PhD Thesis Proposal Form
China Scholarship Council (CSC)/ENS Rennes
Call for projects 2023

FIELD: Health Psychology

THESIS SUBJECT TITLE
Unraveling the neurobiological mechanisms underlying the detrimental effects of sedentary time on cognitive function and health (NEUROSED)

Name of French doctoral school: ELICCE (to be confirmed)

Name of research team: 2SEP department, ENS Rennes, laboratory VIPS2

Name of French Supervisor: Cheval Boris

Name of PhD director-s in Chinese university (if applicable):

- Name: Liye Zou
- Position: Associate Professor
- E-mail: liyezou123@gmail.com

If previous collaborations with the Chinese co-director/university, please elaborate:
We have conducted numerous research with Professor Zou. Currently, we have published 11 peer-reviewed articles and three in progress, mostly related to the effects of physical activity and sedentary behaviour on cognitive health. This joint PhD is an ideal opportunity to explicitly structure our current relationship on an administrative level. It will also be an opportunity to develop a mid-term project aimed at providing new insights into the effects of sedentary behaviour on cognitive function using state-of-the-art methods and tools.

Type of PhD track: please tick the appropriate box:

- ~~Joint PhD/cotutelle (leading to a double diploma) : YES or NO~~
- ~~Regular PhD (leading to a single French diploma) : YES or NO~~
- Research residency visit (for students enrolled at a Chinese institution who will be invited to a French institution to carry out a mobility period): YES ☑ ~~or NO~~

Research proposal abstract (1500 words max.):

Worldwide, the number of people with dementia is estimated at 35.6 million, with one new case every 4 seconds.[1,2] Thus, promoting cognitive health across aging is a public health priority,[1] and non-pharmacological lifestyle interventions are central to this promotion.[2] Specifically, adopting a physically active lifestyle is considered to protect against cognitive decline and dementia as physical activity is positively associated with brain health in older age.[3-8] Sedentary behavior is characterized by an energy expenditure of 1.5 metabolic equivalent of task (MET) or lower while sitting, reclining, or lying down.[9] The effects of sedentary behavior on physical health have shown to be independent from the effects of physical inactivity (i.e., not meeting the recommendations on physical activity)[9] and include obesity, metabolic syndrome, type 2 diabetes, cardiovascular disease, and cancer.[10-15] However, the effect of sedentary behavior on cognitive health is less clear.[16-18] For example, while a recent review reported a relationship between higher sedentary behavior and lower cognitive functioning[16], another review found inconclusive evidence of such relationship.[17] The overall aim of this dissertation is to investigate the potential causal relationship between sedentary behaviour and cognitive function. An additional goal will be to examine the extent to which the type of sedentary behaviour (i.e., more cognitively demanding such as reading a book versus less cognitively demanding such as watching television) may moderate the impact of sitting time on congruent performance.

To achieve these objectives, the project will be structured into 3 work packages. WP1 is based on a series of experimental studies using a virtual reality (VR) environment integrated with state-of-the-art methods for recording brain (EEG and fNIRS) and autonomic activity (e.g., electrodermal activity, heart rate, pupil dilation) to elucidate the neurobiological mechanisms that may underlie the effects of different type of sedentary behavior on multiple dimensions of cognitive function. In addition, biological data (e.g., insulin) will be evaluated to determine the extent to which substances released during prolonged sitting may explain the negative effects of sedentary time on cognitive function. Note that these cutting-edge tools have recently been funded with the *Chaire Rennes Métropole* and are also available in the Chinese site. Moreover, to ensure state-of-the-art approach to capture these biological data, the team of physiologist at the M2S laboratory will be involved. Through a cross-sectional and intensive longitudinal approach, WP2 will assess the detrimental effect of regular engagement in sedentary behaviors on people cognitive health, but also physical and mental health. The WP2 will also aim to better understand the key factors underlying the regular engagement in sedentary behaviors. Based on these findings, WP3 will co-construct and evaluate the effectiveness of an intervention aimed at reducing prolonged sitting during both work and leisure time. Cross-cultural comparisons of key determinants and intervention effectiveness will be conducted.

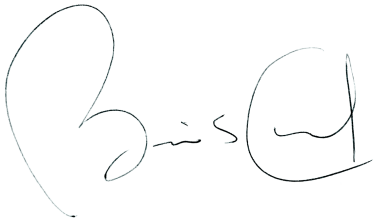
This project will provide new insights into the types of sedentary behaviors that may have detrimental effects and the neurobiological mechanisms that may underlie these effects. Importantly, this project will pave the way for the development of innovative and co-constructed interventions to reduce prolonged sedentary time and, in turn, improve people's cognitive function and health.

