Synaptic competition and cooperation in reward learning: The role of hippocampal and prefrontal inputs to the nucleus accumbens

ABSTRACT:

Background
Synaptic changes underlie memory formation in many brain areas; ventral hippocampal (vHPC) and prefrontal cortex (PFC) projections to the nucleus accumbens (NAc) are a potential site of storage for associations between environmental stimuli and reward.

Aims
Our goals were to identify learning-related changes in synaptic strength in inputs to the NAc during associative learning, and to characterise the interactions between PFC and vHPC projections.

Method
Rats were implanted with electrodes to record synaptic potentials in the vHPC-NAc pathway, and spontaneous oscillatory activity. They underwent place-preference training in which a distinctive context was associated with morphine injection. In parallel experiments, fluorescent viral constructs were injected into vHPC or PFC. Rats were later sacrificed, and their brains were sectioned and imaged to determine the distribution of projections from vHPC and PFC to the NAc.

Results
Training did not cause an overall change in synaptic strength, but morphine caused an acute increase in evoked responses, and a progressive increase in gamma-frequency activity. The tracing experiments revealed that vHPC projects almost exclusively to the NAc shell, whereas the PFC projects predominantly to the core.

Conclusions
Our results do not support the idea that changes in synaptic strength in the vHPC-NAc projection underlie context-reward associations. However, the morphine-induced increase in gamma-frequency activity may be related to the 'incentive sensitisation' that occurs with repeated opioid administration. Fluorescent tracing indicates that there is limited overlap between vHPC and PFC inputs to the NAc; direct interactions between these inputs are thus unlikely to mediate the formation of context-reward associations.

Keywords
Hippocampus, Nucleus accumbens, Prefrontal cortex, Reward, Synaptic plasticity

Published Work:

Sakae, D. Y., & Martin, S. J. (2019). Formation of a morphine-conditioned place preference does not change the size of evoked potentials in the ventral hippocampus-nucleus accumbens projection. *Scientific Reports, 9*: 5206. doi: 10.1038/s41598-019-41568-5

Researcher's Contacts:

Stephen Martin
Division of Systems Medicine
University of Dundee
Dundee, DD1 9SY
UK
Tel: +441382383961
Email s.martin@dundee.ac.uk

Rosalina Fonseca
Cellular and Systems Neurobiology
Universidade Nova de Lisboa
Campo dos Mártires da Pátria, 130 | 1169-056 Lisboa
PORTUGAL
Tel: +351 91 2382568
Email: rosalina.fonseca@nms.unl.pt