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The human motor system (HMS) is a complex, multilevel, self learning, and self repairing system, with many inputs and only one output, which is an organized motor task. The two basic subsystems of the HMS, the structural and functional, interact with each other and with the environment. Quantitative analysis of the HMS is necessary to increase our understanding of human motion, and to objectively evaluate the effectiveness of any medical intervention. The analysis of such a system requires a multidisciplinary approach. The current analysis of the HMS includes studies of the structural properties of the human body in selected biomechanical degrees-of-freedom, and their effect on the functional performance in individuals and/or groups of individuals. Such a classic, deterministic approach, which looks for causes at the structural level (impairment) and effects at the functional level, should be further developed; this is especially true in clinical applications where the evaluation and medical intervention often target individual biomechanical degrees-of-freedom.

There exist successful attempts to apply the tools from nonlinear dynamics to the analysis of the HMS. We intuitively appreciate some rhythmic, oscillatory properties of organs, such as the heart, lungs, and brain; but, inherent oscillatory properties observable at the micro and macro levels of the HMS are often underestimated. The neural and biomechanical oscillators (harmonic and chaotic), with the addition of time delays, create a highly nonlinear dynamic system. We are just beginning to understand these coupled oscillators for which actions extend beyond one particular structure to also include the environment.

One of the challenges of physics is development of a unified theory of the universe based on oscillators called strings. Despite the fact that we do not know yet how the string theory is going to evolve, the parallel between the oscillatory character of the human Mind-Body-Environment (MBE) interactions and string theory cannot be ignored. The commonly reported pathological oscillators (epilepsy, tremor, and clonus) emphasize the potential clinical value of the approach.

The application of the non-linear dynamics approach to the analysis of MBE interactions may lead, not only to a better understanding of human movement, but also to the best medical practice by customizing any intervention to individual patient needs. Our understanding of the compensatory mechanisms utilized by patients with musculoskeletal problems may also require revision. For example, any attempt to change the repetitive motor patterns without structural changes may not be efficient over the long term, because the system will eventually tune back to the non-linear body dynamics, as the most efficient realization of the motion.

The presented above holistic approach to study HMS inherently merges biomechanics and motor control (classical and nonlinear dynamics) into one, requiring the development of common language/definitions.

I recommend:

1. The further development of a deterministic approach based on Newtonian mechanics should be complemented by the nonlinear dynamics approach
2. Collaboration and the development of common language/definitions across researchers working in Newtonian biomechanics/nonlinear dynamics and motor control should be supported
3. An implementation strategy should be supported to introduce the concepts from non-linear dynamics either as class topics within university biomechanics courses, or as a stand-alone elective within biomechanics programs.