The study investigates compensatory brain activity in older adults and the possibility of influencing it through cognitive training.

Studies show that with age human cognitive functioning become less effective. Aging is usually associated with a decline in mental abilities, such as memory, attention, and thinking. Behavioural changes follow the changes at the brain level, which are concern both the structure of the central nervous system as well as its function. However, changes in brain functioning that emerge with age can have also a positive effect on one's cognitive abilities. New patterns of brain activity that develop in late adulthood in order to counter negative effects of aging are called brain compensatory activity. Its main mechanism is based either on the intensification of brain activity in certain areas, as compared with young adults, or on the engagement of additional brain regions. Such brain activity is considered compensatory because research shows that older adults that exhibit these patterns of activity tend to score higher on cognitive tests.

There are two important aspects in which the present project will allow to enrich our understanding of compensatory brain activity in older adults.

First, in the studies that have been conducted so far the compensatory brain activity in older adults was investigated primarily with the use of the functional magnetic resonance (fMRI) or positon emission tomography (PET). In order to identify compensatory activity in our study we will use electroencephalographic markers (observable in EEG). It will allow to confirm the assumptions about compensatory brain activity relying on new data, as in EEG research the brain markers of the same cognitive processes are different from those used in fMRI and PET research.

What is more, in the studies conducted so far brain activity in older adults was only registered and interpreted, whereas the present study additionally adds the training component. The aim of our study is to see if it is possible to influence the compensatory brain activity through cognitive functions training, relying on working memory training. Theoretically, such a training should optimize brain activity in older adults, namely evoke compensatory brain activity during difficult tasks in order to make them easier, whereas in the case of easy tasks it should lead to the disappearance of the need to trigger compensatory activity. This assumption will be verified in an experimental setting.

The study will consist of two phases: a preliminary phase and an experimental phase. 150 volunteers will take part in the study, including 75 older adults (60-75 years old) and 75 young adults (20-35 years old). The participation of young adults in the project will allow to asses if the effects linked to compensatory brain activity are specific to a given age group.

The aims of the preliminary phase are to choose three different difficulty levels of the cognitive task that will be used in the experimental procedure and select a task for the active control groups. Additionally, in this phase the division of study participants into the experimental an control groups will be made. The division process is supposed to limit the influence of factors other than the experimental manipulation by providing maximal equivalence of the groups (within the same age group) in terms of cognitive abilities, i.e. ensuring that the groups will not be different in this regard.

In the experimental phase of the study, the participants will be divided into six groups: two experimental (the groups of young and old adults, 25 individuals in each group), and by analogy two active control groups and two passive (no-contact) control groups. The experiment was designed in the following way: (1) All groups will be subjected to pre-test measurements that will be EEG registration during a cognitive task execution at different difficulty levels; (2) Experimental groups will undergo working memory training. Over the period of 4 weeks participants in the experimental groups will take part in 12 training sessions. In the active control groups instead of the n-back training the practice of tasks which do not involve working memory will be introduced. Participants of the passive control groups will be awaiting post-test (no-contact control); (3) In all groups post-test measurements will be administered analogically to the pre-test measurements in order to assess changes in cognitive tasks performance and related brain activity.

The justification of such a project is its contribution to the development of knowledge on cognitive aging and possibilities to influence cognitive efficiency in older adults. The study will provide new insight into cognitive processes engaged in compensatory brain activity in late adulthood, and will allow to verify the assumption about a possible influence of cognitive training on this brain activity.

New insight into possible optimization of cognitive functioning mechanisms in older adults might additionally inspire applied research, and thus the present project may contribute in the future to improving cognitive interventions offered to older adults.