



Faculty of Cognitive Sciences and Human Development

**The Effect of Neurofeedback Training on Mild Cognitive Impairment
Elderly in Kuching Area**

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**Master of Science
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ABSTRACT

Neurofeedback training (NFT) is a self regulation technique that helps individual learns to control or change their brain activity. This study aimed to apply neurofeedback to enhance the cognitive performance in elderly with Mild Cognitive Impairment (MCI). Using Quantitative Electroencephalography (QEEG) to record and analyzed the brain rhythms patterns of elderly before and after neurofeedback, this study then focused on alpha wave in the neurofeedback training as it was positively associated with cognitive performance decline in elderly. Ten subjects were selected through convenience and purposive sampling after administration of MMSE and other instruments and then were assigned to experimental (NFT) and control group (no NFT). With 15 sessions of alpha neurofeedback, increase in alpha absolute power was rewarded while simultaneous suppression of theta and beta2 were done in experimental group. Results showed that after completion of neurofeedback, all subjects in experimental group learn to increase their alpha absolute power while mixed result was recorded for suppression of theta and high beta either at individual, inter and intra group level. Increase in absolute power in pre and post QEEG in inter (within group) and intra (between group) group level were significant in alpha rhythms except for at location T3T4 in intra group analysis. Cognitive enhancement was measured in terms of working memory (Digit Span & Arithmetic) & processing speed (Symbol Search & Coding) components test of WAIS-IV. Cognitive results in individual level revealed that pattern of increase and decrease of score was regular in experimental group with all of them shown increment in DS, AR and SS while for CD only 2 had lower score in post CD. In control group, the pattern of changes was not regular with few had increment in certain test than and some did not had changes in score at all. At grouped level, significant increment observed in DS and SS in experimental group only. These

results suggest that MCI elderly could learn to increase specific components of EEG activity that such enhanced activity may facilitate in working memory and processing speed enhancement.

Keywords: Neurofeedback training, quantitative electroencephalogram (QEEG), mild cognitive impairment (MCI), elderly, cognitive enhancement

Kesan “Neurofeedback” Ke Atas Warga Tua Yang Mempunyai Kecelaan Kognitif Ringan

ABSTRAK

“Neurofeedback” ialah satu teknik pengawalan sendiri yang membolehkan seseorang individu untuk mengawal atau mengubah aktiviti gelombang otaknya. Kajian ini bertujuan untuk menambahbaik prestasi kognitif warga tua yang mempunyai kecelaan kognitif (MCI) dengan menggunakan “neurofeedback”. Dengan bantuan “Quantitative Electroencephalogram” (QEEG) untuk merekod serta menganalisis gelombang otak warga tua sebelum and selepas “neurofeedback”, kajian ini memfokuskan kepada gelombang alpha kerana ianya berkait rapat dengan fungsi kognitif dalam kalangan warga tua. Sepuluh subjek yang dipilih melalui “convenience” dan “purposive sampling” selepas ditapis melalui MMSE dan instrumen lain dan seterusnya dibahagikan kepada kumpulan eksperimen dan kawalan. Semasa 15 sesi “neurofeedback”, kekuatan mutlak gelombang alpha dinaikan manakala gelombang theta dan beta2 dikurangkan untuk subjek kumpulan eksperimen. Selepas tamat sesi neurofeedback, semua subjek kumpulan eksperimen menunjukkan peningkatan kekuatan mutlak alpha di peringkat individu dan berkumpulan. Untuk theta dan beta2, keputusannya tidak seragam untuk kedua-dua peringkat. Peningkatan pada kekuatan mutlak pada QEEG pertama dan kedua adalah signifikan untuk gelombang alpha untuk analisis dalam kumpulan dan antara kumpulan (kecuali pada T3T4). Perubahan kognitif telah diukur menggunakan ujian komponen WAIS-IV yang merangkumi ujian “working memory” (“Digit Span” & “Arithmetic”) & “processing speed” (“Symbol Search” & “Coding”). Kenaikan atau penurunan pada skor adalah seragam untuk kumpulan eksperimental dengan kesemua subjek menunjukkan peningkatan pada DS, AR dan SS manakala untuk CD hanya dua dari lima menunjukkan penurunan skor di peringkat individu. Di peringkat kumpulan eksperimen, hanya DS dan

SS menunjukkan peningkatan signifikan. Keputusan kajian menunjukkan bahawa warga tua yang mempunyai kecelaan kognitif boleh menaikkan gelombang komponen EEG; alpha dan seterusnya perubahan tersebut mungkin sekali membantu memberi perubahan positif kepada “working memory” dan “processing speed”.

