Theme: Cognitive Neuroscience

PUPIL EVOKED RESPONSES UNDER DIFFERENT UNCERTAINTY LEVELS IN A REINFORCEMENT LEARNING TASK

Hicran Beşikci[1]*, Miguel Castelo-Branco[1,2], Maria J. Ribeiro[1,2]
1 CIBIT-ICNAS, University of Coimbra, Portugal
2 Faculty of Medicine, University of Coimbra, Portugal

*presenting author

Abstract:
Learning theories are associated with the idea that the stimulus value is updated by repeated interventions during a reinforcement learning(RL) task. In the RL tasks, the stimulus value is updated by a base event: the outcome(feedback). The participant decides the value of the new stimulus each time by comparing it with the outcomes of the past choices. This process usually takes place in a probabilistic and uncertain environment. In these conditions, the learning process is characterized by two important phenomena; feedback-dependent reward expectancy (reward prediction errors) and value-based decision making under uncertainty. These complex learning processes in the brain remain poorly understood. Changes in pupil size under conditions of isoluminance indicate engagement of the brainstem neuromodulatory arousal systems. The pupil changes during decision-making or according to the outcome of a choice, expanding and contracting immediately after the moment of choice and after feedback. Engagement of the arousal system might be important for learning. To closely monitor these cognitive processes, pupil responses can be used as an effective non-invasive tool. In this study, we investigated time-dependent learning dynamics and how pupil responses respond to differences in uncertainty during choice and feedback processing. Participants were 73 healthy older people aged 54-77 years. Participants showed significantly higher pupil responses to negative feedback than to positive feedback. Behavioral analyses revealed that participants learned to distinguish the stimuli based on their value. Modulation of reward uncertainty significantly modulated accuracy and reaction time. Accuracy was inversely proportional to the uncertainty levels, while reaction time showed a directly proportional relationship. In conclusion, both accuracy and reaction time revealed that participants were able to learn the value of the stimulus and this learning was tracked by their pupil responses.

Keywords: cognition, reinforcement learning, pupil responses, arousal, decision-making