Physicists find patterns within seemingly random events of physiological systems

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Finding patterns behind seemingly random events is the signature of a recent trio of research studies coming from the statistical physics group in Boston University's Department of Physics. Although describing physical phenomenon is not a surprising industry for research physicists, findings from this BU group increasingly wed phenomena associated with the inanimate world to those of animate beings -- finding commonalities between stock markets fluctuations, earthquakes, and heart rates, for example, or discovering similarities in mice, men, and other mammals for such fundamental phenomena as wake periods during slumber.

Eugene Stanley, a professor of physics and director of BU's Center for Polymer Studies, Plamen Ivanov, a research associate in the Center, and Kun Hu, a research assistant in physics, will discuss their findings March 22 at the American Physical Society meeting in Los Angeles.

The team sought to investigate the role the body's internal clock, the circadian pacemaker, might have on heart performance either directly, through influencing cardiac dynamics such as heartbeat, or indirectly, through its influence on motor activity control. Their analyses of heartbeat dynamics from participants show a significant circadian rhythm, including a notable response at the circadian phase corresponding to 10 a.m., the time of day most often linked to adverse cardiac events in individuals with heart disease. Circadian rhythm, however, does not affect motor activity dynamics, according to their recent analyses, leading the researchers to speculate that the early-

morning peak in cardiac risk is not related to circadian-mediated influences on motor activity.

In research on the dynamical features of the brief awakenings and sleep periods that occur in different mammalian species, the scientists found that the periods of wakefulness that snuggle between sleep periods of various mammalian species, are similar. The findings lead them to speculate that, instead of merely being random disruptions in the sleep cycle, periods of brief wakefulness exhibit what is known as self-organized criticality. This physical phenomenon is exhibited in events such as avalanches, where a system exists in a quiet state, accumulating energy, until it reaches a "tipping" point and collapses, only to build up again and repeat the cycle. The researchers, therefore, speculate that the dynamical patterns found in these wakefulness periods may hint at underlying similarities to the neural networks controlling mammalian sleep.

Scientists at Boston University's Center for Polymer Studies, part of BU's Department of Physics in the College and Graduate School of Arts and Sciences, research polymer systems at the microscopic level, focusing on describing the basic spatial configurations of polymer molecules so as to better predict the macroscopic behavior of polymers. Interdisciplinary science research at the Center includes studies of cardiac dynamics, the statistical mechanisms of Alzheimer's disease, and simulations of liquid water.

Source: Boston University