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국문 강연제목: 운동학습동안 매니폴드의 새로운 탐색과 공고화 과정
영문 강연제목: Manifold exploration and consolidation during motor learning

Abstract

Systems consolidation – a process for long-term memory stabilization – has been hypothesized to occur in two-stages. Whereas new memories require the hippocampus, they become integrated into cortical networks over time, making them independent of the hippocampus. How hippocampal-cortical dialogue precisely evolves during this and how cortical representations (manifold) change in concert is unknown. In this study, we used a skill learning task to monitor the dynamics of cross-area coupling during Non-Rapid Eye Movement Sleep (NREMS) along with changes in primary motor cortex (M1) representational stability. Our results indicate that precise cross-area coupling between hippocampus, prefrontal cortex (PFC) and M1 can demarcate two distinct processing stages. The first stage is closely associated with rapid learning and variability of the M1 low-dimensional manifold (exploration). Notably, a sharp increase in PFC and M1 sleep slow oscillation (SO) coupling coincides with M1 representational stabilization (consolidation). This sharp increase then predicts a drop in hippocampal sharp-wave ripple (SWR)-M1 SO coupling – suggesting feedback to inform hippocampal disengagement and transition to a second stage. We thus suggest evidence for dynamic hippocampal-cortical dialogue associated with manifold exploration-consolidation during motor learning and adaptation.

Brief Biosketch

Dr. Jaekyung Kim is an Assistant Professor at the Korea Advanced Institute of Science and Technology (KAIST) since July 2023. Prior to this appointment, he earned his Ph.D. in the Department of Bio and Brain Engineering in 2017. Following the completion of his PhD, he conducted postdoctoral research at the University of California, San Francisco (UCSF), and the Veterans Affairs Medical Center in San Francisco. Dr. Kim's research is centered around unraveling the intrinsic neural networks underlying motor learning and memory processes. His work also involves the integration of brain-machine interfaces into the motor cortex of rodents. These endeavors have deepened his fascination with exploring the fundamental principles of sleep-dependent processing and its role in forming motor memory during long-term periods of learning. Over the past five years, Dr. Kim has acquired several prestigious grants and awards, including the POSCO Science Fellowship, the K99 Pathway to Independence Award from the NIH NINDS, and the Excellent Research Award from the South Korean Ministry of Education. He has significantly contributed to the field by publishing cutting-edge research in high-impact journals such as Nature, Cell, and Cell Reports. His work has shed light on the intricacies of sleep-dependent memory processing, both in intact brains and in brains affected by conditions such as stroke.