Mental and psychosomatic disorders are not just rising, they are becoming one of the defining public health challenges of the 21st century. According to the last World Health Organization report, one in eight people worldwide now lives with a mental disorder. Our research will focus on a conditions called psychosomatic disorders (PD), where people experience troubling physical symptoms without a clear medical cause. Psychosomatic disorders affect approximately 8% of the global population. In primary care, up to 30% of patients present with medically unexplained physical symptoms often linked to underlying psychological distress. These disorders are difficult to treat, costly, and frequently resistant to conventional pharmacological or psychotherapeutic approaches .

This project explores how the brain perceives signals from inside the body, like heartbeat or breathing. Additionally how problems in this process may contribute to a wide range of mental and psychosomatic health problems, such as chronic fatigue, unexplained pain, or digestive issues. The scientific term for this ability is interoception, and recent research shows that when interoception goes wrong, it may play a key role in disorders like anxiety, depression, or psychosomatic conditions. Yet, one important aspect remains poorly understood: the time course of interoception - how the brain processes these bodily signals moment by moment.

These cases offer a unique opportunity to study how the brain's internal monitoring system might become disrupted. We are particularly interested in predictive coding, a theory that suggests the brain is constantly making predictions about bodily states and comparing them with actual signals from the body. When this process goes wrong, people may misinterpret normal bodily signals as signs of illness or danger. That is, the key problem in psychosomatic disorders.

Using brainwave recordings (EEG), heart rhythm data, behavioral tasks, and computer modeling, we will study how interoceptive signals proceed in time, are processed in the brain, and how this may differ in people with psychosomatic disorders. We will use two different EEG biofeedback methods - techniques that allow participants to see and gradually adjust their own brain activity. One of these methods allows changes in the communication of deeper brain structures by normalizing them relative to the healthy population. Causing overall positive changes in cognitive and emotional functioning. The other is closely related to the processing of a signal from inside the body - the heartbeat. It affects structures inside the brain directly related to interoception. We will compare their effects on brain responses, symptom awareness, and physiological markers. Comparing the impact of these two methods will allow us to isolate changes directly related to information processing from inside of the body. By doing this, we aim to learn more about the flexibility, or plasticity, of interoceptive processing in the brain.

Our approach combines cutting-edge methods from neuroscience, psychology, and data science, including machine learning to analyze large and complex datasets. The expected results include new insights into the timing and communication between key brain regions involved in interoception and how this processing might be disrupted.

Beyond its relevance for psychosomatic disorders, this research could help explain how the brain-body connection contributes to a wide range of psychological states. To support open science, all protocols and tools developed in the project, including source code, will be shared publicly. This will allow other researchers and institutions to use our work to adapt it to other research questions or other patient populations. We want to help accelerate advances in neuroscience and mental health research.