Kata kunci: *Neurofeedback, quantitative electroencephalogram (QEEG), kecelaan kognitif ringan, warga tua, perubahan kognitif*

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LIST OF ABBREVIATIONS

AD	Alzheimer's disease
ADHD	Attention deficit hyperactivity disorder
AMCI	Amnesic mild cognitive impairment
AP	Absolute power
APNA	Asia Pacific Neurofeedback Association
AR	Arithmetic
ARCD	Age related cognitive decline
BF	Biofeedback
CAMCOG	Cambridge Cognitive Examination
CD	Coding
CONT	Control
CSF	Cerebrospinal fluid
DS	Digit Span
EEG	Electroencephalography
EXP	Experimental
FDG-PET	Fludeoxyglucose positron emission tomography
FMRI	Functional Magnetic Resonance Imaging
GAD-7	Generalized Anxiety Disorder 7
ICA	Independent Component Analysis
MCI	Mild cognitive impairment
MMSE	Mini Mental State Examination

MRI	Magnetic resonance imaging
NF	Neurofeedback
NFT	Neurofeedback training
NIA-AA	National Institutes of Health (NIH) and the Alzheimer's Association
PAF	Peak alpha frequency
PHQ-9	Patient Health Questionnaire-9
PS	Processing speed
PSI	Processing Speed Index
QEEG	Quantitative electroencephalography
RCI	Reliable change index
s-LORETA	Standardized low resolution brain electromagnetic tomography
SMR	Sensory motor rhythms
SPSS	Statistical Package for the Social Sciences
SS	Symbol Search
WAIS-IV	Wechsler Adult Intelligence Scale-IV
WM	Working memory
WMI	Working Memory Index

LIST OF SYMBOLS

μV^2	Microvolt
Hz	Hertz

CHAPTER 1

INTRODUCTION

1.0 Introduction

The purpose of this research is to apply alpha neurofeedback (NF) protocol to enhance the cognitive performance in elderly with mild cognitive impairment (MCI). To achieve the goals of this research, electroencephalography or widely known as EEG; a non-invasive real time methods used to view and recording brain activity before applying neurofeedback (NF) training. Quantitative EEG or QEEG is a collection of quantitative approach designed to process EEG signals. Neurofeedback is one of neurotherapy methods for modifying brain function based on human brain neuroplasticity ability (Kropotov, 2010) in various condition including cognitively impaired elderly. Mild cognitive impairment (MCI) refers to a transitional stage between normal aging and dementia, specifically Alzheimer's disease (AD) in which mild cognitive loss is detectable through neuropsychological test but it is not capable enough to affect the individual's ability to carry out everyday activities(Ganguli et al., 2004; Kelley and Petersen, 2007; Petersen et al., 2001). MCI elderly has shown to display a decline in a few cognition aspects specifically in working memory and processing speed (Saunders and Summers, 2011). Application of neurofeedback in this study was applied on elderly with mild cognitive impairment because the brain activity of elderly showed a decrease in high frequency bands; particularly alpha (Luckhaus et al., 2008) while increase in low frequency bands; notably theta (Jelic et al., 2000). Extensive information on reasons to conduct this research is written in the next section of this chapter which including background of study, problem statement, objectives, operational definition and lastly on the significance of study.

1.1 Background of Study

Elderly of the age of 60 and above make up of 7.7% of the whole population in Malaysia and this number is expected to multiply up to 14.7% by 2030 (World Population Prospects, 2010). Cognitive performance of elderly will decline with age and this make them more susceptible to get age related cognitive impairment disease such as mild cognitive impairment and even worse it may lead to dementia (Baker et al., 2008; Rosdinom et al., 2011). The susceptibility for elderly to involve in such condition leads to various researches on how to slow down and combat the condition. Non-pharmacological approach such as neurofeedback training has caught researchers' attention to curb this problem. Neurofeedback training (NFT) is a self regulation technique that helps individual learns to control or change their brain activity (Frank et al., 2010) which has been proved to improve elderly cognitive performance (Angelakis et al., 2007; Becerra et al., 2012; Hanslmayr et al., 2005)

1.2 Problem Statement

Mild cognitive impaired elderly constitute a high-risk population for developing dementia, in particular Alzheimer's disease (Manly et al., 2008; Petersen, 2004). With the yearly increasing number in AD cases worldwide, MCI has become a serious issue to be investigated further to find ways to at least slowing its progression to AD (Alzheimer's Association, 2018). Researchers has been doing extensive work in characterizing MCI by using multimodalities imaging methods to identify the brain anatomy & physiology, brainwaves patterns and also cerebrospinal fluid (CSF) for quantification of specific proteins. In terms of pharmacological treatment, MCI patients will use cholinesterase inhibitors, the same drug prescribed to AD patients and vitamins consumption such as vitamin B, Vitamin E, and Omega-3 fatty acids (Vega and Newhouse, 2014).Non-