The effect of acute exercise and fitness level on the aging brain, an investigation with fMRI

Published: 11-04-2016
Last updated: 19-04-2024

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Ethical review	Approved WMO
Status	Recruitment stopped
Health condition type	Age related factors
Study type	Observational invasive

Summary

ID

NL-OMON43951

Source
ToetsingOnline

Brief title
How does exercise affect the brain?

Condition

- Age related factors

Synonym
aging, cognitive functioning

Research involving
Human

Sponsors and support

Primary sponsor: Universitair Medisch Centrum Groningen
Source(s) of monetary or material Support: Ministerie van OC&W

Intervention

Keyword: aging, cerebral blood flow, cognition, exercise

Outcome measures

Primary outcome

Main study parameters are functional MRI measurements during two N-back tasks (during the exercise and control session), the effects of fitness level on AB task performance and pupil dilation signal, CBF measurements during two resting states (pre and post exercise).

Secondary outcome

The secundary parameter of the proposed study is the BOLD signal of resting state networks, measured during the resting state scans before and after acute exercise.

Study description

Background summary

A growing body of evidence suggests that multiple cognitive domains can be improved by physical exercise, either by a single bout of exercise or exercise training (Colcombe & Kramer, 2003), but little is known about the effect of exercise on working memory and temporal attention. The aging brain shows bilateral brain activity in the prefrontal cortex (PFC), which is suggested to be a compensation mechanism, during a variety of tasks. Recent studies suggest acute exercise enhances bilateral activity in the PFC in older adults, while a high fitness level leads to activation patterns similar to young adults. However, this hypothesis has not been investigated with a working memory task. Li et al. (2014) is the only neuroimaging study investigating the effect of acute exercise on working memory using the N-back task. They found no difference in behavioral performance, but did observe differences in task-induced increases in activation of prefrontal regions among others. We will attempt to expand their results by investigating the effect of acute exercise on the N-back task in young and older adults. In addition, as one of the hypotheses explaining the beneficial effect of exercise on cognition is

that it increases cerebral blood flow (CBF), we will investigate the effect of acute exercise on CBF in rest.
There is also little knowledge about the effect of exercise on temporal attention. Wu & Hillman (2013) showed that fitness level is positively related to visual temporal attention in pre-adolescent children, measured with an Attentional Blink (AB) task. The authors propose that high fitness levels increase the control over the distribution of attentional resources. In the proposed study, we will attempt to replicate and extend these results in young and older adults. As a measure of fitness level, participants will perform a submaximal exercise test. Whereas Wu & Hillman used electroencephalography (EEG) to measure brain responses, we will measure pupil dilation signal instead. Task-evoked pupil dilation is thought to reflect changes in attention and has shown to be a reliable and more sensitive measure than EEG (Wierda et al., 2012), thus requiring fewer trials.
With the proposed study, we will expand the knowledge about the effect of an acute bout of exercise on CBF and working memory performance and underlying neural correlates. As life-span is increasing and cognitive decline increases with age, acquiring knowledge about the effect of exercise on cognition would be especially of importance for the older population, as it may contribute to future interventions to maintain cognitive functioning and improve quality of life.

Study objective

The main objective of the study is to investigate (1) whether acute exercise influences brain responses to a working memory task, (2) the effect of acute exercise on CBF responses to acute aerobic exercise and (3) whether fitness level is related to temporal attention.

Study design

Participants will be asked to fill in questionnaires measuring health, amount of hours playing video games and MRI compatibility and will be screened for in- and exclusion criteria. During the first site visit, participants will practice on a bicycle ergometer with the Borg RPE (rating of perceived exertion) Scale. Then, questionnaires will be taken measuring general intelligence (MMSE), levels of anxiety and depression (HADS), to ensure participants do not have memory complains or high levels of anxiety or depression, as these could influence task-performance. Then, participants will perform a submaximal exercise test. During the second and third site visit, participants will perform two Magnetic Resonance Imaging (MRI) session that will be counterbalanced across subjects: an exercise session and control session. During the second site visit, participants will be presented with two versions of the AB task while pupil dilation signal is measured, followed by one of the MRI sessions. The third site visit consists of three tests: Digit Symbol Substitution Task, Dutch National Adult Reading Test, and Trail Making Test A

and B. In addition, the third site visit consists of the second MRI session. In the exercise session, CBF and resting state scans will be taken of participants, followed by a 20-minute period of aerobic exercise outside the MRI scanner on a stationary bicycle, of which 15 minutes will be at 70% of the maximal heart rate (HR).
Participants are asked to cycle for two minutes at RPE level 13. RPE 13 has been shown to be equal to *moderate intensity* and approximately 74% of the maximal HR. Then, CBF and resting state scans will be taken again, followed by an N-back task. In the control session, participants will rest instead of performing exercise outside the MRI scanner.

Study burden and risks

The burden associated with participation consists of four questionnaires via post or email (with a duration of 30 minutes) and three site visits. The first site visit will have a duration of approximately 90 minutes. Participants will perform a submaximal exercise test at the SportsFieldLab. As participants fill in a health questionnaire before the submaximal test, we consider the risks to be minimal. The second site visit will have a duration of 171 minutes and the third site visit will have a duration of 105 minutes. Pupil dilation will be measured with an eye tracker during the AB tasks. Participants will keep their head in a chin rest during all blocks to optimize eye-tracking and viewing conditions. Concerning the MRI scanner, participants will be exposed to a field-strength of 3 Tesla and scanner noise. Thus far, there is no evidence to suggest that exposing humans to a magnetic field of this strength has a negative influence on their health. With regard to the noise, earplugs and headphones will be provided. If evident abnormalities in the brain are noticed, then the General Practitioner, who is indicated by the participant, will be notified.

Subjects will not benefit directly from participating in the study, however the data collected during this study will enhance understanding of the complex relationship between physical fitness, acute exercise and cognition. As life expectancy is increasing and cognitive decline increases with age, acquiring knowledge about the effect of exercise on cognition would be especially of importance for the older population, as it may contribute to future interventions to maintain cognitive functioning and improve quality of life.

Contacts

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Trial sites

Listed location countries

Netherlands

Eligibility criteria

Age
Adults (18-64 years)
Elderly (65 years and older)

Inclusion criteria

Normal (or corrected to normal) vision, healthy, fMRI compatible, no (history of) neurological or psychiatric disorders, fluent in Dutch. Age range: 18-30 or 50-65.

Exclusion criteria

Smoking. Health issues that could influence the ability to exercise, MR incompatable (posibility of any incompatible metal objects inside the body), alcohol/drug abuse, answering 'yes' to one or more questions on the r-PARQ. MR incompatible, based on the fMRI questionnaire. This includes (but is not limited to) claustrophobia, presence of MR incompatible implants, such as pacemakers or insulin pumps, (suspicion of) pregnancy, tattoo(s) that contain red pigment.

Study design

Design

Study type: Observational invasive

Masking:	Open (masking not used)
Control:	Uncontrolled
Primary purpose:	Other

Recruitment

NL

Recruitment status:	Recruitment stopped
Start date (anticipated):	02-05-2016
Enrollment:	100
Type:	Actual

Ethics review

Approved WMO

Date:	11-04-2016
Application type:	First submission
Review commission:	METC Universitair Medisch Centrum Groningen (Groningen)

Study registrations

Followed up by the following (possibly more current) registration

No registrations found.

Other (possibly less up-to-date) registrations in this register

No registrations found.

In other registers

Register	ID
CCMO	NL54807.042.15