery of this area took place in 1861, when Broca examined the brains of patients with speech impediments postmortem. He discovered that all his patients had damage in the same area of the brain. This area was located on the frontal lobe of the left lateral cerebral cortex next to the motor cortex. Broca published his findings in

1865 and this area became known as Broca’s area. (Kalat 2007) This region was among the first to be described as having a localized function and has led the way on the theory of brain specialization. Over a century of research has confirmed Broca’s original findings and has validated the idea that certain brain processes are in fact exclusive and located in select parts of the brain.

There is no anatomical consensus of what Broca’s area constitutes of, but Paul Broca “ described the posterior third frontal convolution” also known as the “ inferior frontal gyrus – as most crucial for the expression of speech.” (Keller et al. 2009) Broca’s area, rather than being an isolated structure has connections to nearby structures that aid in the overall goal of allowing speech. The area displays asymmetry compared to its right hemisphere counterpart. This asymmetry in structure is often attributed to speech processing but the real reason for it has not been confirmed. Broca’s area is not the only area of the brain dedicated to speech, nor is this asymmetry unique to humans. It has been shown that three great ape species possess the same asymmetry on the homologue of Broca’s area. (Cantalupo and Hopkins 2001) A more reasonable theory for this is that the asymmetry comes from the special connection that Broca’s area has with Wernicke’s area through the neural pathway of the arcuate fasciculus where they overlap “ with phonological language activations in the left but not right hemisphere” (Keller et al. 2009) This applies to most right handed people only; the position of Broca’s area depends on the dominant hemisphere after all, and may be located on the right side of the brain if the individual is left handed.

The area is divided into two sections, the Pars triangularis, located anteriorly, and the Pars opercularis, located posteriorly. The function of each region of Broca’s area is thought to be different from the other. The Pars triangularis is thought to predominantly control verbal behavior while the Pars opercularis is thought to mainly control the organs responsible for the production and articulation of language. This makes sense because of the close proximity to the primary motor cortex in controlling general and fine motions of facial features and speech. Fine motor control could be closely related to position

Broca’s area is also though to control linguistic mechanisms such as action perception, working memory, syntactic complexity and syntactic movement. Action perception refers to the mechanisms that allow for the association of “ action observation and execution”, essentially the planning of movements needed to articulate a thought. Working memory refers to the verbal working memory responsible for controlling speech organs and how they move to allow for clear speech. Syntactic complexity refers to the “ processing of complex input” of phrases or written sentences, this is to say, it allows for the understanding of complex grammatical structures. Syntactic movement refers to the “ computation of syntactic movement in reception” (Grodzinsky and Santi 2008), or in layman’s terms, the ability to move and rearrange the words of a written sentence and still perceive the sentence as meaningful. All these mechanisms are thought to be in some way associated with Broca’s area, and various bits of evidence support the claims, from MRIs to analysis of homologous areas in monkey brains.

It is through common linguistic mechanisms that sign language can also be generated. In fact, experiments have been done in which chimpanzees tried

to attract the attention of seemingly inattentive caretakers with hand motions and noises. These chimpanzees showed a significant increase in activity in their Broca's homolog than the control counterpart, which did not try to attract the caretakers' attention. (Taglialatela et al. 2008) The understanding that lower primates show precursors to language have given rise to a new field in research dedicated to understanding the evolution of language. If scientists better understand how homologues of brain regions behave in lower primates, they might be able to decipher how it works in humans as well. This knowledge could prepare scientists to deal with human brain conditions that currently have no treatment or cure.

Broca's area has shown its importance in the development and use of language but as with other parts of the brain, lesions in these specific areas can result in specific neurological conditions. The most well known condition of damage to Broca's area is Broca's aphasia. Broca's aphasia, also known as non-fluent aphasia, is typically caused by stroke and generally consists of a loss of fluidity in speech, repetition and loss of grammatical correctness when speaking. Individuals afflicted by Broca's aphasia have no problem understanding and processing what others are saying but cannot generate normal speech or read complex sentences. As a result, individuals with Broca's aphasia often become frustrated by not being able to articulate what they think. Treatment of Broca's aphasia is usually individualized and consists of sessions of daily speech therapy. The prognosis varies per individual, but the condition can be ameliorated by practice to stimulate brain plasticity. Not surprisingly, data supports that damage to Broca's area will also affect sign language, causing slow and effortful signing, much like

the difficulty experienced when these individuals try to express themselves verbally. Interestingly enough, deaf people who depend on sign language are often worse off when receiving damage to the Broca’s area. (Grodzinsky and Amuts 2006)

Another curious fact about Broca’s area is that it could be responsible for symptoms relating to other diseases or conditions. One example is schizophrenia. Verbal auditory hallucinations are common in schizophrenic individuals but little is known on how these hallucinations originate. But it has been observed that there is an increase in blood flow to Broca’s area during auditory hallucinations suggesting the production of these hallucinations in schizophrenic individuals might be associated with areas specialized in language processing. (McGuire et al. 1993)

Broca’s area serves a very important purpose in everyday life but goes ignored without second thought. Broca’s area serves as a nexus for higher speech processes and all the functions associated with complex conversation. Without the structure that we call Broca’s area, our language, gesticulation and complex social interactions might not exist in the same state that they exist today.