ICFO



# PhD THESIS DEFENSE: Hybrid diffuse optics methods to assess the emergence of dementia in older adults

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10:00

Elements Room and Online (Teams)

Hybrid diffuse optical devices offer a non-invasive and continuous and cost-effective method for monitoring cerebral blood flow and metabolism on the bedside use and realistic simulation applications. The incorporation of diffuse correlation spectroscopy (DCS) and near-infrared spectroscopy (NIRS) in these devices extends their versatility. This PhD project focused on utilizing diffuse optics to assess brain activity during functional and stress tests in older populations.

Ageing is the primary risk factor for various brain conditions such as stroke, cognitive disorders, and mobility issues. As the population becomes increasingly older, these age-related pathologies are becoming a significant social and economic burden. The underlying assumption is that microvascular damage and changes in brain blood flow

regulation contribute significantly to an increased risk of cerebrovascular diseases, cognitive and mobility disorders. This underscores the importance of creating a widely accessible monitoring system and associated protocols able to detect these changes early on, ultimately leading to personalised interventions. Two multi-disciplinary studies were performed during my doctorate studies to identify alterations in the haemodynamic parameters of older adults in response to existing pathologies.
Microvascular cerebral blood flow (CBF) in a cohort of younger and older adults (>65 y.o.) with and without mild cognitive impairment (MCI) in overall good health was monitored during functional and stress tests. It was observed that CBF of older adults with MCI could not recover to baseline conditions compared to younger participants indicating possible autoregulation and vasoreactivity problems similar to those previously observed in chronic sleep apnea and chronic carotid stenosis patients. CBF measurements during functional cognitive tasks revealed gender differences. For a given test MCI participants presented a statistically higher response than normocognitive (NC) subjects. The combination of these results favour the "inefficiency hypothesis" that suggests that older adults activate the brain networks as NC individuals to cope with behavioural demands but with increased activity.
? A new hybrid diffuse optics device was developed combining a custom-made fast-DCS with a commercial NIRS device along with external devices for physiological signal recordings n the second study. The project aimed to measure changes in cerebral haemodynamics n older adults with Motoric Risk Syndrome (MCR) during functional cognitive and motor tas s protocols to evaluate the pre-post impact at 3 and 6 months of physical exercise alone r combined with transcranial direct current stimulation (tDC). Results revealed higher CBF b t not oxy-haemoglobin (HbO2) responses in dual tasks (DT) compared to single (ST). The e were no differences between groups at baseline and 3 months but statistically differe t responses in CBF were observed at 6 months for both intervention groups compared to t e control group but not in HbO2 response, indicating that intervention affects CBF respon e possibly due to improvements of vascular health, highlighting the importance of physic l activity and transcranial stimulation on the maintenance of vascular healt
. A big part of my research focused on the development of new algorithms f r de-contaminating the measured data from extracerebral signal to develop an optimal mod l to minimise the effect for both studie
. In summary this study proves the capability of hybrid optics to capture the evok d haemodynamic responses in the pre-frontal cortex and offers insights into the use f techniques to assess cognitive function in older adults, specifically those with MCI and MC . The findings highlight the complex relationship between blood flow responses and cogniti e activities suggesting that compensatory mechanisms may play a role in individuals faci g cognitive challenges. Future research in these areas holds promise, for enhancing o r understanding of decline and developing interventions to mitigate its impac

**Friday May 03, 10:00 h. ICFO Elements Room and online via Teams**

**Thesis Director: Prof Dr. Turgut Durduran**

**Hosted by:** Academic Affairs