

Research Project: Understanding Intelligence

A long-term goal of Artificial Intelligence researchers is to understand intelligence (Russell, 1997; Russell, 2014). To date, the vast majority of these researchers follow a long tread path of neuron research.

For over two centuries, the study of brain function has been dedicated to extracting the importance of neurons – cells that have long been known to convey and receive information that links our sensory experience to the world around us. The study of neuronal function has been instrumental in guiding our understanding of neural physiology and clinical neurology. However, the neuronal paradigm of studying brain function has left us with major limitations in our understanding of how the brain translates basic stimuli to higher order cognitive functions in humans. In fact, analyses show that neuronal properties are remarkably similar across species.

The human brain is a tangled mass of synapses, neurons, dendrites, axons, and glial cells. The research project Understanding Intelligence will specifically seek to help discover the role astrocytes (glia cells) play in memory, learning, and cognitive development (such as creativity, thinking, reasoning, logic) and *"making sense of the environment"* (Allen, 2015).

Astrocytes could be the missing piece to understanding the basis of human intelligence. *"Although the intellectual capacity of humans exceeds that of other species [...] it seems unlikely that the increased functional competence of the human brain can be attributed to any discrete aspect of neuronal number, form or function"* (Oberheim et al., 2006). It is more likely *"the astrocytic domain might extend the processing power of human brain beyond that of other species"* (Oberheim et al., 2006).

Key questions:

- Are there prominent features of astrocytes in the human brain that contribute significantly to intelligence and cognition?
- Are astrocytes functions (and dysfunctions) primarily concerned with the internal logic, the general "bio-logical" aspects, of Intelligence?

Researchers now know that astrocytes play many active roles and are critical for the development, information processing, and function of the Central Nervous System and brain plasticity. Further, *"[a]strocytes can control synaptic networks and in such a capacity they may represent an integral and overlooked component of the computational power of the brain"* (Verkhhratsky, Parpurac, & Rodríguez, 2011). Indeed it is thought that virtually every aspect of brain development and function involves a neuron-glia partnership and that the *"versatility of astrocytes is key to the development of human intelligence"* (Rodríguez et al., 2016).

Understanding the importance of astrocytes and how they might contribute to the increased processing power of the human brain “*could be the crack in the door that lets us understand the brain's code*” (Sejnowski, 2014).

Furthermore, understanding the brain's code will lead to being able to build human-level intelligent devices.

Finally, we believe a combined understanding of the brain together with the development of intelligent devices will contribute to significantly improving the quality of life for all human beings.

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