

## **Project Title**

Secondary Benefits of a Brain-Computer Interface Based Therapy for Children with ADHD

## **Project Lead and Members**

Project lead: Shernice Lim Shi Yun

Project members: Goh Tze Jui, Jane Teo Sze-Hui, Lim Choon Guan, Daniel Fung Shuen Sheng, Guan Cuntai, Zhang Haihong, Lee Tih Shih

## **Organisation(s) Involved**

Department of Developmental Psychiatry, Institute of Mental Health

School of Computer Science and Engineering, Nanyang Technological University

Neural & Biomedical Technology Department, Institute for Infocomm Research  
A\*STAR

Neuroscience and Behavioral Disorders Program, Duke-National University of  
Singapore Medical School

## **Healthcare Family Group Involved in this Project**

Medical, Allied Health

## **Specialty or Discipline (if applicable)**

Psychology, Computer Science

## **Aims**

The use of brain-computer interface (BCI) in neurofeedback therapy has been shown to be effective in alleviating inattentive symptoms in children with ADHD. The project aims to explore secondary improvements, specifically in the areas of social and thought problems, in children undergoing BCI-based therapy.

## **Background**

See poster appended/ below

## **Methods**

See poster appended/ below

## **Results**

See poster appended/ below

## **Lessons Learnt**

A major challenge was the technical difficulties encountered during the clinical trial. As the technology was relatively new, we had familiarise ourselves with the program and equipment, and troubleshoot often during the training sessions. In order to ensure each training session run as smoothly as possible, we would set up and check the equipment in advance. As this project requires heavy commitment from participants, another challenge was participant retention and compliance. Building rapport with both the children and parents was important in maintaining participant retention and motivation.

## **Conclusion**

See poster appended/ below

## **Additional Information**

SHBC Student Awards (Open Category) Bronze Award

## **Project Category**

Primary Category: Applied/Translational Research, Quantitative Research

## **Keywords**

Brain-Computer Interface, Attention Deficit/Hyperactivity Disorder, Technology, Attention, Social Problems, Thought Problems

**Name and Email of Project Contact Person(s)**

Name: Shernice Lim Shi Yun

Email: Shernice\_SY\_LIM@imh.com.sg



# Secondary Benefits of a Brain-Computer Interface Based Therapy for Children with ADHD

Shernice Shi Yun LIM<sup>1</sup>, Tze Jui GOH<sup>2</sup>, Jane Sze-Hui TEO<sup>2</sup>, Choon Guan LIM<sup>2</sup>, Shuen Sheng Daniel FUNG<sup>2</sup>, Cuntai GUAN<sup>3</sup>, Haihong ZHANG<sup>4</sup>, Tih Shih LEE<sup>5</sup>

<sup>1</sup> National University of Singapore

<sup>2</sup> Department of Developmental Psychiatry, Institute of Mental Health

<sup>3</sup> School of Computer Science and Engineering, Nanyang Technological University

<sup>4</sup> Neural & Biomedical Technology Department, Institute for Infocomm Research A\*STAR

<sup>5</sup> Neuroscience and Behavioral Disorders Program, Duke-National University of Singapore Medical School

## Introduction

Attention-Deficit/Hyperactivity Disorder (ADHD) can be categorised into three subtypes: predominantly inattentive (PI), predominantly hyperactive (PH) and combined (CB). Research has found that children with ADHD PI or CB subtype are more likely to exhibit deficits in social functioning (Solanto et al., 2009). This may be due to deficits in executive functioning (EF; Bunford et al., 2015). EF is crucial in evaluating social situations and formulating an appropriate response while simultaneously filtering out irrelevant information (Kofler et al., 2011).

