MIGHTEX

STUDYING NEGATIVE AFFECT USING A HEAD-FIXED RODENT BEHAVIOR TRAINING SYSTEM AND MIGHTEX BEHAVIOR CAMERA

Chang Xu, Justin Wang, Alexxai Kravitz and Meaghan Creed, Washington University in St. Louis

Application Note

My main research goal in the Creed lab is to understand negative affect that emerges in opioid withdrawal, which drives drug relapse. To this end, I am using the Mightex system to understand how opioid withdrawal alters the neural circuits that regulate responses to natural rewards and threats, as a computational approach to understanding negative affect. Specifically, we are interested in using orofacial expressions in mice to understand how drug use alters affective behaviors. We acquire these ethologically relevant behaviors in addition to choice and decision variables during the head-fixed decision-making tasks. In this way, we require orthogonal data: decision strategy we can model computationally to make inferences about reward and punishment sensitivity, as well as learning rates and perseveration, along with unconditioned reflexive behaviors (grimacing, eye closure, pupil dilation, and appetitive licking) that together provide a comprehensive picture of an animal's underlying affective state.

The Mightex products used for our behavior experiments include a CMOS Camera (SBE-B015-U) with a 10x Zoom lens (MLH-10X), DIN8 cable with BNC connectors (ACC-CCD-TS) and PolyScan software. All experiments are performed in dark with infrared illumination. We followed tutorial from Mightex to remove IR cut filter preinstalled in the camera. The excellent imaging quality under infrared illumination has been instrumental in advancing this work. One demo video is attached, showing the mouse receives a tone stimulus followed by an air puff (video is down sampled for demonstration purpose). In our experiment (Fig1), we trained mice to perform a Pavlovian condition task in a head-fixed preparation and utilized Bonsai to acquire timestamps for different events such as licking and running. Notably, the camera is compatible with Bonsai, but we decided to use PolyScan software to acquire behavior videos as it exhibits more reliable performance at a high sampling rate. Figure 2 is the wiring diagram showing how we synchronize the Bonsai and PolyScan systems. With this method, we can reliably find frames where key behavioral events happened and analyze mice's behavioral responses to air puff-predictive cues and air puffs (Fig 3).

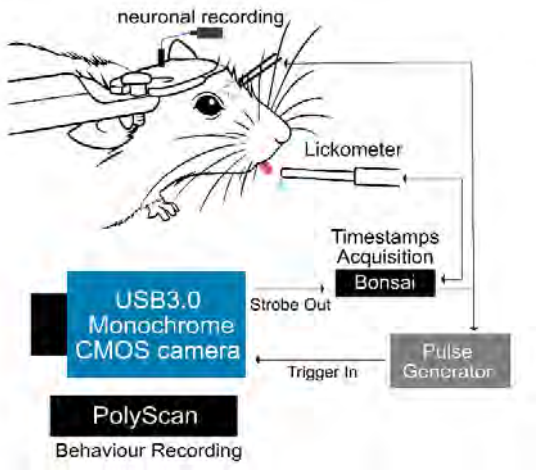

Figure 1: *Acquisition systems used for collecting decision variables and face expressions.*

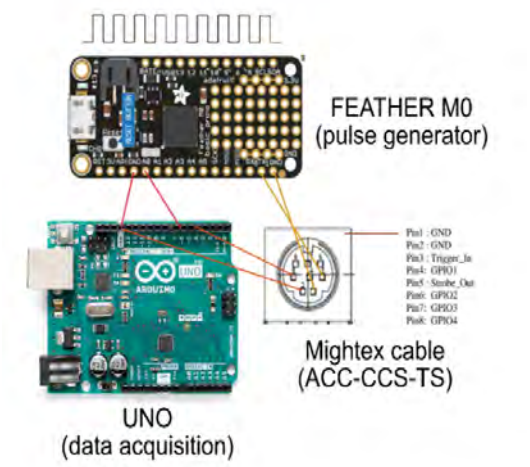

Figure 2: *Wiring diagram for synchronizing the Mightex behavior camera with the Bonsai acquisition system. We used Arduino UNO to send digital outputs to the FEATHER M0 board (pulse generator) and receive camera Strobe out. Note, configuration in the PolyScan software is required for the camera to communicate with external devices. Codes for Feather M0 board and Bonsai script are available upon request.*

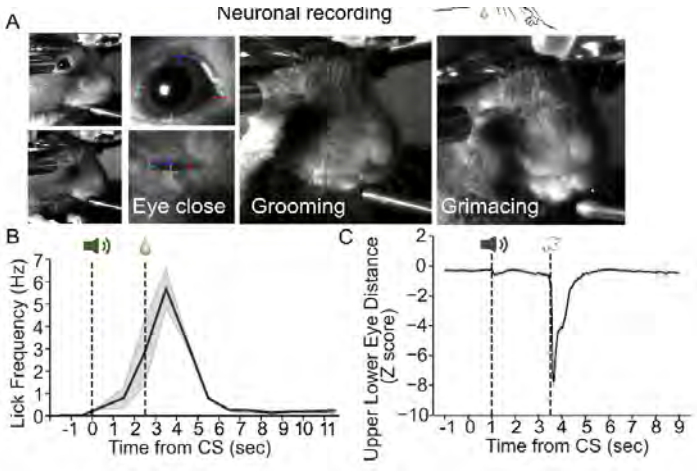

Figure 3: *Pavlovian conditioning task in a head-fixed preparation. A: Representative examples of eye closure, grooming, and grimacing behaviors displayed by mice during air-puff trials. Markers surrounding the eye indicate the four key points (eye top, eye bottom, eye left and eye right) tracked using DeepLabCut. B: Mice showed anticipatory lickings in response to a reward-predictive cue. C: Mice showed anticipatory eye closure response to an air puff-predictive tone.*

This application of Mightex's SBE camera with time stamping using the PolyEcho provides a vital addition to the OASIS Fiberscope or Photometry platforms. By integrating the SBE camera for behavioural recording, time stamped using the same synchronized clock as data capture and optical signals, you are able to efficiently and accurately connect brain to behaviour. Further this behaviour recording and imaging data integration allows for the possibility of predictive and close loop control experiments. That is. optogenetic stimulation can be initiated based on observed neural signals or behaviour, providing time sensitive modulation layered on top of observations all driven through the oasis platform.

If you found this Application Note valuable, we encourage you to explore our additional Application Notes and eBooks, and to stay tuned for future releases. We continually develop new educational content to bring these complex and fascinating topics to a broader audience and to equip our customers with the knowledge needed to conduct the highest-quality research. We also frequently collaborate with our customers to develop new content and application insights, fostering a two-way exchange of expertise that allows us to learn from one another and advance the field together. If you are interested in collaborating with Mightex, please contact us at sales@mightex.com.