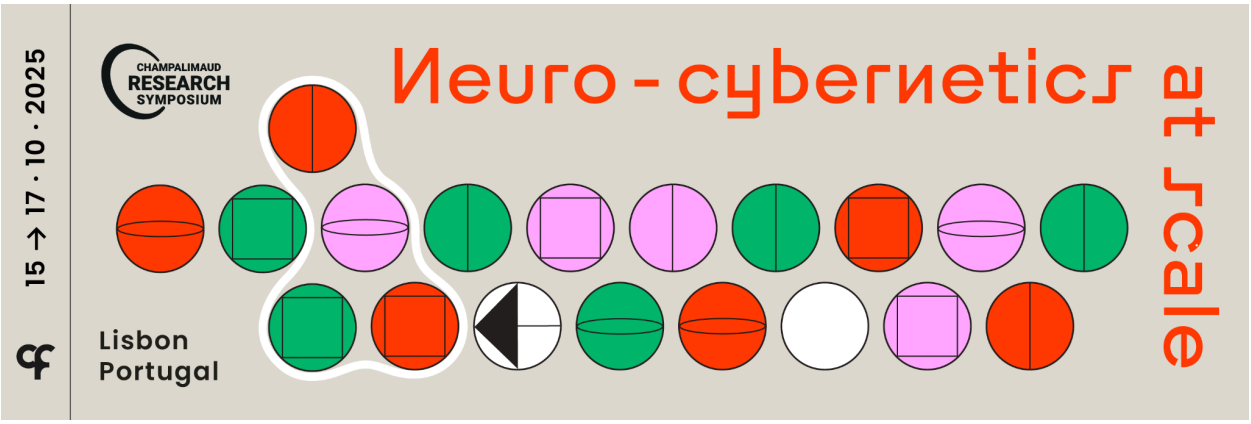

(V)Repetition without (V)Repetition: using virtual reality tennis to replicate and expand on a foundational result in motor control

Alice C. Navalho 1*, Filipe S. Rodrigues 2*, Joseph J. Paton 2
1 Instituto Superior Técnico, Lisbon, PT
2 Champalimaud Foundation, Lisbon, PT
*co-first authors

It has been nearly 100 years since Bernstein's seminal experiments on expert blacksmiths established repetition without repetion—the idea that reproducible task performance variables arise from variable elemental movements—as a core aspect of dexterous motor control[1]. Here we combined virtual reality (VR), tennis and motion tracking in an attempt to replicate and expand on this foundational study on motor control. A tennis-inspired VR task was developed in Unity with realistic physics simulation to enable the characterization of forehand movement stereotypy within and across tracked features, and conditional on subject expertise and task demands. The task consisted of four phases, starting with only a proximal goal of simply hitting a virtual tennis ball and then progressing to nested goals with a distal component—hitting the ball such that it landed on specific court locations—with increasing precision requirements. In a pilot experiment, expert participants showed more stereotypical trajectories in the center of the racket stringbed than in any other tracked point, echoing Bernstein's original observations. Moreover, ball trajectories became more stereotypical as target locations became narrower, whereas racket movement stereotypy seemed to decrease. These preliminary findings comport with the minimum intervention principle[2], which posits that the nervous system stabilizes task-relevant performance variables rather than intermediate elemental variables. More generally, this work demonstrates VR's potential for studying the human motor system under complex and dynamic conditions without sacrificing experimental control[3].

Motor control, DoF Problem, Virtual Reality, Movement Stereotypy, Tennis, Minimum Intervention Principle