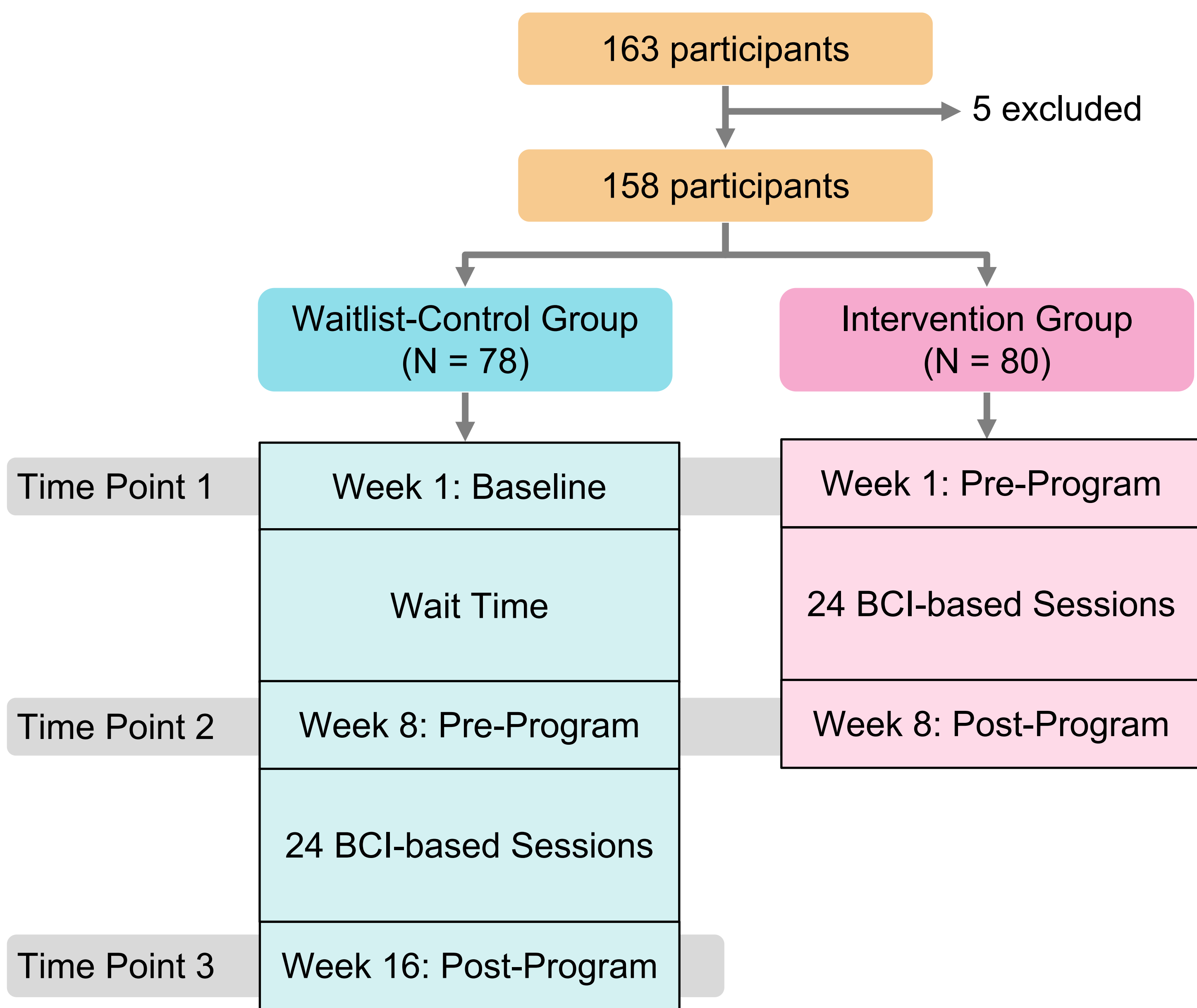
In a recent study by Lim et al. (2019), the use of brain-computer interface (BCI) in neurofeedback therapy has been shown to be effective in alleviating inattentive symptoms in children with ADHD PH or CB subtype. This study aims to explore secondary improvements, specifically in the areas of social and thought problems, in children undergoing the program.

## Methods

### Participants

A total of 163 participants aged 6 to 12 years old was enrolled into the program. The final sample consisted of 158 children ( $M_{age} = 8.63$ ,  $SD = 1.51$ ). 5 participants were excluded from analysis due to incomplete data. All participants were clinically diagnosed with ADHD by a child psychiatrist and fulfilled the criteria of either PI or CB subtype of ADHD verified by the Computerized Diagnostic Interview for Children (C-DISC).

### Procedure



### Measures

Parents from both groups completed The Child Behavioral Checklist (CBCL; Achenbach & Rescorla, 2001) at each time point, and the Social Problems and Thought Problems subscale were used as the dependent measure.

