Associative learning about threat probability

2020-03/Area: cognitive psychology/computational neuroscience

Background

Learning about the probability of threat is thought to be a fundamental ability of many mammal species, including humans. While associative learning theory and, more recently, cognitive-computational neuroscience have developed elaborate models of this process [1, 2], it is far from clear whether and how it can be measured in humans [3-5], where typically autonomic nervous system (ANS) readouts are used [6]. First, it is unclear which learning quantities map onto the readouts. Secondly, it is unknown how neural input into the ANS evolves over time.

The goal of this project is to clarify these two mappings for pupillometry, and possibly other data sources (skin conductance, cardiac cycle, fear-potentiated startle). You will generate hypotheses from an existing data set, and collect new data in a threat conditioning task.

What you can learn

- Model-based analysis of biophysical signals with the Matlab-based software PsPM (bachlab.org/pspm)
- Reinforcement learning modelling skills
- Background knowledge in associative learning theory, signal processing methods, threat conditioning neuroscience
- Experimental skills in human psychophysiology and learning research
- Coding skills

Your profile

Your background is in neuroscience, psychology, biology, or related fields, and you have first experience with data analyses (e.g. in Python, R, or MATLAB).

Supervision

Dr. Dominik R. Bach, MBBS PhD
Principal Research Fellow
Max-Planck UCL Centre for Computational Psychiatry and Ageing Research
Wellcome Centre for Human Neuroimaging
Queen Square UCL Institute of Neurology
10-12 Russell Square
London WC1B 5EH

Information and contact

d.bach@ucl.ac.uk
bachlab.org

Literature

1. Gershman, S.J., Radulescu, A., Norman, K.A. & Niv, Y. Statistical computations underlying the dynamics of memory updating. *PLoS computational biology* **10**, e1003939 (2014).
2. Rescorla, R.A. & Wagner, A.R. A theory of Pavlovian conditioning: Variations in the effectiveness of reinforcement and nonreinforcement. in *Classical conditioning II: Current research and theory* (ed. A.H. Black & W.F. Prokasy) 64-99 (Appleton-Century-Crofts, New York 1972).
3. Tzovara, A., Korn, C.W. & Bach, D.R. Human Pavlovian fear conditioning conforms to probabilistic learning. *PLoS computational biology* **14**, e1006243 (2018).
4. Li, J., Schiller, D., Schoenbaum, G., Phelps, E.A. & Daw, N.D. Differential roles of human striatum and amygdala in associative learning. *Nat Neurosci* **14**, 1250-1252 (2011).
5. Zhang, S., Mano, H., Ganesh, G., Robbins, T. & Seymour, B. Dissociable Learning Processes Underlie Human Pain Conditioning. *Current biology : CB* **26**, 52-58 (2016).
6. Bach, D.R. & Melinscak, F. Psychophysiological modelling and the measurement of fear conditioning. *Behav Res Ther* **127**, 103576 (2020).