Publications of the laboratory in the field (max 5):

- Cheval, B., & Boisgontier, M. P. (2021). The theory of effort minimization in physical activity (TEMPA). *Exercise and Sport Sciences Reviews, 49*, 168-178.
- Cheval, B., Darrous, L., Choi, K., Klimentidis, Y.C., Raichlen, D.A., Alexander, G.E., Cullati, S., Kutalik, Z., & Boisgontier, M.P. (2023). Genetic insights into the causal relationship between physical activity and cognitive functioning. *Scientific Reports*, *13*, 5310.
- Pierre N, Appriou Z, Gratas-Delamarche A, *Derbré F*. From physical inactivity to immobilization: dissecting the role of oxidative stress in skeletal muscle insulin resistance and atrophy. *Free Rad Biol Med*. 2016 Sep;98:197-207.
- Taylor A, Kong C, Zhang Z, Herold F, Ludyga S, Healy S, Gerber M, Cheval B, Pontifex M, Kramer AF, Chen S, Zhang Y, Müller NG, Tremblay MS, Zou L. Associations of meeting 24-h movement behavior guidelines with cognitive difficulty and social relationships in children and adolescents with attention deficit/hyperactive disorder. Child and Adolescent Psychiatry and Mental Health.2023
- Zou L, Herold F, Ludyga S, Kamijo K, Müller NG, Pontifex MB, Heath M, Kuwamizu R, Soya H, Hillman CH, Ando S, Alderman B, Cheval B, Kramer AF. (In Press) Look into my eyes - What can eye-based measures tell us about the relationship between physical activity and cognitive performance? Journal of Sport and Health Science

Date: 16.10.2023

Signature of the French Supervisor:



References:

1 WHO. Dementia: a public health priority. Geneva, Switzerland, 2012. **112** (2012).

2 Maasakkers, C. M. *et al.* The association of sedentary behaviour and cognitive function in people without dementia: a coordinated analysis across five cohort studies from COSMIC. *Sports Med* **50**, 403-413 (2020).

3 Ten Brinke, L. F. *et al.* Aerobic exercise increases hippocampal volume in older women with probable mild cognitive impairment: a 6-month randomised controlled trial. *British journal of sports medicine* **49**, 248-254 (2015).

4 Hamer, M., Terrera, G. M. & Demakakos, P. Physical activity and trajectories in cognitive function: English Longitudinal Study of Ageing. *Journal of Epidemiology and Community Health* **72**, 477-483 (2018).

5 Cheval, B. *et al.* Genetics insights into the causal relationship between physical activity and cognitive functioning. *Scientific Reports, 13,* 5310 (2023).

6 Baumgart, M. *et al.* Summary of the evidence on modifiable risk factors for cognitive decline and dementia: a population-based perspective. *Alzheimer's and Dementia* **11**, 718-726 (2015).

7 Norton, S., Matthews, F. E., Barnes, D. E., Yaffe, K. & Brayne, C. Potential for primary prevention of Alzheimer's disease: an analysis of population-based data. *The Lancet Neurology* **13**, 788-794 (2014).

8 Piercy, K. L. *et al.* The physical activity guidelines for Americans. *Jama* **320**, 2020-2028 (2018).

9 SBRN. Sedentary Behaviour Research Network. Letter to the editor: standardized use of the terms" sedentary" and" sedentary behaviours". *Applied Physiology, Nutrition, and Metabolism* **37**, 540-542 (2012).

10 Ford, E. S. & Caspersen, C. J. Sedentary behaviour and cardiovascular disease: a review of prospective studies. *International journal of epidemiology* **41**, 1338-1353 (2012).

11 Hamilton, M. T., Hamilton, D. G. & Zderic, T. W. Role of low energy expenditure and sitting in obesity, metabolic syndrome, type 2 diabetes, and cardiovascular disease. *Diabetes* **56**, 2655-2667 (2007).

12 Owen, N., Healy, G. N., Matthews, C. E. & Dunstan, D. W. Too much sitting: the population-health science of sedentary behavior. *Exercise and sport sciences reviews* **38**, 105 (2010).

13 Ekelund, U. *et al.* Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A harmonised meta-analysis of data from more than 1 million men and women. *Lancet* **388**, 1302-1310 (2016).

14 Ekelund, U. *et al.* Do the associations of sedentary behaviour with cardiovascular disease mortality and cancer mortality differ by physical activity level? A systematic review and harmonised meta-analysis of data from 850 060 participants. *British journal of sports medicine* **53**, 886-894 (2019).

15 Ekelund, U. *et al.* Joint associations of accelero-meter measured physical activity and sedentary time with all-cause mortality: a harmonised meta-analysis in more than 44 000 middle-aged and older individuals. *Br J Sports Med* **54**, 1499-1506 (2020).
16 Falck, R. S., Davis, J. C. & Liu-Ambrose, T. What is the association between sedentary behaviour and cognitive function? A systematic review. *British journal of sports medicine* **51**, 800-811 (2017).
17 Olanrewaju, O., Stockwell, S., Stubbs, B. & Smith, L. Sedentary behaviours, cognitive function, and possible mechanisms in older adults: A systematic review. *Aging Clinical and Experimental Research*, 1-16 (2020).
18 Saunders, T. J. *et al.* Sedentary behaviour and health in adults: an overview of systematic reviews. *Applied Physiology, Nutrition, and Metabolism* **45**, S197-S217 (2020).