## Results

To examine the effectiveness of the program in improving social and thought problems in children with ADHD, CBCL social and thought problems subscale scores from time point 1 to time point 2 was compared between the intervention and waitlist-control group. A mixed ANOVA analysis found that improvements in social ( $F(1, 38) = 3.20$ ,  $p = .076$ ,  $\eta_p^2 = .02$ ) and thought problems ( $F(1, 156) = 1.24$ ,  $p = .268$ ,  $\eta_p^2 = .008$ ) in the intervention group were not statistically significant compared to the waitlist-control group, as illustrated in Figure 1 and 2 respectively.

## Results – cont'd

Figure 1.

Social Problems Scores

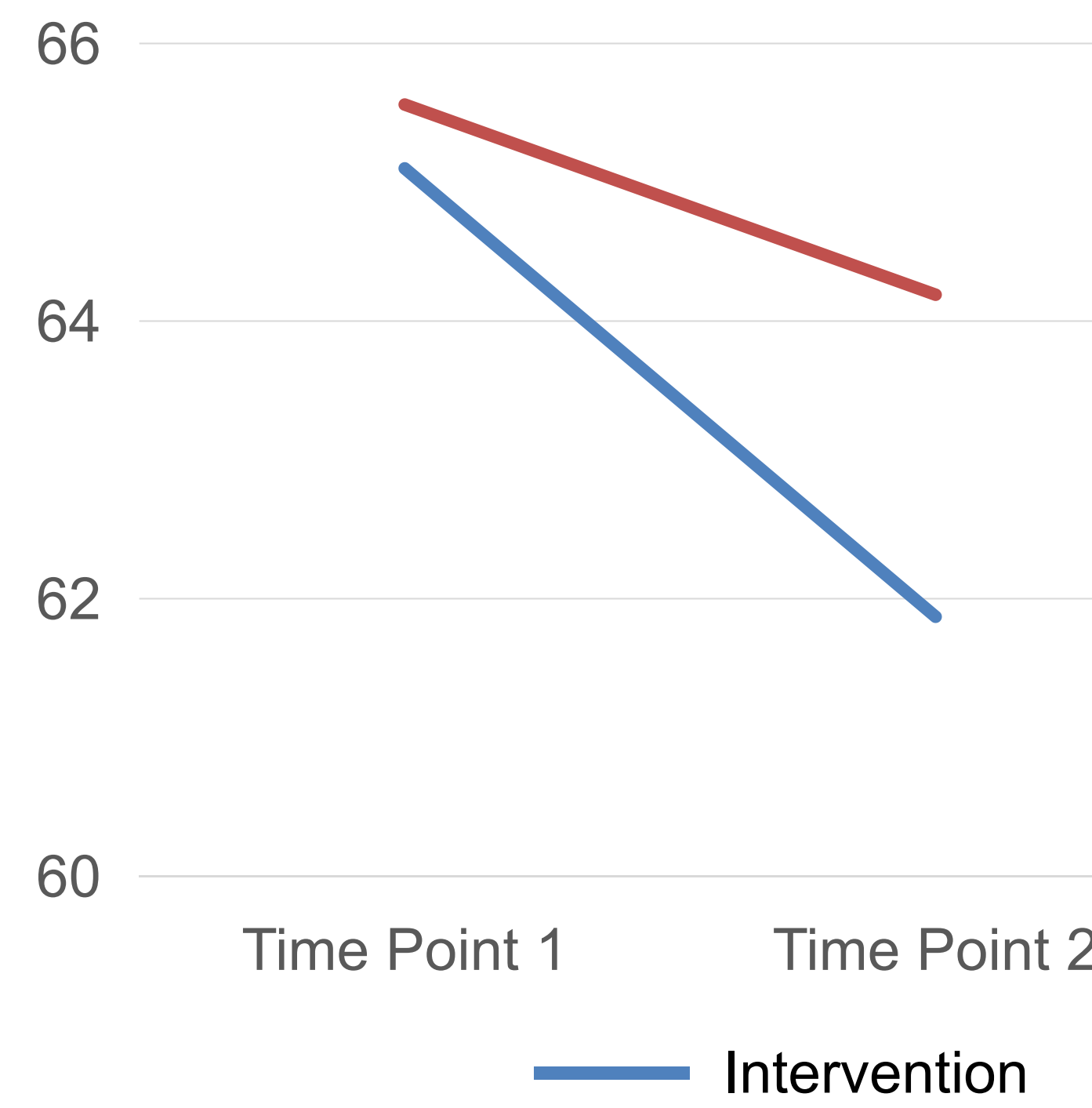
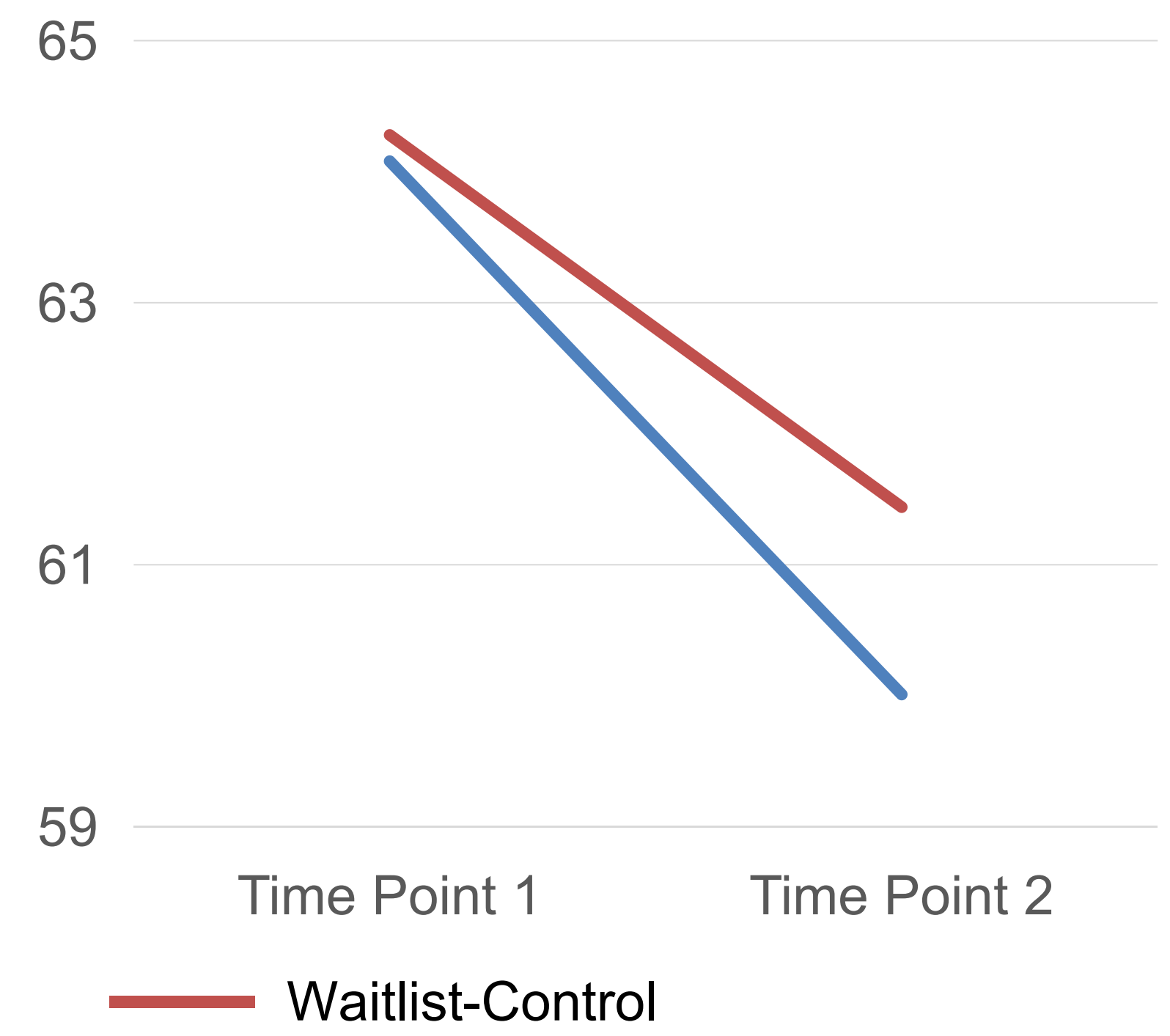


Figure 2.

