A Searching Hierarchy

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Electroencephalography (EEG) is one of the most popular functional imaging techniques in psychology, neurology, and neuroscience. Compared to methods such as magnetic resonance imaging (MRI) and positron emission tomography (PET), EEG has unparalleled advantages in temporal resolution and cost. The blaring weakness of EEG is the inverse problem which leads to a deficiency in spatial resolution. Cohen and colleagues tackle this impasse in their recent *Journal of Neurophysiology* report. The researchers combined measurements of intracranial single-neuron spikes, local field potentials (LFPs), and event-related potentials (ERPs) from the macaque frontal eye field (FEF) to investigate the source of the human N2pc, an attention-related ERP component.

A visual search task was employed where the monkeys made a saccade to a target (**L** or **T**) among a group of 1, 3, or 7 distractors (**T** or **L**). The target selection time was measured by three spatially distinct electrophysiological techniques; microelectrodes recorded single-neuron spikes and LFPs in the FEF while skull electrodes recorded m-N2pc ERP components over extrastriate visual cortex, hypothesized to be the macaque homologue to the human N2pc. Selection times were consistently faster in single-neuron spikes than LFPs, and LFP selection times were consistently faster than m-N2pc selection times. The selection times in all three techniques increased in parallel with the number of distractors, which is consistent with increased saccade response times. In a majority of test pairs there was a trial-by-trial correlation between the amplitude of FEF LFPs and the amplitude of extrastriate ERPs. These results supported the authors' hypothesis that "feedback from FEF contributes to the generation of the m-N2pc component."

There is often a gap between scientific studies performed in humans and those performed in animal models. The advantage of animal models is the ability to invasively explore the underlying biology and physiology of disease and behavior that are, for obvious ethical reasons, otherwise prohibitive in humans. Here, Cohen *et al.* used two invasive electrophysiological techniques (single-neuron spike recording and LFP) commonly used in animal studies in parallel with one noninvasive electrophysiological technique (ERP) that is frequently used in human studies. These techniques span the spatial scale and together provide a better understanding of the origin of monkey selective visual attention that can in turn be directly utilized in human research. The combination of methodologies provides exceptional temporal and spatial resolution to overcome the limited spatial resolution inherent to EEG scalp recordings. In doing so, the authors succeed in bridging the gap between human and nonhuman primate electro-physiology. One expects to see more investigators employing similar multimodal approaches to further our understanding of the neural bases of noninvasive technologies.

Original Research Article:
JY Cohen, RP Heitz, JD Schall and GF Woodman (2009). On the origin of event-related potentials indexing covert attentional selection during visual search. *J Neurophysiol.* **102** (4): 2375-2386.

Stress, Plasticity and Abuse

The bed nucleus of the stria terminalis (BNST), a key nucleus within the "extended amygdala", is anatomically poised in both the reward and stress circuitry. Given this unique position, the BNST has become a focal point of studies interested in exploring the link between anxiety and addiction. In this nucleus, long-term depression (LTD) plays a critical role in monitoring excitatory influence over circuits which impact cognition and emotional behavior. Previous evidence suggested that both noradrenergic and glutamatergic initiated G_q-coupled signaling in the BNST converge on a final common mechanism for LTD maintenance. McElligott *et al.* provide evidence to the contrary. While norepinephrine induced LTD via α1-adrenergic receptors (α1-AR) occurs in the same neurons as glutamate-induced LTD (mGluR5-LTD), α1-AR mediated LTD transpires exclusively through the downregulation of calcium permeable AMPA receptors. mGluR5-dependent LTD, however, does not involve the regulation of calcium permeable AMPA receptors. Importantly, these differences are emphasized by the fact that the persistence of these two distinct forms of LTD can be impacted differentially by environmental challenges. For example, α1-AR dependent LTD is disrupted by stress and is resistant to disruption by cocaine. While, on the other hand, mGluR5 dependent LTD is susceptible to cocaine-induced disruptions but is resilient to stress challenges. The authors extend these findings by further demonstrating that the α1-AR dependent LTD can also be diminished by chronic ethanol exposure. Together, these data suggest that in the BNST noradrenergic- and glutamate- activated G_q-coupled initiated signaling is delicately tuned to specific stimuli. Thus, these distinct pathways allow for fine differential control of glutamate synapse efficacy in response to stress.

Original Research Article:
ZA McElligott, JR Klug, **WP Nobis**, S Patel, BA Grueter, TL Kash and DG Winder (2010). Distinct forms of G_q-receptor-dependent plasticity of excitatory transmission in the BNST are differentially affected by stress. *PNAS.* **107** (5): 2271-2276.