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Neuroscience 201

Martha Farah: Integration of Psychology, Neurology, and Neuroethics

While neuroscience is rapidly emerging as a field known for having a magnificent array of growth opportunities, the field itself is still in early stages of development. The neuron doctrine did not even develop until late in the 19th century. These tenants of neuroscience now form the basis for understanding mood, movement, and development. Along with the enthusiasm of new discoveries, scientists also face hurdles related to ethical research practices. Examining neurons, brains, and related structures pose concerns within non-human subjects. Testing on humans therefore raises many more questions. Further, researchers experiment with various drugs and treatments to study the effects on neurological systems. However, these experiments do not come with certainty that they will produce the desired short-term or long-term results. Martha Farah, a pioneer neuroscientist born in 1955 has taken a special interest in the ethical concerns related to neuroscience (*1*). Her post-graduate work prompted her to excel throughout various topics in neuroscience and thoroughly incorporate high ethical regards into her own research. This essay examines Farah's research on visual perception and socioeconomic status, as well as her contributions towards neuroethics.

Before paving the way with her influences in neuroscience, Farah attended Massachusetts Institute of Technology where she received an SB of metallurgy and materials science as well as an SB of philosophy. She continued her education at Harvard, graduating with a Ph.D. in experimental psychology. Her interest in neuroscience truly took shape, however, at MIT and Boston University School of Medicine where she focused her postdoctoral studies on neuropsychology (*1*). For several years following graduate school, Farah held positions as professor in psychology at various universities. Her initial research combined her experience in psychology with her interest in neuroscience. With this background, she examined the perception of visual stimuli and neurological mechanisms of imagery. She found that visual input signal transmitted to the brain becomes represented in series of rows and columns in the visual field. In further analyses, she explained how certain disorders and syndromes contribute to an

individual's inability to recognize faces. These individuals will still respond to facial cues in acceptable manners. This shows how reactions and memories may result from activation of different areas of the brain. She published these findings in her first book, *Visual Agnosia*, in 1990. This research has been heavily cited in many future studies, and the scientific community has recognized her work as founding research in this area (2). Despite her early studies of visual stimuli, Farah broadened her research and has spent most of her professional life studying emotion and decision-making, affects of socioeconomic status on the brain, and neuroethics.

In 2008 Farah examined the similarities and differences between environment, parental nurturance, and cognitive development in humans and animals. Farah looked at how the brain structure of neurons, glial cells, myelination, dendrites and synapses change in these different situations. This was the first study to look at how varying childhood experiences can connect to differences in neuronal growth in the brain related to language and memory functions. Her results show a relationship between language and environmental stimulation. The largest effect on memory, however, was parental nurturance. This study further differentiated itself from other research in that Farah sampled from a group of African Americans with low socioeconomic status. Many previous studies in this area examine American children in higher socioeconomic stature. The study does discuss the hesitations of applying these results to other races or people in differing economic statuses. In this way, Farah combined her interests in psychology, neurology, and human rights to produce a highly respected study (3).

Socioeconomic status describes a person's position in society. Farah's research has taken particular interest in how childhood experiences alter adult life. Studies have found that maturing in low socioeconomic status leads to poor health, impaired psychological well-being, and less cognitive and emotional development compared to those of high socioeconomic status. In addition, there has been a clear correlation between socioeconomic status and neural development (4). Farah's studies have concluded that socioeconomic status affects language, spatial cognition, memory and some executive functioning. Some research that exemplified this was based on examining elementary school children from various socioeconomic statuses. She explains that language is processed in the perisylvian brain region. This region has a slower maturation in utero than other neural regions. Therefore, it may still develop during infancy. During this development, the socioeconomic environment influences the child's ability to

process language later in life. She does continue to discuss, however, the correlational nature of the study may not predict neural specificity with complete confidence (5). Other concerns with children developing in low socioeconomic environments include higher risk for toxin exposure, less access to proper nutrition, prenatal drug exposure, and stress (4). All of which can influence how the brain and child develop.

Through Farah's innovative research on socioeconomic effects on neurological structures, she remains highly attuned to the ethical standards involved in this research. By studying poverty and finding the differences between high and low socioeconomic status children, she offers cautionary notices to her audience to understand that low socioeconomic status is not innate or immutable. The results show how this situation does lead to poor neurological development. However, it is neither the fault of the victim, nor an irreversible problem (4). Farah has influenced the community to see this as a situation with room to change. Some solutions could include healthcare becoming a more viable option for lower status individuals or giving education systems in these areas greater attention. Instead of assuming that nothing can be done to help people in low socioeconomic statuses, child development experts and neuroscientists can combine forces to improve these lives. Further, growth in a lower socioeconomic status does not conclude that an individual's adult life may not be extremely positive and fulfilling.

Through all of her work, Farah has placed large emphasis on the ethics behind her own work and promoted strong ethical standards to others in the field. She has participated in the inception of the term "neuroethics" which encompasses social, legal, and ethical implications of cognitive neuroscience. Some common concerns include protecting humans when using MRI or other imaging technologies. Safety of the subject should have a higher importance than obtaining results for science. Farah explains that science is on the verge of predicting individuals' abilities, personalities, and attitudes with high degrees of certainty. What people need to understand is how this information could create a positive effect and how it could potentially be detrimental to the individual or to society as a whole. Farah also shows concern for using chemicals to induce psychological or neurological changes. With any new treatment, the "risks, tradeoffs and changes in self-concept" must be understood (6). Since the field of neuroscience is relatively new compared to many other sciences, there are less defined lines for ethical standards. Farah

continues her work at the University of Pennsylvania and as the director for the Center for Neuroscience and Society to prevent the abuse of new technologies and promote safe and ethical results. While she has already assisted in publishing upwards of 50 research articles, in many ways, her career and influence in the neuroscience community is just beginning. As she has established herself within the neuroscience community, her future publications and collaborations will undoubtedly be anything short of unique and innovative.

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