Project Details	
Project Code	MRC23NMHEx Tsaneva-Atanasova
Title	Identifying the neurobiological signatures of multisensory processing of emotional information to establish biomarkers for anxiety and post-traumatic stress disorder
Research Theme	Neuroscience and Mental Health
Summary	Mathematical modelling and data analysis provide powerful tools to identify features of brain electrical activity along with other physiological signals. This PhD project will develop network physiology approaches to integrate available experimental data and enable classification of emotional states and responses. The ultimate goal is to define digital biomarkers for anxiety and post-traumatic stress disorder (PTSD).
Description	Individuals with post-traumatic stress disorder (PTSD) show altered emotion regulation (either an inability to manage overwhelming emotions or emotional numbing) and interpersonal difficulties such as lack of trust and social isolation (Cloitre et al., 2005). It has been suggested that altered processing of facial (e.g. Shin et al., 2005) or verbal (prosody) socio- emotional cues (Nazarov, 2015) may contribute to an individual's ability to effectively regulate affective states and interact with others. An analogue study in individuals with elevated dispositional anxiety levels (Koizumi et al., 2011) suggest that both anxiety and stress also impact multisensory integration in a way that amplifies processing of negative threat-related cues and attenuating positive emotional cues. Hence, altered multisensory processing may provide a useful target area for potential interventions to help improve both sensory and socio-emotional processing. Our recently graduate GW4 BioMed PhD student, Naomi Heffer, has begun to explore multisensory integration in anxiety (Heffer et al., 2022) and PTSD by collecting multi-modal experimental data over the course of her PhD project (September 2018 – July 2022). Now, we would like to leverage the data collected during Naomi's project to explore AI approaches to identifying the neurobiological signatures of multisensory processing of emotional information and establish biomarkers for anxiety and PTSD. Specifically, in this project we propose to analyse complex, multi-modal datasets of simultaneously recorded electroencephalogram (EEG), heart rate and skin conductance collected in patients with PTSD as well as healthy control subjects. To achieve this, we aim to: 1) Analyse the data sets using statistical/data analysis (Year 1/1.5) a. The student will start with analysing each modality in the data separately, i.e. only the EEG data; only heart rate time series, etc. This will enable the student to gain expertise and experience in time series analysis techniques such as spectral analysis, microstates analysis, etc. b. Develop a data-driven predictive models to discriminate between healthy individuals and patients based on individual modality. This will enable the student to learn machine and statistical learning techniques and explore the identification of single modality biomarkers for anxiety and PTSD. 2) Develop network physiology approaches for multi modal integration of time series data (Year 1/2.5) a. Derive networks composed of multi-modal data to investigate the interactions between brain activity and physiological responses such as heart rate. This will enable the student to learn and gain expertise in the emerging field of

	network physiology (Plamen Ch. Ivanov 2021). b. Analysing networks compound of different interacting physiological signals and systems, such as the brain and the heart, with different dynamics is highly challenging. Because they consist of different systems with their own complexity and different aspects of network activity and connectivity. The output will be a data-driven methodology for multi-modal data integration tailored to mental health applications. 3) Identify multi-modal biomarkers of anxiety and PTSD at individual (or patient-specific) level (Year 2/3.5) a. This analysis will include state-of-the-art statistical methods designed to determine the individual signatures of the dynamic and interacting physiological systems which might underpin different degrees of anxiety and PTSD (Słowiński et al., 2016). Prof. Tsaneva-Atanasova has previously done this with high specificity and precision using the kinematic signatures of individuals who have been diagnosed with schizophrenia (Słowiński et al., 2017). b. The output of this aim will be an integrated framework for employing multi-modal physiological data in predictive modelling for mental health applications.
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