Arthur S. Iberall Distinguished Lecture

December 1, 2017 ⌘ University of Connecticut ⌘ 4:00 p.m.

Liberman Conference Room, Bousfield Psychology Building

Complex structural organization of the muscular-connective-skeletal system

Sérgio Fonseca

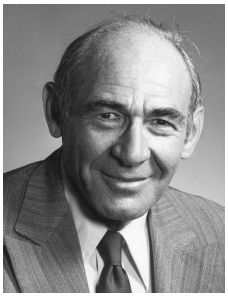
Universidade Federal de Minas Gerais (UFMG), Brazil

Abstract

Arthur Iberall has argued that the fundamental problem for a science of complex systems is to explain how the diversity of forms and evolutionary processes arise from few principles, which should hold across the micro and macro scales of organization. As a complex system, the animal's structure should conform to these principles. Scale-invariance is seen in the architecture of our bodies, from the cell to the muscular-connective-skeletal system (MCS) organization. At the micro scale, cellular tensegrity structures are governed by laws of form, which define the existence of stable architectures resulting from the organization of few elements (microtubules and micro- filaments). Similarly, at the macro level, physical principles that govern tensegrity structures account for the complex organization of the MCS (fascial, muscle and other connective tissue architecture).

Tensegrity, or tensional integrity, is an architectural design that allows the emergence of flexible and omnidirectionally stable structures, by virtue of the presence of a pre-existing tensional force (prestress) and by an organization, in which its internal elastic elements are continuous. The organization of the MCS system conforms to that of a tensegrity structure. Bones are discontinuous compressive elements, while fascia, ligaments, muscles and tendons form a continuous tensile network. Muscle tone provides the same effect as prestress in tensegrity structures. As expected from a tensegrity structure, the existence of prestress and tissue continuity allows the MCS system to act as a medium for force propagation that redistributes mechanical energy globally.

The concept of tensegrity contributes not only to the understanding of the intrinsic stability of the cell and the MCS system, but also opens new possibilities to understand body-related perceptual mechanisms. The similarities between the transformations in optical flow and the changes in geometrical force balance as the result of the energy flows within a tensegrity structure offer the basis for the cell's mechanosensation and the body's haptic perception. Transformations of postures, in the tensegrity-like MSC system, are transformations of patterns of tension distributions. This array of tension transformations in the body's tissues, in which the mechanoreceptors are immersed, constitutes information similar to Gibson's optic array. And, as Arthur Iberall has argued, perception emerges naturally out of organized matter-energy flows.



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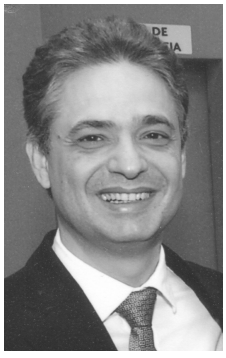
Dedicated to the exploration of connections between physical processes and their manifestations in nature, life, humankind, mind, and society. The series honors the physicist, Arthur S. Iberall (1918-2002), whose intellectual legacy includes homeokinetics, a method of applying the laws of thermodynamics to all self-organizing systems. His applied research contributed significantly to the development of the first space suit, the high-speed dental drill, stove surface burners, the fancy-stitch sewing machine, and the electric knife.



Sérgio Fonseca is Full Professor in the Department of Physical Therapy, Universidade Federal de Minas Gerais (UFMG), Brazil, as well as Dean of the School of Physical Education, Physical Therapy and Occupational Therapy at UFMG. He received a B.Sc. degree in Physical Therapy from UFMG, M.Sc. in Physical Therapy from University of Alberta, Canada, and Sc.D. in Applied Kinesiology from Boston University. He was also an invited scholar at the Center for the Ecological Studies on Perception and Action at the University of Connecticut. Dr. Fonseca is the Editor of the *Brazilian Journal of Physical Therapy* and a member of the Brazilian Council of Research in the area of Physical Therapy. He has published more than 100 articles in peer reviewed journals and his research activities focus on applying dynamic systems and ecological approaches to the understanding of human movement, especially in the area of rehabilitation and is considered a pioneer in the application and evaluation of tensegrity in rehabilitation science.