Project Details	
Project Code	NMH27Ca Zhou
Title	Neural Dynamics of Perceptual Decision-Making During Robot-Mediated Motor Learning
Research Theme	Neuroscience & Mental Health
Project Type	Dry lab
Summary	How does the brain make decisions while we are moving and learning? This PhD project will combine EEG, virtual reality and robotic platforms to investigate how perceptual decisions unfold during active movement and how these neural processes change through motor learning. Participants will interact with immersive environments while performing controlled reaching tasks, allowing brain activity, movement and behaviour to be measured simultaneously. The project will develop new insight into how the brain integrates perception, decision-making and action, with longer-term potential to inform personalised rehabilitation for neurological conditions.
Description	Everyday decisions are rarely made while sitting still. We decide where to reach, how to avoid obstacles and how to adapt our actions while already moving. Yet much of what is known about perceptual decision-making comes from highly controlled laboratory experiments in which participants remain stationary and report choices using simple button presses. This leaves an important gap in our understanding of how the brain forms decisions during natural movement, particularly when actions must adapt through learning. This project will investigate how perceptual decisions unfold during ongoing movement and how these neural processes change as people learn to interact with unfamiliar or changing environments. It will combine electroencephalography (EEG), immersive virtual reality and robotic movement platforms to measure brain activity, behaviour and movement simultaneously. A recently developed movement-compatible EEG platform by the PI will enable decision-related neural activity to be studied during active reaching, rather than only before or after movement. The key research question is: How does motor learning influence the neural dynamics of perceptual decision-making during ongoing goal-directed movement? Participants will perform reaching tasks while interacting with a robotic platform and an immersive virtual environment. Virtual reality will be used to systematically manipulate the information available to the participant, for example by changing target uncertainty, visual reliability or feedback about movement. The robotic platform will provide precise measurements of movement and, where appropriate, introduce controlled changes to the physical interaction. EEG will be used to quantify neural signatures associated with the formation of perceptual decisions. The project will address four main objectives. Objective 1: Establish a movement-based perceptual decision-making paradigm. The student will develop and validate an immersive reaching task in which participants make perceptual decisions while movement is already unfolding. This will provide controlled measures of decision accuracy,

	reaction time, reach trajectory, online corrections and learning across repeated trials. Objective 2: Characterise decision-related brain activity during active movement. The student will use EEG to investigate how neural signatures of perceptual decision formation change during reaching. Particular attention will be given to separating decision-related activity from movement-related variability and determining how neural measures relate to behavioural and robotic measurements. Objective 3: Determine how motor learning changes perceptual decision processes. The student will introduce a controlled learning manipulation, such as altered visual feedback or robotic perturbation, and examine how participants adapt over time. The project will test whether changes in neural decision dynamics accompany, precede or predict changes in movement performance. Objective 4: Develop computational models linking brain activity, behaviour and movement. The student will integrate EEG, kinematic and behavioural data to model individual learning trajectories. The aim will be to determine whether neural measures provide information about adaptation and decision performance beyond movement outcomes alone. The project is deliberately designed to allow substantial student ownership. The student will be able to shape the precise perceptual task, choose the most appropriate learning manipulation and determine which neural and behavioural features should be prioritised. Depending on the student's background and interests, the project may place greater emphasis on computational modelling, EEG analysis, immersive task design or robotic interaction. The student will also be encouraged to identify new research questions arising from the data and to develop an independent final study that extends the core project. The longer-term ambition is to establish a new framework for studying perception, decision-making and action under more naturalistic conditions. By understanding how neural decision processes change through movement and learning, the project could also provide foundations for future personalised rehabilitation approaches in neurological conditions where both decision-making and motor function are affected.
Can be completed part time?	No
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