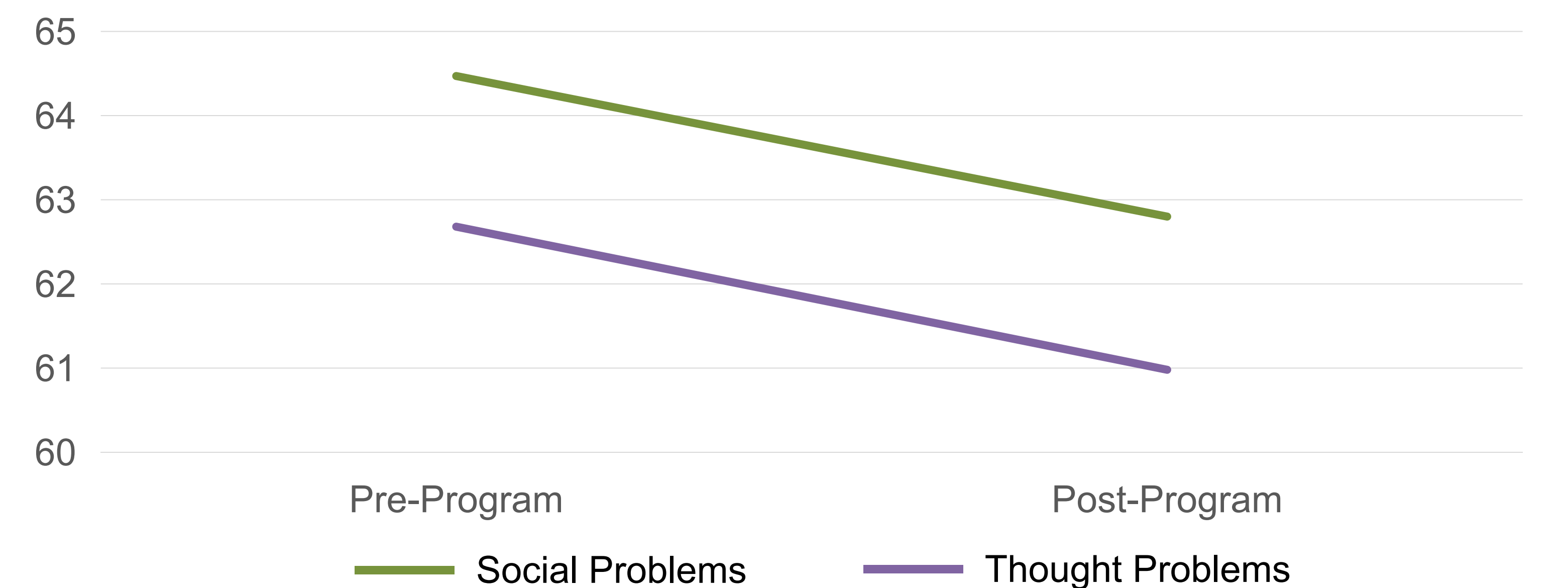
Thought Problems Scores



A paired sample t-test was conducted to compare between pre- and post-program scores pooled from both groups. The results indicated that children showed significant improvement in both areas of social,  $t(157) = 2.99$ ,  $p = .003$ , and thought problems,  $t(157) = 3.04$ ,  $p = .003$ , after receiving the program (Figure 3).

Figure 3.

Pre-Program and Post-Program Scores



## Discussion

Although BCI-based training program primarily targets inattention, the findings suggest that children who completed the program experienced improvements in social functioning and thought regulation. While pooled analysis suggests improvement in both areas, the mixed ANOVA results indicate that these changes may not be attributed to the program. Children may be experiencing natural improvements in ADHD symptoms, and in turn improvements in social functioning and thought problems, due to developmental changes (Hart et al., 1995). The improvements observed during the waiting time in the waitlist-control group could be due to parents' expectation of change after being involved in a trial. In addition, as training sessions are supervised by a research assistant, interactions between research assistant and child could have attributed to the changes reported. Future research can examine if the effectiveness of the program varies across age. The intervention group can also be compared against a placebo-control group to further investigate the efficacy of BCI-based training. The relationship between clinical inattention in children with ADHD and thought problems can be further examined as well.

## Acknowledgements

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