〔目的〕

The brain is capable of storing and recalling memories through a set of cells, termed engram cells, which are activated during experience. Activity in these cells corresponds to a specific event, ensuring recovery of that particular experience. However, it is unclear how these cells are organized to form the engram, mainly because of technical limitations that have made it difficult to identify both engram and non-engram cells during in vivo recording/imaging.

〔方法並びに成績〕

Here, we show that contextual memory in the hippocampus is represented as distinct subsets of synchronous activity (defined by Ca2+ transients) that comprise several ensembles of engram cells. In contrast to non-engram cells, these ensembles maintain their activity not only during learning but also during post-learning sleep and retrieval sessions. We developed an imaging system with a miniature head-mounted fluorescent microscope with which we identified engram cells using the photoconvertible fluorescent protein Kikume Green Red (KikGR) and the c-fos-tet-tag system. We observed neuronal activity in the CA1 hippocampal area via Ca2+ influx and G-CaMP7. Engram cells exhibited repetitive activity, characterized by remarkable synchrony, upon exposure to a novel context. Population vector distance (PVD) analysis revealed that the activity pattern of engram cells was stable not only during learning but also across sleep and retrieval sessions. Furthermore, non-negative matrix factorization (NMF) analysis detected several engram-cell ensembles comprising collectively active neurons whose activities were repeated during encoding, sleep (NREM and REM), and re-exposure sessions; however, they were weaker in a different context.

〔総括〕

These findings demonstrate that contextual memory in the hippocampus is represented as distinct subsets of synchronous activity (defined by Ca2+ transients) that comprise several ensembles in engram cells. In contrast to non-engram cells, these ensembles maintain their activity not only during learning but also during post-learning sleep and retrieval sessions and suggest that subgroups of ensembles represent distinct pieces of information, which are

then orchestrated to form the entire contextual memory.