Harnessing the power of closed-loop neuronal control to identify the circuit basis of decision making

ABSTRACT:

Making the correct decisions is key to our health and wellbeing. This is especially relevant in the context of nutrition. Accordingly, animals have developed behavioral strategies to decide which nutrients to ingest.

In this project we therefore proposed to develop and use a novel closed loop optogenetic behavioral setup (optoPAD) to identify and characterize neurons involved in nutrient decisions.

In this grant we have developed, benchmarked, and published a new experimental behavioral setup called optoPAD to study the circuit basis of food choice in *Drosophila* (Moreira et al., 2019). The optoPAD allows the closed loop optogenetic manipulation of neurons and the quantitative assessment of the consequences of the manipulations on feeding behavior. In the spirit of open science we have made the design, plans, and software required to build and use the optoPAD freely available (https://github.com/ribeiro-lab). We have used this setup to characterize the taste peg gustatory neurons and shown that they mediate specific aspects of protein homeostasis (Steck et al., 2018). We also developed new behavioral paradigms allowing us to study how *Drosophila* shapes its behavior contingent on neuronal activity (Moreira et al., 2019). We used the optoPAD system to create dynamic virtual food environments. Finally, we have screened a library of transgenic flies labeling sparse sets of neurons for food choice phenotypes upon silencing the labeled neurons. We have identified sparse lines producing specific and reproducible food choice phenotypes.

Overall this project has allowed us to establish a new technology to link circuit function to behavior and has produced important insights into how specific circuits shape behavioral decisions.

Published Work:

Münch, D., Ezra-Nevo, G., Francisco, A. P., Tastekin, I., & Ribeiro, C. (2020). Nutrient homeostasis - translating internal states to behaviour. *Current Opinion in Neurobiology, 60*, 67–75. doi: 10.1016/j.conb.2019.10.004

Sánchez-Alcañiz, J. A., Silbering, A. F., Croset, V., Zappia, G., Sivasubramaniam, A. K., Abuin, L., ... Benton, R. (2018). An expression atlas of variant ionotropic glutamate receptors identifies a molecular basis of carbonation sensing. *Nature Communications, 9*(1): 4252. doi: 10.1038/s41467-018-06453-1

Steck, K., Walker, S. J., Itskov, P. M., Baltazar, C., Moreira, J.-M., & Ribeiro, C. (2018). Internal amino acid state modulates yeast taste neurons to support protein homeostasis in Drosophila. *ELife, 7*, e31625.

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