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DENDRITES: WHY ARE THEY IMPORTANT!?

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ABSTRACT

Few research studies and experiments have examined the dendritic patterns and effects in the brain. Some minuscule research studies on the brain's functions indicate that the dendrites, or branch-like fibers at the end of nerve cells, are largely important to both brain structure and thought processes. More interestingly, there seem to be vast and distinct variations between the younger generations versus the older population. This study aimed to investigate whether dendrites truly are important to the brain and everyday life.

DENDRITES: WHY ARE THEY IMPORTANT!?

Dendrites are important. The tiny nerve cells have significant importance to the overall functions of the brain. Dendrites are primarily important due to what dendrites are, but also because of the multiple interesting facts about dendrites, the functions of dendrites, how dendrites are grown, and the vast dendritic studies and experimentations.

First and foremost, dendrites are truly interesting cells within the host body. A neuron is a tiny, microscopic cell. Often, neurons are confused with nerves, but they are different things, although related! Nerves are made from a large bundle of axons and dendrites and are macroscopic or visible to the naked eye (Chabner 346; Coon and Mitterer 63). In fact, both neurons and nerves are the parenchyma, or the essential characteristic tissue of an organ, to the nervous system (Chabner 347). Most neurons have four basic parts: the cell body (also known as the soma), the axon, axon terminals, and the dendrites (Coon and Mitterer 58). The neuron has two different types of nerve fibers, one of them being the dendrites. A dendrite is a fiber that carries impulses from other neurons or receptors toward the cell body of the neuron (Jovanovich 689). Not only do the dendrites look like roots of a plant, but they also receive the

electrochemical impulses or electrical signals or messages from other neurons (Coon and Mitterer 58; Jovanovich 689). Neurons, especially their dendrites, are essential for the brain.

Furthermore, there are a plethora of intriguing facts regarding the lovely dendrites. For starters, unlike other cells, neurons can communicate with each other using their dendrites (Feldman 94). Before birth, neurons are being made constantly, roughly 250, 000 neurons per minute to be exact (Sprenger). That is quite a number and feat to see! At birth, an infant's brain has approximately 100 billion neurons, but these have comparatively few connections to each other (Feldman 94; Sprenger). Sadly, these same neurons lose their connectivity powers over time if not used properly (Sprenger). It is therefore important to keep mentally engaged. When the child makes it to two years of age, billions of neuron connections are established, which only increase throughout the lifetime (Feldman 94). It was once alleged that the brain could not generate new neurons to replace old or damaged neurons, but this belief was found untruthful. Research from a part of the brain known as the hippocampus showed evidence of new cells and formation (Sprenger). This new research found that the brain loses cells on a daily basis while simultaneously growing new neurons to replace the dead cells through a process known as neurogenesis (Coon and Mitterer 63). Another interesting fact is that most neurons are stored in columns in the neocortex part of the brain, and a chain of neurons is called a neural network. This all relates to the vital theory of Long-Term Potentiation (LTP), which states that every time a neuron sends information, the memory of the data sent is literally programmed to that cell. The information is learned multiple times while it is practiced, and the electrical signal has the potential to go faster each time, thus learning the material faster as well (Sprenger). Scientists must learn what these new cells do, but these new cells are believed to be bigly involved in learning and memory processes (Coon and Mitterer 63). Dendrites are truly interesting and amazing cells!

Moreover, the function of dendrites play a critical role in bodily processes, especially of thought and perception. Dendrites relay information with electrical impulses to the brain (Ferro). In fact, each neuron in the brain has an electrical charge of approximately -70 millivolts, which allows the neurons to act like miniature "biological batteries" (Coon and Mitterer 59). The stimulus initiates an electrical impulse at the dendrites, which causes the impulse to pass and leave the cell through the terminal end fibers. The information then moves from one neuron to the next through these electrical impulses (Chabner 346). It has been discovered that the electrically stimulated brain affects behavior. This was proved by researcher José Delgado, who experimented with a bull and radio transmitter (Coon and Mitterer 60-61). In fact, a new paper in *Nature* by Spencer Smith suggests that dendrites are no longer passive but actively calculate the electrical signals. Spencer Smith is an assistant professor of neuroscience and engineering at the University of North Carolina at Chapel Hill, who in collaboration with the University of London and the University of North Carolina School of Medicine completed this research. They did a study with mice and found that the mice responded to various visual stimuli, and their dendrites fired an electrical impulse in response, as expected. The research found that nothing happened in the rest of the neuron and that the activity was only reported in the dendrites. The dendrites did the entire processing on their own. Spencer Smith testified that "all the data pointed . . . [that] the dendrites are not passive integrators of sensory-driven input; they seem to be a computation unit as well" (Ferro). All the data collected supports that the dendrites are clearly important for brain processing powers.

