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| A virtual reality system to study predictive neural processing during social interaction  Kuo-Hua Huang  Institute of Molecular Biology, Academia Sinica, Taiwan  Our ability to predict other’s behavior allows us to make better decisions for collaboration or competition during social interaction. Deficit in making accurate prediction has also been proposed to cause pathological mental conditions such as autism spectrum disorder (ASD). Despite its significance, how our brain encodes prediction and violation of prediction during social interaction is largely unknown. One challenge is that multiple forebrain regions controlling emotion, memory and decision making are involved in generating social behavior, while current technologies have limited capacity to monitor cross-region activity with a high spatiotemporal resolution. Another challenge is that social stimulus is the behavior of another animal, which is difficult to manipulate by its nature.  My lab takes advantage of the miniature size of adult zebrafish for brain activity measurement across forebrain regions at a single-cell resolution. At Academia Sinica, we recently developed a novel VR system using a 6-axis force/torque sensor that enables a head-restrained zebrafish to navigate in a 3D virtual environment. This VR system is integrated into a two-photon microscope for monitoring the forebrain activity during behavior. Simultaneously, the respiration rate and the eye angle of the animal are monitored, which could enable us to correlate neural activities reflecting emotion and visual attention. Currently, we are developing 3D models of adult zebrafish and using them as a controllable stimulus to probe brain activity in response to predicted vs. unpredicted social situations.  As predictions are acquired by learning, we are focusing on neural circuits that control learning behavior and social behavior. Dm neurons in the dorsal forebrain and the y321 neurons in the ventral forebrain play essential roles in fear conditioning and innate social orienting behavior, respectively. We are investigating whether y321 neurons project to Dm and whether this input is used by Dm to mediate fear conditioning involving conspecifics. Finally, we are investigating how the mutation of shank3, which leads to a syndromic ASD in human, perturbs social behavior, learning behavior and predictive neural processing in zebrafish. | |
| Selected 5 recent publications:   1. Henley, J.R., **Huang, K.**, Wang, D., and Poo, M. (2004). Calcium Mediates Bidirectional Growth Cone Turning Induced by Myelin-Associated Glycoprotein. Neuron *44*, 909–916. 2. Valente, A.\*, **Huang, K.-H.**\*, Portugues, R., and Engert, F. (2012). Ontogeny of classical and operant learning behaviors in zebrafish. Learning & Memory *19*, 170–177. (\* equal contribution) 3. **Huang, K.-H.**\*, Ahrens, M.B.\*, Dunn, T.W., and Engert, F. (2013). Spinal Projection Neurons Control Turning Behaviors in Zebrafish. Current Biology *23*, 1566–1573. (\* equal contribution) 4. Ahrens, M.B.\*, **Huang, K.-H.**\*, Narayan, S., Mensh, B.D., and Engert, F. (2013). Two-photon calcium imaging during fictive navigation in virtual environments. Frontiers in Neural Circuits *7*. (\* equal contribution) 5. **Huang, K.-H.**, Rupprecht, P., Frank, T., Kawakami, K., Bouwmeester, T., and Friedrich, R.W. (2020). A virtual reality system to analyze neural activity and behavior in adult zebrafish. Nature Methods 17, 343–351. | |