**University of Leicester**

**BBSRC MIBTP Studentship Project 2024-5 entry.**

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| **Project Reference** |  |

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**Section 2 – *Project Information***

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| **Project Title** | An assessment of the effects of healthy ageing and transcranial Direct Current Stimulation (tDCS) on human foraging cognition  |
| **Project Summary**  |
| Identifying cognitive markers of human heathy ageing is of extreme importance considering that global population over age 65 is expected to increase by 120% by 2050. Nonetheless, there are inconsistencies in our understanding of the cognitive correlates of ageing in humans. Different tests, allegedly measuring similar functions, can produce conflicting results and it is becoming clear that ecologically valid tasks afford the most accurate detection of cognitive changes in healthy ageing. One reason for this is that ecologically valid tasks enable the expression of accumulated learning in task specific situations, life experience and crystallised abilities that are preserved with ageing, whereas working memory and the ability to acquire new information is compromised. This account is consistent with evolutionary explanations of the age-related reduction in brain metabolism observed in heathy older individuals. Brain functions underpinning efficient foraging are central to these explanations. Processes resulting in the reduction of brain metabolism would be adaptive when the requirement of learning new environments and regularities in resource availability in support of foraging is reduced because of the experience accumulated by ageing individuals. Metabolism reducing processes start early in adulthood and, although functional when the lifespan of individuals was much shorter, their progress leads to a dysfunctional level of cognitive decline in modern living conditions with considerably increased life expectancy. This project will involve a series of experiments where the performance of a sample of younger individuals (below 35 years of age) is compared with that of older individuals (above 65) in touch screen and immersive virtual reality based foraging tasks. Further experiments will involve other age groups across adult human lifespan. In these tasks, coloured targets of different shapes represent different species of trees that can yield fruit rewards according to specific spatiotemporal and probabilistic patterns depending on the conditions of specific experiments. Uniquely, the tasks afford the measurement of a number of cognitive functions implicitly contributing to foraging efficiency defined as the number of targets visited before all the available resources are depleted. These include: 1) working memory for targets selected within a given foraging bout to prevent revisits of locations where resources have been already depleted; 2) long-term memory for targets that do not yield reward across foraging bouts and that should be avoided;  3) the ability to detect, monitor and exploit temporal and probabilistic regularities with which targets yield fruit rewards; and  4) the ability to encode the spatial location of targets despite the presence of competing visual information.  This project will determine which of these ecologically valid and evolutionary relevant measures of cognitive function change with normal ageing and are affected by single and multiple brain stimulation sessions. This study will identify cognitive markers of heathy ageing and determine the conditions under which non-invasive, non-pharmacological interventions can slow or reverse cognitive decline Techniques that will be undertaken during the projectThe techniques used for this study comprise computerised cognitive testing paired with non-invasive brain stimulation (transcranial direct current stimulation, tDCS). Participants of different age groups will be tested using simulated foraging tasks implemented using touch-screen and virtual reality environments. The same number of participants within each age group will be assigned to a tDCS stimulation condition and a sham condition according to a between subject design. Depending on the specific experiments, repeated measure procedure will be used as well, with participants receiving both tDCS and sham stimulation in separate testing sessions. Stimulation procedure and tDCS parameters will be those that proved effective in pilot tests carried out by the supervisors and which showed an enhancement of working memory capacity following anodal stimulation to the left Dorso-Lateral Prefrontal Cortex. The foraging tasks will immediately follow tDCS (or sham) stimulation. A difference between age groups in the sham condition would indicate an age effect on the functions assessed. A difference between tDCS and sham condition for participants within the same age group would reveal an effect of brain stimulation and confirm the involvement of DLPFC in these functions. The pattern of interactions between age groups and tDCS/sham conditions will reveal the extent to which tDCS can compensate for decline in the functions assessed. Anodal stimulation of other areas such as the right DLPFC and parietal cortex will also be used to assess the specific involvement of these different brain areas in the functions assessed. Data analyses will comprise ANOVA models and trend analyses carried out using statistical packages such as JASP 0.18.0.  |
| **References** |
| Roncero et al., (2023) A person with frontotemporal dementia shows increased metabolic rate across multiple brain regions after a series of tDCS sessions. *Brain Stimulation*, 16: 828-829 Reser, J.E. (2009). Alzheimer's disease and natural cognitive aging may represent adaptive metabolism reduction programs. *Behavioral and Brain Functions*, 5: 13 Talbot, S. Gerdjikov, T. & De Lillo, C. (2021). Two variations and one similarity in memory functions deployed by mice and humans to support foraging. *Quarterly Journal of Experimental Psychology* 1–15. |

**To apply please refer to**

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