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Brainstorm: Head Injuries and the NFL, Part 9: The Tau of CTE

John J. Medina Ph.D.

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These next two entries all about a protein called tau, which you have probably never heard of before. To understand CTE, however, we need to understand some critical biology surrounding tau. And to do that, we have to discuss something of which you have heard all your life. To talk about tau, we have to talk about salt.

Neurons are chock full of salt, conveniently dissolved in water, making a neuron’s interior briny as an ocean. Neurons also float in saltwater, reminiscent of the time when we used to be sea-dwelling. The salt concentrations (and types of salt) inside the cell are quite different from the salt concentrations (and types of salt) outside the cell.

Nerve cells go through great efforts to keep all of this interior/exterior salt partitioned. The partitioning occurs because of the neuron’s cellular membrane. Why go through this effort? The nerve cell exploits salty differences between the inside and outside, amongst other things, to generate the electricity used to create human thought.

Here’s how it works:

When you think about something, it is because your neurons allow tiny little exchanges of salt to occur between those inside and outside worlds. This “loosening” happens in a highly controlled, tightly regulated fashion. Think of it like a well-functioning immigration authority. When a thought occurs, it is because the immigration authorities in a nerve decided to allow a certain number of salt atoms to flow back and forth across the border. If the immigration authority is unable to regulate this salty traffic, human thought can get confused, resulting in chaos.

One can see the results of this chaos at the behavioral level. When a football player suffers a concussion, the sideline doctor often asks the athlete a series of obvious questions, such as “Where are you?” If the damage is sufficient, the player may not be able to answer those questions for some time. This is
all because of salt deregulation at the neuron's cellular border crossing.

How does that happen?

Cells can get punctured during a head injury. When that happens, two bad things occur, leading to the previously described behavior. First, the salts that are supposed to stay inside start pouring out of the puncture wound. Second, salts that are supposed to stay outside come flooding in. Interestingly a cell doesn't have to be punctured in order to make its border regulatory machinery go haywire. For reasons not entirely clear, experiencing a blunt force can disrupt salt trafficking.

This loss of salt regulation plays a critical role in understanding the molecular biology of CTE. And tau. In our next installment, I will try to put it altogether into a single story. Oddly enough, this narrative may involve premature Alzheimer's disease.

That's right. You just read “Alzheimer's disease.”

I obviously have some explaining to do.