Computational modelling of visual disorders

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Primary Objective: To explore the computations which occur in the brain which occur in visual disorders and determine how these differ from healthy controls. Specifically, we expect that the overall sensitivity (area under the curve) which reflects...

Ethical review	Approved WMO
Status	Pending
Health condition type	Vision disorders
Study type	Observational non invasive

Summary

ID

NL-OMON57377

Source
ToetsingOnline

Brief title
vdNCSF

Condition

- Vision disorders

Synonym
amblyopia (lazy eye), Glaucoma

Research involving
Human

Sponsors and support

Primary sponsor: Amsterdam UMC
Source(s) of monetary or material Support: KNAW

Intervention

Keyword: Computational modelling, Functional magnetic resonance imaging (fMRI), Human visual cortex, Visual disorder

Outcome measures

Primary outcome

Difference in overall sensitivity (area under the curve, from the nCSF model)

between patients and controls

Secondary outcome

Comparison of overall sensitivity between the eyes of patients (i.e., left vs

right)

Relation of model parameters (i.e., overall sensitivity; pRF size) with basic

visual functions (visual acuity; perceptual contrast sensitivity)

Study description

Background summary

Visual disorders can occur due changes at any stage of visual processing. Glaucoma affects the earliest stage in the retina, and leads to blindspots. In contrast, patients with amblyopia can have perfectly healthy eyes, and it is thought of as a cortical disorder. There is a long standing debate about how the brain is altered in these disorders [1]. Is there neuroplasticity to compensate for these impairments? If so, at what stage of visual processing do these adaptations occur?

Functional magnetic resonance imaging (fMRI) allows us to monitor activity in the visual cortex noninvasively. Computational models provide an explanation for this activity, i.e., how the visual information is being processed. These models can be used to compare patients to controls exploring how visual field maps and receptive fields are altered [2]. More specifically we will use sophisticated "population receptive field" [3] models which predict how specific populations of neurons will respond to the spatial extent of stimuli; and the "neural contrast sensitivity function" [4] which predicts the sensitivity of populations of neurons to different stimuli. Together these

models will constitute a *computational* perspective to complement the existing anatomical and behavioural understanding of these disorders, potentially providing novel methods for tracking progression and treatment.

[1] Wandell, Brian A., and Stelios M. Smirnakis. "Plasticity and stability of visual field maps in adult primary visual cortex." Nature Reviews Neuroscience 10.12 (2009): 873-884.
[2] Dumoulin, Serge O., and Tomas Knapen. "How visual cortical organization is altered by ophthalmologic and neurologic disorders." Annual Review of Vision Science 4 (2018): 357-379
[3] Aqil, M., Knapen, T., & Dumoulin, S. O. (2021). Divisive normalization unifies disparate response signatures throughout the human visual hierarchy. Proceedings of the National Academy of Sciences, 118(46), e2108713118.
[4] Roelofzen, C., Van Dijk, J. A., De Jong, M. C., & Dumoulin, S. O. (2020). Measuring contrast sensitivity functions in human visual cortex. Journal of Vision, 20(11), 1379-1379.

Study objective

Primary Objective: To explore the computations which occur in the brain which occur in visual disorders and determine how these differ from healthy controls. Specifically, we expect that the overall sensitivity (area under the curve) which reflects the responsiveness of a brain region to images of different contrasts, will be reduced in patients compared to controls.
Secondary Objective(s): To compare other model parameters (i.e., pRF size) (and their differences) with basic visual processing (i.e., acuity, visual field deficits and contrast sensitivity).

Study design

The study will be an observational, cross-sectional study comparing healthy controls and patients (amblyopia, glaucoma). Contact will occur through two routes. [1] Physicians: patients will be given study information by the relevant physicians, if they are interested in taking part they will then contact the project leader (Marcus Daghlian). [2] Flyers, online advertisement and word of mouth will be used to recruit additional participants. If interested they will contact the project leader (by email), who will provide them with the full information sheet (E1 E2). The project leader will then call the participants, ensure that they understand and have read the information sheet; perform screening and obtain informed consent. Participants will be contacted by the project leader to visit the study centre for two separate sessions (screening and informed consent will be recollected on both sessions). Session one will consist of anatomical MRI scans; functional scanning for the first eye (presenting participants with low level visual stimuli, while one eye is patched) and basic psychophysical tests to assess the level of visual

function (again for the first eye). The second session will be identical to the first, but the second eye will be patched, and anatomical data will not be reacquired. Participants will lie on the MR (Philips 7T scanner) table while the scan takes place (maximum duration 1hr 30mins), either resting (during anatomical scans) or viewing stimuli (during functional scans). Visual stimuli will consist of synthetic images (e.g., textures and patterns) or natural images (i.e., scenes, objects); these images will not contain any content which could be offensive or stressful (i.e., pornography, violence, emotive scenes etc.). During the functional scans, participants will perform a task; maintaining fixation (looking at the centre of the screen) and pressing a button in response to a change in the stimuli.

Study burden and risks

There are no risks associated with participation in this study, provided the exclusion criteria for fMRI are taken into account. The burden of participation is mainly restricted to the time involved in the measurements; in each of the two sessions there will be a maximum of 1 hour of psychophysical assessment and a maximum of 1 hour and 30 minutes in the scanner. Scan sessions will take place over separate days, unless the participants request otherwise to reduce their travel time. In the latter case there will be a minimum of 2 hours between sessions to ensure participants are well rested. Functional MRI is a non-invasive technique, and there is no need for special preparation for the subject. The psychophysical tests involve button presses in response to basic (non-emotive, non-explicit) images. For both fMRI and psychophysical testing, participants will have one eye patched, this may be mildly uncomfortable. The patch will only be applied while the participants are seated / lying, immediately before the tasks / scans respectively, and will be removed as soon as the task / scans have finished. .

The MRI data are used for research purposes only. However, severe abnormalities may be noticed, in which case a specialist (radiologist) may be asked for advice, upon decision of the research team. If the specialist confirms that medical treatment is indicated, then the subject participant*s general physician will be notified. If the abnormalities are classified as untreatable by the specialist, no information will be passed on to the general physician. The volunteer is informed of this possibility prior to participating in the experiment, and signs a separate paragraph on the informed consent form to signal their consent with this procedure. If they do not consent to this they will not be scanned.

The participants of this study will have no direct benefits from participating, aside from financial compensation for time.

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

Male or female
18 years or older
Healthy, English or Dutch speaking
Patients with glaucoma, amblyopia, also healthy controls (no visual disorder)

Exclusion criteria

Personal history of psychiatric or neurological disorder. This includes dementia; alzheimers; multiple sclerosis; parkinsons and epilepsy. Psychiatric disorders excluded include schizophrenia; and autism.

Contraindications for MRI: including claustrophobia and tinnitus. Participants cannot have any medical implants: pacemakers, surgical aneurysm clips, and other known metal fragments embedded in the body, including eyes. Cannot have had surgery in the past 6 weeks.

Significant previous adverse response to fMRI scanning.
Participant does not speak English or Dutch

Study design

Design

Study type:	Observational non invasive
Intervention model:	Other
Allocation:	Non-randomized controlled trial
Masking:	Open (masking not used)
Control:	Active
Primary purpose:	Other

Recruitment

NL

Recruitment status:	Pending
Start date (anticipated):	01-02-2025
Enrollment:	80
Type:	Anticipated

Ethics review

Approved WMO

Date:	17-03-2025
Application type:	First submission
Review commission:	METC Amsterdam UMC

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	NL88086.018.24