Study Protocol

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Contents

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1 Background

Falls is one of the major causes to serious injuries in older people. About one-third of the frail adults age over 65 will experience at least one fall a year when living in their own homes, and the fall rate is three times higher in older people who are residents of care homes [1], [2]. Identifying and reducing risk of falls in the elderly hence have been extensively studied to carry out appropriate therapeutic interventions for the fallers. Risk assessment tools are used for falls screening and falls management. A wide range of fall risk assessment tools are used to identify fall risks of older people who are dwelling in the community [3] or in care homes [4], [5].

Ageing and mental disorders lead to gait and cognitive impairments. Correlation between cognitive impairments and fall risks have been identified in existing studies. Both literature evidence was provided and trials of experiments were conducted to in the studies to prove that older people with cognitive impairment are entitled to higher fall risk [6]–[9]. These studies mainly focused on examining damaged or declined cognitive functions impacts on gait in older people, and their relations to falls. Since falling in older people happened mostly when gait and balance control is poor, risk factors related to gait variables were investigated [9]–[11]. Results from the studies ascertained that aspects of execution function including attention, processing speed and working memory in the cognitive domain are essential to control gait and postural tasks for human body. An appropriate intervention to improve cognitive function in older people therefore becomes a possibility to reduce the fall risk.

So far, many studies have developed fall prevention guidelines that recommend interventions including physical activity, medical alleviation and care facilitation for older people with higher fall risks [3], [4], [12]. Although cognitive decline is a target risk factor of falling for older adults, the guidelines provide fall risk prevention recommendations related to cognitive decline in a indirect and sparse manner. In fact, recent trial of studies provided evidence of beneficial effects on fall risk reduction using computer-based cognitive training, such as motor training [13], [14]. More specifically, older people improved gait to control postural sway as a result of enhancement in attention and cognitive processing speed by the cognitive training. As the studies proposed were not explicitly conclusive, result evidence from the existing studies encourages future work to be carried out. Considering fall risk reduction, present study will bridge the gap between fall risk and cognitive decline using brain-computer-interface.

2 Rationale

Falls in older people are major health care issue worldwide. An evidence-based review study suggested that over 50% of potential fall incidents happen on older people will be avoided if prevention interventions take place rigorously [15].

To date, emerging studies on the use of Brain-Computer-Interface(BCI) for cognitive training supported that BCI could strengthen neural plasticity by neurofeedback training(Add some reviews).

In particular, neurofeedback training applies BCI to change cognitive process and provide real-time feedbacks in either visual or acoustic form. The aim of the study is to investigate the performance of BCI approach on reducing fall risks in older adults. (Add more: in relation of relevant policy and literature bases?)

3 Theoretical Framework

A widely used therapy for improving cognitive function is electroencephalogram (EEG) based neurofeedback(NF) training. EEG based NF is a supportive training where the participant modulates his/her EEG activity based on real-time visual or auditory feedback from real world. Since EEG signals has been proved to expose one's intent and cognitive performance, expected EEG patterns transmitted from a healthy elderly could be the reference for a NF training. With repetitive volitional practice, reinforcement and sensory feedback,the participants will

learn to better control neural activity that imposes positive effects on cognitive functions and gait or balance control [16].

The last decade has seen the rapid ascent of non-invasive brain-computer-interface(BCI) technology for NF training. BCI provides communication between human brain and an external device. One randomized controlled study has showed the safety, usability, acceptability and efficacy of BCI intervention in older people [17]. Executive function, processing speed [18] and attention [19] enhancement using EEG based BCI NF training was proved to be effective in a number of studies. Non-invasive BCI intervention requires slighter and less-expensive implementation compare to conventional fall-prevention programmes such as physical therapy and reconstruction of living environment.

While NF training tasks are usually monotonous and repetitive, training tasks in the form of gaming are usually preferred. Game-like features in cognitive training can provide an intuitive rule to engage the participant which gives them self-efficacy [20]. This is to prevent the older participants from feeling demotivated or sleeping in the training session.

(Add more.. tbc)

4 Research Question/Aim

- **Research Question:** Can neuralfeedback training by BCI reduce risk of falls in older people by improving their cognitive function?
- **Present hypothesis:** Neuralfeedback training by BCI can reduce risk of falls in older people by improving cognitive function.

5 STUDY DESIGN and METHODS of DATA COLLECTION AND DATA ANALYIS

METHOD:

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