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Brain network malleability by computerised cognitive training in attention deficit hyperactivity disorder

Submission date
06/05/2024

Recruitment status
No longer recruiting

Registration date
09/05/2024

Overall study status
Completed

Last Edited
03/07/2025

Condition category
Mental and Behavioural Disorders

[ ] Prospectively registered
[ ] Protocol
[ ] Statistical analysis plan
[X] Results
[ ] Individual participant data

Plain English summary of protocol

Background and study aims
Individuals with attention deficit hyperactivity disorder (ADHD) often face problems in executive functions, including visuospatial and verbal working memory. Cognitive training has been proposed as a candidate for ADHD rehabilitation, and previous studies have shown it can have positive effects on untrained working memory tasks and even on inhibition control and attention. It is less clear how cognitive training affects brain activity or structure in individuals with ADHD. This study aims to explore how working memory training affects the brain's white matter structures and brain activation during working memory performance, rest, and movie watching in individuals with ADHD.

Who can participate?
Participants aged 18 to 63 years with ADHD

What does the study involve?
Adults with ADHD took part in a randomised controlled working memory trial, either training on a dual n-back working memory task or, as an active control, playing the Bejeweled 2 computer game. Participants in both groups trained for 5 weeks, thrice a week, for 25 minutes at a time. Neuropsychological assessment, other cognitive tasks, and functional and MRI scans were conducted before and after the training period.

What are the possible benefits and risks of participating?
Magnetic resonance imaging is a safe, non-invasive method, and due to careful pre-screening no harms were expected or experienced. Working memory training might in general have positive effects on ADHD symptoms and working memory deficits.

Where is the study run from?
1. Åbo Akademi University (Finland)
2. University of Helsinki (Finland)
3. Hospital District of Helsinki and Uusimaa (Finland)

When is the study starting and how long is it expected to run for?
January 2015 to February 2018

Who is funding the study?
1. Åbo Akademi University (Finland)
2. Research Council of Finland

Who is the main contact?
Tuija Tolonen, tuija.tolonen@helsinki.fi

Contact information

Type(s)
Principal investigator

Contact name
Prof Matti Laine

Contact details
Tehtaankatu 2
Turku
Finland
20500
N/A
matti.laine@abo.fi

Type(s)
Scientific

Contact name
Dr Juha Salmitaival

Contact details
Otakaari 3
Espoo
Finland
02150
N/A
juha.salmitaival@aalto.fi

Type(s)
Public

Contact name
Ms Tuija Tolonen

Contact details
Haartmaninkatu 3
Helsinki
Finland

00290
N/A
tuija.tolonen@helsinki.fi

Additional identifiers

Study information

Scientific Title
A randomised controlled trial to examine the effects of computerised working memory training on brain activity and structural and functional connectivity in adults with attention deficit hyperactivity disorder

Acronym
ADHD-Train

Study objectives
Due to its exploratory nature, this study is based on study questions, rather than hypotheses:
1. Does working memory training affect regional brain activation during working memory performance, rest, or movie watching?
2. Does working memory training affect temporal brain activity correlations between brain areas during working memory performance, rest, or movie watching?
3. Does working memory training affect white matter microstructure or connectivity?

Ethics approval required
Ethics approval required

Ethics approval(s)
Approved 30/06/2015, Ethics Committee for Gynecology and Obstetrics, Pediatrics and Psychiatry of the Helsinki and Uusimaa Hospital District (Tukholmankatu 8 C, Helsinki, 00290, Finland; +358 (0)40 359 4618; eettiset.toimikunnat@hus.fi), ref: HUS/1166/2021

Primary study design
Interventional

Study design
Double-blind randomized controlled single-center study

Study type(s)
Treatment

Health condition(s) or problem(s) studied
Attention deficit hyperactivity disorder

Interventions
After a pretest including neuropsychological assignment, cognitive tasks, and magnetic resonance imaging, the participants were assigned to an experimental group (performing dual n-back working memory task) or an active control group (playing Bejeweled 2 computer game) with simple randomisation using an equal amount of lottery tickets per group. Each participant in both groups trained for 5 weeks, three times a week, 25 minutes at a time, adding up to total

of 15 training sessions. A post-test with the same elements as the pretest was conducted after the cognitive training. The participants were blind to whether they belonged to the experimental or the control group, as was the experimenter conducting the pre- and post-tests.

Intervention Type
Behavioural

Primary outcome(s)
Blood oxygen level dependent (BOLD) signal in the brain measured by functional magnetic resonance imaging during the pretest (within few weeks before the cognitive training) and the posttest (within few weeks after the cognitive training). Due to the study's experimental design, BOLD signal is assessed in different conditions (during working memory task, rest, and movie watching) and can be analysed in several ways, including regional activity and their temporal correlations.

Key secondary outcome(s)
White matter properties of the brain measured by diffusion-weighted magnetic resonance imaging during the pretest (within a few weeks before the cognitive training) and the posttest (within a few weeks after the cognitive training). White matter properties can be analysed in several ways, including microstructure and tractography.

Completion date
28/02/2018

Eligibility

Key inclusion criteria
1. Age between 18 and 63 years
2. Diagnosed with attention deficit hyperactivity disorder according to DSM-IV by a specialised doctor
3. Excellent competency in Finnish
4. Sufficient vision and hearing

Participant type(s)
Patient

Healthy volunteers allowed
No

Age group
Adult

Lower age limit
18 Years

Upper age limit
63 Years

Sex
All

Total final enrolment
44

Key exclusion criteria
1. History of brain damage
2. Other severe neurological or psychiatric disorders apart from ADHD, including substance abuse or other addictions
3. IQ lower than 70 assessed by the Wechsler Adult Intelligence Scale III
4. Magnetic resonance imaging contraindications

Date of first enrolment
01/08/2015

Date of final enrolment
31/01/2018

Locations

Countries of recruitment
Finland

Study participating centre
Institute of Behavioural Sciences, University of Helsinki
Siltavuorenpenger 5
Helsinki
Finland
00170

Study participating centre
Advanced Magnetic Imaging Centre, Aalto University
Otakaari 5
Espoo
Finland
02150

Sponsor information

Organisation
Åbo Akademi University

ROR
https://ror.org/029pk6x14

Funder(s)

Funder type
University/education

Funder Name
Åbo Akademi

Alternative Name(s)
ÅA

Funding Body Type
Government organisation

Funding Body Subtype
Local government

Location
Finland

Funder Name
Research Council of Finland

Alternative Name(s)
Academy of Finland, Suomen Akatemia, Finlands Akademi, AKA

Funding Body Type
Government organisation

Funding Body Subtype
Research institutes and centers

Location
Finland

Results and Publications

Individual participant data (IPD) sharing plan
The datasets generated during and/or analysed during the current study are not expected to be made available due to the details in the ethical agreement for the study.

IPD sharing plan summary
Not expected to be made available

Study outputs

Output type	Details	Date created	Date added	Peer reviewed?	Patient-facing?
Results article		19/08/2020	07/05/2024	Yes	No
Results article	Working memory related functional connectivity	02/11/2024	03/07/2025	Yes	No