MAR16-2015-004651

Abstract for an Invited Paper
for the MAR16 Meeting of
the American Physical Society

Collective Dynamics of Oscillator Networks: Why do we suffer from heavy jet lag?

HIROSHI KORI, Ochanomizu University

The circadian rhythm of the entire body in mammals is orchestrated by a small tissue in the brain called the suprachiamatic nucleus (SCN). The SCN consists of a population of neurons, each of which exhibit circadian (i.e., approximately 24 h) gene expression. Neurons form a complex network and interact with each other using various types of neurotransmitters. The rhythmic gene expressions of individual cells in the SCN synchronize through such interaction. Jet-lag symptoms arise from temporal mismatch between the internal circadian clock orchestrated by the SCN and external solar time. It may take about one week or even longer to recover from jet lag after a long-distance trip. We recently found that recovery from jet lag is considerably accelerated in the knocked-out (KO) mice lacking the receptors of a certain neurotransmitter in the SCN [1]. Importantly, all other properties of mice including sleep-awake rhythms and breeding seem to be intact. Only the response to the jet lag changes. It was also found that after a few days of jet lag, cells in the SCN desynchronize in the wild type (WT) mice, whereas they do not in KO mice. This desynchrony might be a main reason for heavy jet lag symptoms. To understand the mechanism underlying jet lag, we propose a simple model of the SCN, which is a network of phase oscillators [1]. Despite its simplicity, this model can reproduce important dynamical properties of the SCN. For example, this model reproduces the desynchrony of oscillators after jet lag. Moreover, when intercellular interaction is weaker, this desynchrony is suppressed and the recover from jet lag is considerably accelerated. Our mathematical study provides a deeper understanding of jet lag and an idea how to circumvent heavy jet lag symptoms. [1] Y. Yamaguchi, T. Suzuki, Y. Mizoro, H. Kori, K. Okada, Y. Chen, J.M. Fustin, F. Yamazaki, N. Mizuguchi, J. Zhang, X. Dong, G. Tsujimoto, Y. Okuno, M. Doi, H. Okamura: Mice Genetically Deficient in Vasopressin V1a and V1b Receptors Are Resistant to Jet Lag, Science 342, pp. 85-90 (2013).