

On the coordination dynamics of agency

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This presentation addresses a fundamental problem—the origins of agency-- that great scientists have remarked upon, almost since the beginning of physics as we know it. The problem is so obvious that some may take it for granted, as gravity once was. Witness, however, Bohr: “A description of the internal function of an organism and its reaction to external stimuli requires the word *purposeful* (italics his) which is *foreign* (italics mine) to physics and chemistry... (*Daedalus*, 87, 1958). Or Schrödinger in his famous book *What is life?* asks: “If my body functions as a pure mechanism according to the Laws of Nature, what is this ‘I’?” Or even Newton himself, in a Letter to Oldenberg in 1675: “The power of life and will by which animals move their bodies with great and lasting force. . . demonstrate that there has to be other (undiscovered) laws of motion.” Or most recently Chomsky (2022): “You decide to lift your finger. Nobody knows how that is possible; to this day we haven’t a clue...You have no science of voluntary action”. The present research aims at the very core of this issue using human infants as a test field and the so-called Mobile Conjugate Reinforcement (MCR) paradigm as an experimental entry point. Infants begin the MCR procedure as disconnected observers, but when one of their feet is tethered to a mobile hanging above, they discover they can make the mobile move. Increased kicking is classically interpreted as evidence that infant leg movements are linearly reinforced by mobile motion which is assumed to be inherently rewarding. However, a complete dynamical analysis which includes the baby, the mobile and their interaction reveals that there is much more going on than originally conceived. We provide evidence that conscious agency emerges as a phase transition in a coupled dynamical system that spans the infant and the environment. There are currently at least three quantitative mathematical and computational modeling efforts going on around the world to account for our observations, none of which individually covers all the facts. In particular, the pause structure (‘stillness’) between movements presents a significant theoretical challenge, as does the persistence of action after the baby is decoupled from the mobile. Practically speaking, individual infants are shown to navigate functional coupling with the world in different ways, suggesting a novel phenotyping method that may be useful for preventive care and early treatment of infants at risk.

Scott Kelso holds the Glenwood and Martha Creech Chair in Science at Florida Atlantic University (FAU) in Boca Raton where he is also Professor of Psychology and Neuroscience, Biological Sciences and Biomedical Sciences. He is Emeritus Professor at The University of Ulster's Intelligent Systems Research Centre. Kelso was educated at Foyle College in Derry~Londonderry, N. Ireland and later at Universities in Belfast, Calgary and Madison, Wisconsin where he received both MSc and PhD degrees. Kelso's research uses a combination of behavioral methods, brain imaging and theoretical modeling to understand how human beings (and human brains)—individually and together--coordinate behavior on multiple levels from the cellular to the social. His approach is grounded in the concepts, methods and tools of self-organizing dynamical systems tailored to the activities of animate, living things, a theoretical and empirical framework called Coordination Dynamics. Kelso and colleagues' research has appeared in over 450 journal publications, including *Science* and *Nature* as well as other prominent journals in the fields of neuroscience, physics, biology and psychology. He is the author or editor of 10 books and serves or has served on the Editorial Boards of 15 scientific journals and book series. Kelso is an elected Fellow of the American Psychological Association (1986), the American Psychological Society (1990), the American Association for the Advancement of Science (2002), and the Society of Experimental Psychologists (2012). In 2016, he was elected an Honorary Member of The Royal Irish Academy (MRIA). Immersed in a specifically interdisciplinary setting, Kelso's PhD students and Postdoctoral fellows have gone on to careers in some of the top academic and research institutions in the world.