

 <p><b>UniSR</b> Università Vita-Salute San Raffaele</p>	<p><b>APPLICATION TO ACT AS SUPERVISOR AND RESEARCH PROJECT PROPOSAL</b></p>	<p><b>MO 20-5</b> ed. 02 of 16/01/2026 PO 20 Page 5 of 12</p>
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**PROJECT**

**Supervisor:** Dr. Elisabetta Sarasso

**Title:** Integrated technological assessment of freezing of gait in Parkinson’s Disease: a multidimensional perspective

**Curriculum:** Cognitive and Behavioural Sciences

Link to the personal page of the University or relevant hospital site website: <https://research.hsr.it/en/institutes/institute-of-experimental-neurology/neuroimaging-research/elisabetta-sarasso.html>

**Description of the Project (max 3,000 characters including spaces)**

**Background/gap of knowledge**

Freezing of gait (FoG) is a disabling and multidimensional phenomenon commonly observed in Parkinson’s disease, yet its underlying mechanisms remain poorly understood. Current evidence suggests that FoG arises from altered interactions between motor, cognitive and behavioural networks, which may explain its heterogeneous clinical presentation in terms of triggers and patterns. However, most neuroimaging studies rely on MRI paradigms in which FoG cannot be directly observed during natural gait and is instead inferred through surrogate tasks performed inside the scanner. Moreover, the current gold standard for FoG evaluation requires expert video-analysis of FoG-provoking tasks, a time-consuming and operator-dependent procedure. Therefore, there is a need for more ecological paradigms capable of reliably eliciting FoG and for objective, automated methods to detect and quantify FoG episodes.

**Rationale and hypothesis**

Mobile neuroimaging techniques such as functional near-infrared spectroscopy (fNIRS) and electroencephalography (EEG) enable the investigation of brain activity during real walking tasks. Their integration with electromyography (EMG) and wearable inertial sensors could allow the simultaneous acquisition of neural and motor signals associated with FoG. We hypothesize that combining ecological FoG-provoking tasks, potentially enhanced through virtual reality environments, with multimodal signal acquisition will allow the identification of objective signatures of FoG and potential biomarkers preceding its onset.

**Objectives and specific aims**

The main objective of this project is to develop and validate an integrated framework for the ecological assessment and automated detection of FoG. Specific aims are:



1. to develop and validate standardized tasks capable of reliably eliciting FoG, including the implementation of virtual reality scenarios reproducing real-life triggering conditions (e.g., dual-tasking, time pressure, anxiety-related contexts);
2. to acquire synchronized multimodal signals (EMG, inertial sensors and fNIRS/EEG) during these tasks;
3. to characterize the motor and neural signatures associated with FoG episodes through integrated signal analysis;
4. to develop and validate machine-learning algorithms capable of automatically detecting FoG and potentially predicting its occurrence.

**Expected outcomes**

This project is expected to provide standardized and more ecological paradigms for FoG assessment, as well as objective multimodal biomarkers of FoG occurrence. The development of automated detection and prediction algorithms could improve clinical evaluation and enable scalable assessment tools. Ultimately, these findings may contribute to a better understanding of FoG mechanisms and inform targeted therapeutic interventions, including physiotherapy and neuromodulation, also providing objective outcome measures for treatment efficacy.

**Skills that the student should acquire** (max. 600 characters including spaces):

The student will acquire interdisciplinary skills in clinical and translational neuroscience, including the design of ecological experimental paradigms for gait assessment and FoG elicitation. He/she will gain expertise in multimodal data acquisition using wearable technologies (EMG, inertial sensors, EEG/fNIRS) and in signal processing and integration of neural and motor data. The student will also develop competencies in machine learning for automated detection and prediction of FoG, as well as skills in data analysis, scientific communication and research project management.

**References** (max. 15)

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