Discuss whether glial cells are merely helper cells for neurons.

The term ‘merely’ is a word equivalent to ‘simply’ in meaning as well as a word that connotes triviality. Thus, when asked whether glial cells are ‘merely’ helper cells for neurons, the answer has to be simply ‘no.’ Indeed, with numerous studies now showing how critical glial cells’ roles are for proper functioning of the brain and a number of complex tasks they execute, glial cells deserve to be regarded as more than ‘merely’ helper cells for neurons. In this essay, we discuss how the influence of glial cells extend beyond simply helping neurons and a few of the many complex tasks they execute to confirm that glial cells are more than helper cells for neurons.

Until recently, as opposed to neurons in gray matter, a significant chunk of myelin-coated axons—referred to as white matter—has been regarded as passive tissue, not playing any significant role other than simply providing insulation and passageways (Fields, 2008a). Moreover, in discussions of topics of wide interest regarding brain, such as learning, memory, psychiatric disorders and etc., only neurons—that is, gray matter—were extensively studied. This may not have been so irrational, because glial cells of white matter do not generate electrical impulses, which are necessary for information processing in brain. In any case, white matter was regarded as irrelevant to much of fundamental functions of the brain as a result (Fields et al, 2014). But recent findings proved preconceived notion about white matter not playing any critical role in brain functions wrong and revealed that white matter engage in wide range of tasks, suggesting their active role in brain (Fields et al, 2014).

Although it is true that brain functions are fueled by electrical signals from neurons, infrastructures for carrying them may be just as important, if not more. Consider, for example, cars without properly paved roads. In this case, car would be electrical signal and paved roads infrastructure. Certainly, even if many cars are manufactured, if there are no roads or highways for cars to cross, the entire transportation system, which is the backbone of society, would come to a halt and ultimately bring down all the other critical functions in society. Hence, as glial cells are found to be responsible for maintaining, constructing, and refining white matter, which functions as infrastructure in our brain, they are finally receiving the attention they deserve for the significant role they play in proper functioning of brain.

To understand how glial cells maintain, construct, and operate this infrastructure we call white matter, we first need to clarify how they are related. First of all, white matter make up nearly half of the human brain and consists of millions of axons with myelin wrapped around them (Fields, 2006). Myelin, a white, fatty substance that gives white matter its color, is what we are primarily concerned with, as this—not axon—influences brain in numerous ways, the details of which will soon be discussed. And this important substance, myelin, is made by two types of glial cells, oligodendrocytes and Schwann cells (Fields, 2006). In other words, white matter—which we can denote simply as a chunk of myelin—and glial cell are related in that glial cells generate myelin. So, there would be no myelin if it were not for glial cells. The ensuing question, then, would be, “But how important is myelin for brain functions?”

Certainly, one effective method for identifying the importance of a component in a system is to observe the ramifications of removing or altering the component. If such procedure leads to critical malfunctioning of the system as a whole, then we not only can observe what its role is in the system but also are able to indirectly gauge its importance from an overall perspective. In this manner, recent studies found evidences showing association of

surprisingly wide range of psychiatric disorders, such as schizophrenia, chronic depression, bipolar disorder and etc., with white matter defects and had to acknowledge their fallacy of having underestimated the importance of white matter. More specifically, damage in myelin was found to result in devastating consequences, such as paralysis, sensory-motor dysfunction, cognitive impairment, mental retardation and death (Fields, 2008a). What's more, accumulating evidences suggest that without astrocyte, which is star-shaped glial cell, neurons die. This is obvious, because astrocytes are the cells responsible for delivering energy source to neurons. In detail, astrocytes regulate blood flow, sending more blood to regions where neuronal activity has increased, for instance. After ensuring that the blood has been sent to the region, astrocytes deliver to neurons their energy source, glucose and oxygen, by extracting them from blood (Allen and Barres, 2009).

If you are still not convinced that glial cells are more than mere helper cells for neurons, we can look look at other complex tasks glial cells engage in for non-neuronal cells. First, let us take a look at how much glial cells contribute to intelligence. Studies have shown that white matter comprises over half the human brain, the proportion of which is far greater than other animals (Fields, 2008b). Could this be a reason humans are more intelligent than animals? Many evidences seem to say that this is definitely one of the reasons, if not the reason. Characteristics that can be associated with human intelligence, such as cognitive ability, IQ, reading skill, memory and musical proficiency, were found to be correlated with differences in white matter structure in regions of the brain overseeing these tasks. Moreover, studies observed a proportional increase in white matter with the number of hours subjects in an experiment spent learning complex skills, such as playing piano, showing that acquiring new skill is equivalent to more white matter (Fields, 2008b).

Correlation of myelination—a technical term for more white matter—with intelligence becomes plausible when you understand the underlying mechanism for information processing. What myelination simply does is increase conduction velocity for electrical impulses crossing axons. This control of conduction velocity is crucial, because in order for information to be processed, certain amount of electrical impulses is required. As such, in order for impulses to reach designated threshold point, multiple electrical impulses need to arrive at a neuron at the same time for build-up effect. This means that we need to enable electrical signals coming from more distant regions of the brain to travel faster than those from closer regions (Fields, 2008b). And this is where myelinating glial cells come in. Coordinating myelination of millions and millions of axons for proper neural circuitry, glial cells perform immensely complex tasks and thus are indispensable for our intelligence. Decline in thinking and cognitive ability, which are critical components of human intelligence, as a result of defects in myelin insulation further corroborates our assumption that myelinating glial cells are essential for our intelligence.

Another important function glial cells contribute to is memory encoding and consolidation. Astrocytes can augment or suppress synaptic transmission in neurons and influence changes in cortical activity during sleep when memory consolidation occurs. Additionally, studies have found that occasional failure of astrocytes to deliver even temporarily energy substrates to neurons can lead to serious impairment in later formation of long term memory. Moreover, in addition to astrocytes, microglia, oligodendrocytes, and astroglia were also found to play important roles in later stages of memory consolidation (Fields et al., 2014).

Despite the fact that brain is an immensely complex organ in our body, the amount of time invested for its research has been very minimal. As a result, it is an area where many questions and assumptions need to be answered, confirmed or corrected. Amongst these, glia cells have been those that were imposed with a certain assumption, that they are nothing more than mere helper cells for neurons. However, the more we got to understand through recent studies, the clearer it became that glia cells perform far more than just helping neurons. As mentioned above, from regulating blood flow, feeding neurons their energy substrates, maintaining cognitive ability, redefining conduction velocity of axons to control information processing to memory encoding and consolidation, glia cells have indeed shown to be far more complex in types and a number of tasks they perform than neurons. Given the wide range of tasks they perform and the importance they display for proper functioning of the brain, glia cells deserve more than just being labeled "neurons' helper cells."

References

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