On top of that, new growth for dendrites seems possible. In fact, research implies that humans only use about 1-20% of the brain's true processing powers. Naturally, we still use all parts of the brain, since without utilizing the brain, humans would outright die (Sprenger). Truthfully, more dendrites means the more brain processing powers there are. These dendrites are akin to transistors, in which the dendrites store and compute data (Ferro). Arnold Scheibel, the head of the UCLA Brain Research Institute, suggests to keep a fervent mind and that intellectually challenges can serve as a stimulus for dendritic growth, since it adds to the "computations reserves in the brain." In fact Scheibel further says that "the important thing is to be actively involved in areas unfamiliar to you (Golden). Neuroscientists further reinforce this by defining learning as two neurons communicating with each other (Sprenger). In fact, many thought-provoking activities can help in dendritic growth. Psychologist Sherry Willis of Pennsylvania State

University suggests doing puzzles and states that "people who do jigsaw puzzles show greater spatial ability, which you use when you look at a map." Other activities that help dendritic growth are both music and the arts. Musical instruments use a large amount of brain power, whereas writing in a journal and painting with watercolors could help stimulate dendrite activities (Golden). It must be noted that all the Renaissance masters, such as Leonardo da Vinci, were highly involved in the arts and sciences. Other scientific visionaries, such as Tesla and Einstein, were also involved in music; Tesla could play piano, whereas Einstein fiddled with the violin. Another great activity to support dendrite growth is dance, as physical exercises and cognitive maintenance are linked together. Marilyn Albert, the Harvard brain researcher, states that moderately strenuous exercise leads to the development of small blood vessels that carry more oxgen to the brain. Arnold Scheilbel further says

> "All of life should be a learning experience, not just for the trivial reasons bur because by continuing the learning process, we are challenging our brain and therefore building brain circuitry. Literally. This is the way the brain operates." (Golden).

Life ought to be a learning and fine cultural experience, one filled with wonderment and stupefaction. The longer we keep our brains and bodies active, the less likely bad health issues will arise.

Likewise, there have been numerous experiments and research studies on dendrites. These experiments are currently ongoing as the brain is a difficult organ to interpret. One such experiment by Daniel A. Dombeck and Mark E. J. Sheffield used a high-resolution microscope to study the neuron. These researchers analyzed special place cells of an animal navigating a virtual reality maze and observed the hippocampus of the brain. The hippocampus region is the residence for hundreds of place cells, which are specialized neurons for the body's natural GPS coordination system. Dombeck and Sheffield are the very first to image activity of individual dendrites in place cells. They both observed that lasting memory of the experience was not formed by the whole neuron. The cell body was found to represent the ongoing or current memory, whereas dendrites help store the experience as a memory. Dombeck notes that

> "Now we have uncovered signals in dendrites that we think are very important for learning and memory. Our findings could explain why some experiences are remembered and others are forgotten."

These findings point to dendrites as prospective target therapeutics to combat memory deficits, which may help greatly against Alzheimer's Disease (Fellman). Obviously, this would greatly help millions if further progress is made. All this research refers to plasticity, which is the brain's ability to grow and change in response to environmental changes (Coon and Mitterer 63: Sprenger). Neural networks constantly change and adapt to the environment (Coon and Mitterer 63). Mirian Diamond of the University of California at Berkeley studied rat development for more than forty years. In 1988, she observed rats in different environments. Enriched environments had toys, whereas impoverished environments lacked toys. The rats raised in the enriched environment had more synapses and longer dendrites than the rats raised in the impoverished environment. Also, the rats learned more by living together and in the enriched environment compared to a solitary lifestyle (Coon and Mitterer 63; Sprenger). William Greenough of the University of Illinois also did experiments with rats. It was found that the rats in the enriched environments had 25% more connections between neurons and performed better overall in tests. He concluded that the more dendrites there are, the more synapses are made. William Greenough also performed several studies with kittens and found that more of a social environment benefited the animals (enrichment). Social interaction, care, mental exercise, and play were all found to be important for growing more dendrites. Obviously, activities influence how much we learn and govern the dendritic growth in our brain (Sprenger). So many research studies and experiments have been done and progressed humankind's understanding of the dendrite.

In conclusion, dendrites are extremely proficient and necessary for normal brain performance. Dendrites, the tiny nerve cells of the body, are amazing; they have numerous facts, functions, dendritic

growth potential, and a profuse amount of experiments with them. Without any dendrites, the body would not even continue to function. Dendrites are an essential part of humankind's physiology and psychology.

SUMMARY

Several studies and experiments prove that the dendritic functions are essential for proper bodily performance. The function of the dendrites affect the electrical impulses in the body, thus proving the bioelectricity theory of old. Further, the vast number value of billions of dendrites throughout the body, especially in the brain, indicates their significance. Dendritic growth observations show the importance of an enriched environment. In fact, the rat-dendrite experiments showed great promise and revealed the effects of social life and how one's environment can play a major part on the brain. This study proved without a doubt that the dendrites are truly important.

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