Project Details	
Project Code	NMH27Ex Karl
Title	Using sleep-based memory cues to support recovery from stressful memories
Research Theme	Neuroscience & Mental Health
Project Type	Dry lab
Summary	Many people who experience trauma go on to develop PTSD, and while talking therapies are effective, not everyone fully recovers. We examine whether sleep can be used to improve trauma therapy. When we sleep, the brain naturally strengthens what we have learned during the day. Using a gentle sound played during deep sleep, linked to a therapy session, we aim to help the brain hold on to the progress made in therapy. The student will use wearable sleep technology that assesses the brain activity at home and explore why some people benefit more than others using cutting edge mathematical modelling.
Description	BACKGROUND Post-traumatic stress disorder (PTSD), the inability to recover from psychological trauma, affects between 3-19% of trauma survivors worldwide (Kessler et al., 2017). Trauma-focused therapies such as eye movement desensitisation and reprocessing (EMDR) are effective for many, but a considerable proportion of patients show only partial improvement, and PTSD itself is closely tied to disrupted sleep. Sleep in PTSD often shows altered REM and non-REM patterns, although no single objective sleep profile has been consistently identified (Koffel, Khawaja, & Germain, 2016). More importantly, sleep may influence treatment success rather than simply reflect symptom severity. While baseline sleep problems do not generally hinder trauma-focused therapy, improvements in sleep during treatment are associated with better clinical outcomes (Bottari et al., 2023). Consistent with this, studies of veterans and primary-care patients have found that gains in sleep quality during therapy predict lower PTSD severity later on (Park et al., 2025; Yap et al., 2025). This raises an appealing possibility: could sleep be used not just as an outcome to monitor, but as a tool to strengthen therapy itself? Targeted Memory Reactivation (TMR) offers one route in. During deep sleep, a sensory cue linked to something learned earlier can be quietly re-presented, nudging the brain to replay and consolidate that specific memory. Van der Heijden et al. (2024) provided the first test of TMR in PTSD. Following a single EMDR session, replaying the EMDR click cue during sleep increased slow oscillation and spindle activity, which was associated with greater PTSD symptom reduction compared with sham stimulation. Sleep was not disrupted, supporting TMR as a promising proof of concept that now requires testing across multiple nights and in home-based settings. Furthermore, mathematical modelling of sleep EEG has the potential to improve our understanding of the physiological mechanisms (e.g. changes in synaptic connectivity) that underpin observed differences in brain dynamics (Dunstan et al., 2025). KEY RESEARCH QUESTION Can targeted memory reactivation, delivered over multiple nights using wearable EEG, strengthen the effects of trauma-focused therapy in PTSD, and can patients' sleep help identify who is most likely to benefit?

	OBJECTIVES Objective 1: Building directly on van der Heijden et al. (2024), design and pilot a multi-night TMR protocol delivered after trauma-focused therapy sessions, using a wearable, home-based EEG system so that reactivation can be repeated across a full course of treatment rather than a single night. Objective 2: Compare patients who receive cued reactivation with those who receive the same therapy without cueing (or with sham cueing), looking at PTSD symptom change, the sleep markers of consolidation identified in the original trial, and whether any benefit is maintained at follow-up. Objective 3: Track patients' sleep across the course of treatment and test which features predict who responds best to TMR, building on findings that sleep quality change tracks treatment outcome more broadly (Bottari et al., 2023; Park et al., 2025; Yap et al., 2025), and asking whether more specific physiological markers can sharpen this prediction. Objective 4: Use mathematical models of EEG (neural mass models) to interpret physiological markers in terms of changes to underlying brain architecture (Dunstan et al., 2025), and to develop model-based predictors of treatment response. Objective 5: Assess how practical, safe, and acceptable repeated home-based TMR is for patients, including adherence and data quality, since this will determine whether the approach could realistically move from a single-night proof of concept towards routine care. AREAS FOR STUDENT OWNERSHIP The framework above leaves real room for the student to shape the project. Decisions about the precise TMR protocol, including cue design, timing relative to therapy, and number of nights, will be worked out with both supervisors, drawing on PL's expertise in sleep-based memory reactivation and AK's clinical and EEG/psychophysiology expertise. Which sleep and physiological markers to prioritise for predicting treatment response is also open, and the student can lean this towards a more mechanistic or a more clinically predictive angle depending on their own interests and what the early data suggest. The choice of clinical population and treatment setting has flexibility built in, and the student will be encouraged to build their own collaborations in addition to the Exeter MDC AccEPT clinic, for instance with local clinical services (Talkworks within Devon Partnership Trust, Cardiff Trauma Clinic) and data science expertise for handling wearable EEG data at scale under MG's supervision. Identifying which patient characteristics predict TMR benefit is deliberately left as an open question for the student to develop as their own line of enquiry within the wider project.
Can be completed part time?	Yes
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