THE UNIVERSITY OF BRITISH COLUMBIA

Impact Report

Your support is advancing innovative treatments for Parkinson's disease.

Thank you.

For more information, please contact:

Pacific Parkinson's Research Institute
210 - 1095 West Pender Street
Vancouver, BC V6E2M6
Telephone: 604 681-5031
Email: ppri@telus.net

support.ubc.ca

BIOFEEDBACK AS TREATMENT FOR PARKINSON'S DISEASE

2017 IMPACT REPORT

Prepared for the Pacific Parkinson's Research Institute

February 2018

The UBC Faculty of Medicine and the Pacific Parkinson's Research Centre are grateful to the Pacific Parkinson's Research Institute and your community of donors for supporting research to deepen knowledge of the brainwave signature of Parkinson's and whether patients can use biofeedback to modify their thoughts to improve the status of their disease. Led by Dr. Martin McKeown, Professor of Neurology and Director of the Pacific Parkinson's Research Centre, this three-year project began with a pilot stage to develop computerized models of brain connectivity in people with Parkinson's and healthy controls. The research team has also begun to train study participants in different biofeedback strategies. We are pleased to present you with the following update on our progress so far, which is moving us closer to developing a new and likely appealing treatment option for many people with Parkinson's.

Progress Update

Research Assistant Emma Kiss wearing the wireless EEG headband. The headband uses Bluetooth to connect to a laptop (not shown) that runs the algorithms that decide what the participant sees on the monitor (seen here). The participant uses different forms of visual feedback to modulate their brain waves - in some trials the screen is blank, in others there is a bar graph, and in still others a checkmark or an x appears to inform the participant of their success (or not) modulating their brainwaves.

ABOUT BIOFEEDBACK

Also known as neuromodulation, biofeedback is the process in which people learn to control their own autonomic bodily functions such as heart rate, blood pressure, and brain waves, using real-time recordings displayed back as a visual representation on a computer screen. Recent research has shown that patients and healthy controls can manipulate their brain function through biofeedback using electroencephalography (EEG) and functional magnetic resonance imaging (fMRI).

Biofeedback presents a unique possibility as a treatment for Parkinson's disease because the training is non-pharmacological and non-invasive, thus avoiding potential negative side-effects associated with deep brain stimulation, surgery, or medications. Recently, movement-based biofeedback has been successfully used in the treatment of posture in Parkinson's, however EEG biofeedback used to treat Parkinson's disease remains largely unstudied. For this reason, we have chosen to investigate EEG biofeedback in Parkinson's.

RESEARCH OBJECTIVES

This research has three main objectives:

1) To determine if people with Parkinson's can manipulate their own EEG (brain-wave) signal using real-time biofeedback and a variety of different modulation strategies

2) To determine whether a predictable relationship exists between EEG brain rhythms and cardinal Parkinson's symptoms (as measured by standard clinical tests)

3) To determine which strategies best aid in modulating one's own EEG

PROGRESS IN YEAR 2

This year we completed the first stage of the project, which was a pilot study that recorded the resting EEG of 8 subjects (4 healthy controls and 4 with Parkinson's). This enabled us to develop computerized models of brain connectivity to predict the brain waves of healthy controls and Parkinson's patients.

We are now working on the second stage of the project, which involves a 3-week biofeedback training program using the model of healthy brain waves as a target for those with Parkinson's. We are currently recruiting at least 25 subjects with Parkinson's and collecting data from them using a custom-designed wireless, 6-electrode, dry EEG system. Each subject visits the Djavad Mowafaghian Centre for Brain Health 3 times for training with different biofeedback strategies and an assessment to determine which strategy works best for them. The subjects train at home twice daily with this strategy and are assessed at each subsequent visit to determine whether the training was effective.

Using preliminary data, we have determined that common spatial pattern (CSP) algorithms can be used to substantially lower the variability of data, and that EEG can be modulated by Parkinson's subjects using differing mental strategies. These findings were included in an abstract accepted for the Canadian Association for Neuroscience conference in Vancouver in May 2018, where the Pacific Parkinson's Research Institute will be gratefully acknowledged.

NEXT STEPS

Once all subjects have been tested, the data will undergo a multitude of analytics by experts in EEG processing and computerized modeling. Any significant findings will be written into a scientific report and submitted for publication in a peer-reviewed journal. Findings from this research may provide novel insights for using EEG signature patterns as a feedback mechanism to inform and develop portable, therapeutic electrical brain stimulation. Our ultimate goal is to develop a treatment option that allows people with Parkinson's to use EEG biofeedback in their daily lives to successfully alter their own brain waves to improve their motor symptoms.

CAN-ACN
CANADIAN ASSOCIATION FOR NEUROSCIENCE
ASSOCIATION CANADIENNE DES NEUROSCIENCES

COMMON SPATIAL PATTERN APPROACH TO EEG NEUROFEEDBACK IN PARKINSON'S DISEASE

ABSTRACT ACCEPTED FOR THE 2018 CANADIAN ASSOCIATION FOR NEUROSCIENCE

Emma M. Kiss, Christina B. Jones, Saurabh Garg, Soojin Lee, Martin J. McKeown

Electroencephalographic (EEG)-based neurofeedback may be an inexpensive, non-invasive treatment strategy for Parkinson's disease (PD). PD may be well-suited for EEG neurofeedback therapy as pathological oscillations are well documented in PD and related to motor symptoms. This pilot study aims to test 3 neurofeedback strategies as a means of modulating EEG in PD.

EEG data were recorded from 4 PD participants on medication using a lightweight, dry, wireless, 6-electrode headband (Cognionics, USA). After instruction, participants performed three modulation strategies (3x 60s trials each) in randomized order: imagining movement, imagining rewards, and mindfulness meditation. A common spatial pattern (CSP) algorithm was used on a subject-by-subject basis to maximize variance during modulation strategies compared to rest. Average power was calculated for each strategy across 5 EEG bands.

The EEG could be effectively modulated in all PD subjects, but the strategies had differing effects across subjects. Trial-by-trial variability was substantially lower with the CSP combination of electrodes compared to any individual channel ($p < 0.0001$). Our results suggest 1) PD subjects are able to effectively manipulate the EEG (measurable by consumer quality EEG headsets) and 2) CSP is a reasonable preprocessing strategy for EEG based neurofeedback. Further work is required to determine optimal strategies for EEG neurofeedback, if PD subjects can use this newfound capacity to modulate their EEG to "normalize" their EEG, and if EEG normalization translates into behavioural improvement.

Financial Report

Actual Expenses Incurred in 2017

Balance Brought Forward: $0

Payment received from PPRI: $103,480

Expenditures		
Salaries and benefits	$	81,150
Travel (conferences/field trips)	$	400
Materials, supplies, other	$	733
Telephone	$	1,492
Equipment (desktop computer/printer)	$	1,108
Total	**$**	**84,883**
Balance (as of December 31, 2017)	$	18,597

Projected budget for 2018

Carry forward: $18,597

Final pledge payment: $44,220

Total available: $62,817

Expenditures		
Salaries and benefits	$	55,000
Patient reimbursement	$	1,000
Travel (conferences/field trips)	$	2,000
Materials, supplies, other	$	4,000
Equipment (desktop computer/printer)	$	1,000
Total	**$**	**63,000**

Thank You

The UBC Faculty of Medicine and the Pacific Parkinson's Research Centre sincerely appreciate the support of the Pacific Parkinson's Research Institute and your community of donors. You have made it possible for us to investigate an innovative treatment option that holds great promise for helping people with Parkinson's manage the symptoms of this challenging disease. Thank you for your forward-thinking and generosity.