Neuromechanics – Perspectives, Challenges, and Opportunities

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Maeder Hall, ACEE

Ellen Kuhl
Stanford University

Arguably, the brain is the most complex organ in the human body, and—at the same time—the least well understood. The fields of neuroscience, neurobiology, and neuroimaging have seen tremendous progress throughout the past two decades; yet, the field of neuromechanics remains underappreciated and poorly understood. Here, we discuss the importance of neuromechanics in integrating knowledge across the disciplines and scales, from individual neurons via neuronal tissue to brain as a whole. We show that mechanical stretch, strain, stress, and force play a critical role in modulating the structure and function of the human brain, both across space and time. We review current research highlights, and discuss challenges and potential future directions. Using the nonlinear field theories of mechanics, we illustrate two phenomena, which are tightly regulated by mechanical factors: neurodevelopment, the formation of the brain, and neurosurgery, the mechanical manipulation of the brain. We hope that this presentation will inspire discussion around the mechanics of the brain with potential impact in preventing, diagnosing, and treating neurological disorders.

Ellen Kuhl is a Professor of Mechanical Engineering and Bioengineering at Stanford University. She received her Ph.D. from the University of Stuttgart in 2000 and her Habilitation from the University of Kaiserslautern in 2004. Her area of expertise is Living Matter Physics, the creation of theoretical and computational models to predict the behavior of living systems. Ellen is the Vice Chair of the U.S. National Committee on Biomechanics, a Fellow of the American Society for Mechanical Engineers, a Fellow of the American Institute for Mechanical and Biological Engineering, and a standing member of the NIH study section MABS. She has co-authored more than 150 journal articles at the interface of engineering and medicine, she is an editorial board member of eight journals, and a founding member of the Living Heart Project. Ellen received the National Science Foundation Career Award in 2010 for her research on the virtual heart and the Humboldt Research Award in 2016 for her research on the human brain.

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Social period following the seminar outside of Maeder Hall