

Progetto Formativo – Research Project

This assegno di ricerca (research fellowship) is part of an interdisciplinary project funded by the PRIN-2022 program of the Italian Ministry of University and Research. The project involves the University of Bologna, with its Departments of Psychology and Electrical, Electronic, and Information Engineering (DEI), as well as the National Research Council (CNR). Consequently, the grant recipient will have the opportunity to gain research experience within a multidisciplinary team composed of psychologists, cognitive neuroscientists, engineers, and computer scientists.

The research team from the Department of Psychology will focus on studying individual differences in the field of human reinforcement learning, contributing to the project's overarching goal of creating a human-inspired framework for designing heterogeneous swarms of autonomous unmanned aerial vehicles (UAVs).

The study of human cognition shows that human reinforcement learning can be described as the combination of a Pavlovian system, which learns what environmental stimuli lead to desired (rewards) or undesired (punishments) outcomes, and an instrumental system, that learns which actions will maximize rewards and minimize punishments. The extent to which these two systems influence decision-making varies among individuals. Specifically, so-called sign-Trackers (ST) are individuals who preferentially engage and respond to Pavlovian stimuli and rely on model-free instrumental learning while Goal-Trackers (GT) are more focused on task outcomes and depend more on model-based instrumental learning. As a consequence, Pavlovian stimuli tend to exert a more powerful influence over STs' than GTs' decisions.

We will study the capabilities of human participants at Pavlovian learning and its influence on instrumental learning, leading to greater or less success in decision-making. In fact, on one hand, using cue learning to guide behavior can be adaptive to survival, as it can lead to a rapid reduction of the realm of possible actions to select. On the other hand, it can become maladaptive in case the individual continues to exploit Pavlovian stimuli even when the elicited course of action is no longer appropriate (e.g., such a mechanism is at the core of substance use disorders). Individuals are known to have different learning styles (STs vs GTs) and these differences modulate the extent to which individuals are influenced by Pavlovian stimuli.

Project Tasks of the Psychology Unit include:

- Collaborative definition of a Transversal Dictionary between Cognitive and Engineering Sciences

Together with the other project members, we will prepare a dictionary to share a common language between neuroscientists and engineers about reinforcement learning in sequential choice problems. We will define the meaning of stimuli and rewards, learning models, and we will identify common performance metrics.

- Experiments on humans for the Identification of STs and GTs

We will conduct experiments aiming at the identification of sign- and goal-trackers learning style through the use of psychophysiological measures.

- Experiments for Model-Based and -Free Learning

We will conduct experiments aimed at studying decision making of sign- and goal-trackers learning style when Pavlovian stimuli are present in the environment.

- Experiments for Collective Model-Based and -Free Learning

We will conduct experiments aiming at studying how collaboration between different learning styles affects decision-making.

Programma delle attività dell'assegnista – Program of activities of the research fellow

- Literature review: deepen theoretical knowledge on relevant topics.
- Experiments design: define the experimental paradigm, pilot it, refine it as needed, and preregister it.

- Data collection on adult humans: recruit participants and collect behavioral, psychophysiological and neurophysiological data.
- Data analysis: preprocess the collected data and perform statistical analyses.
- Writing and dissemination of results: prepare the results for submission to a peer-reviewed journal and present them at international conferences.
- Discussions with the supervisor and research team.
- Attendance of seminars, workshops, and conferences.

Sede di svolgimento delle attività - Location of activities of the research fellow

Cesena Campus of the University of Bologna