MED MEDIZINISCHE FAKULTÄT

Forschungsbericht 2023

Institut für Medizinische Psychologie

INSTITUT FÜR MEDIZINISCHE PSYCHOLOGIE

Leipziger Straße 44, 39120 Magdeburg
Tel. 49 (0)391 67 21800, Fax 49 (0)391 67 21803
imp@med.ovgu.de

1. LEITUNG

Prof. Dr. med. habil. B.A. Sabel, Ph.D. (geschäftsführender Leiter)

2. HOCHSCHULLEHRER/INNEN

Prof. Dr. med. habil. B.A. Sabel, Ph.D.

3. FORSCHUNGSPROFIL

Arbeitsgruppe Neuropsychologie

- Durchführung klinischer Prüfungen zur Etablierung non-invasiver Elektrostimulation
- Entwicklung und Validierung computergestützter Diagnose-und Therapieverfahren für Patienten mit Sehbehinderungen nach Hirnschädigung oder Augenerkrankungen (z.B. Glaukom, Sehnervschädigung)
- Gesichtsfelddiagnostik, Eyetracking und elektrophysiologische Untersuchung von Gebieten des Residualsehens
- Untersuchung der Lebensqualität bzw. Beeinträchtigung von Aktivitäten des täglichen Lebens bei Sehbeeinträchtigungen nach Augenerkrankungen oder Läsionen der zentralen Sehbahn
- Untersuchung von Mechanismen visueller Plastizität bei behavioraler Intervention mit visueller Restitutionstherapie, Augenbewegungstraining, oder nicht-invasiver Elektrostimulation
- Computersimulation der Plastizität im visuellen Kortex/Prädiktoren der Erholung von Sehfunktionen

Arbeitsgruppe Verhaltensneurowissenschaften

- Untersuchung neuroanatomischer Korrelate von neuronaler Schädigung und Erholung
- Pharmakologische Behandlung von Versuchstieren mit verschiedenen therapeutischen Ansätzen
- Repetitive transkorneale Elektrostimulation zur Restitution des Sehvermögens bei Ratten
- In vivo neuronales Imaging retinaler Ganglienzellen
- Erforschung der Blut-Hirn-Schrankenpassage von Nanopartikeln im Zusammenhang mit ZNS Pharmakotherapie Toxizitäts- Molekularbiologische in vitro Versuche zu Nanopartikeleffekten

4. METHODIK

Neuropsychologie

- Neurovisuelle Rehabilitation von Patienten mit Sehbeeinträchtigungen mittels visuellem Restitutionstraining (Vision Restoration Therapy, VRT), repetitiver transorbitaler alternating current stimulation (rtACS) und transcranial direct current stimulation (tDCS) bei Sehnervschädigung (Optikusneuropathie), Glaukom (grüner Star) oder Schlaganfall
- Evaluation und Entwicklung von Verfahren der Lebensqualität des Sehens
- Messung visueller Funktionen (Kontrastsehen, Dynamisches Sehen, Lesegeschwindigkeit usw.)
- Gesichtsfeld-Messung mit Perimetrie (Tübinger Automatik Perimeter, Twinfield Oculus), Computerkampimetrie (High Resolution Perimetry)

- Augenbewegungsmessung (Eyetracking): Tobii ET1750, ClearView (Tobii Technology AB, Sweden), Eyelink1000
- EG & visuell evozierte Potentiale: 128 Channel Geodesic EEG System 300, BrainVision Recorder und BrainVision Analyzer
- Dynamische, vaskuläre Regulationsmessung mit dem DVA (Dynamic vessel analyzer)

Verhaltensneurowissenschaften

- In Vivo Confocal Neuroimaging (ICON) bei Nagern
- Ex vivo wholemount Präparat
- In vivo Modell zur transcornealen Wechselstromstimulation der Ratte (unter Narkose und frei beweglich) Messung von Tiefen-EEG und Visuell Evozierten Potentialen (VEP) in chronisch implantierten Ratten unter Narkose und freibeweglich
- In vitro molekularbiologische Untersuchungsmethoden zu Neuroprotektionsmechanismen (Zellkultur, Westernblot, Absorptionsspektrophotometrie; Histologie)

5. KOOPERATIONEN

- Chinese Academy of Sciences, Inst. Automation, Prof. Dr. He
- Ecole d'optométrie, University of Montreal, Canada, Prof. Elvire Vaucher
- Fakultät für Informatik (OVGU), Prof. Dr. Nürnberger
- Helsinki University Central Hospital (HUCH), Department of Neurology, Prof. Turgut Tatlisumak
- Institut für Verfahrenstechnik (OvGU), Prof. van Wachem / Dr. Hintz
- Leibnitz Institut für Neurobiologie (LIN), Dr. Werner Zuschratter
- Photonscore GmbH, Dr. Yury Prozakov
- Politechnical University of HongKong, China, Dr. Allen Cheong

6. FORSCHUNGSPROJEKTE

Projektleitung: Prof. Dr. Bernhard Sabel
Projektbearbeitung: Luisa Fricke
Förderer: Stiftungen - Sonstige - 01.05.2020 - 30.09.2023

The influence of eye yoga on vascular regulation and neuroplasticity in vision loss

In glaucoma which leads to neuro-visual damage of retina, optic nerve or brain, vision can be partially restored by rehabilitation, but underlying neurovascular plasticity mechanisms are unclear.
Because long-term mental stress is a main cause of glaucoma, we conducted a randomized, controlled trial to study if relaxation using eye-yoga exercises combined with breathing meditation can improve visual field and eye movement dysfunction and normalize the typical vascular dysregulation.

While regarding the visual field analysis no significant improvements were detected in controls, vision recovery was observed in eye-yoga patients (p=0.001).

An interim analysis suggests that relaxation induced by eye-yoga and meditation is helpful to recover visual field loss and neurovascular regulation. The final conclusion need to wait the RCT completion.

Projektleitung: Prof. Dr. Bernhard Sabel
Projektbearbeitung: Wanshu Zhou
Förderer: Haushalt - 01.01.2018 - 30.09.2023

Vascular dysregulation in glaucoma: retinal vasoconstriction and normal neurovascular coupling in altitudinal visual field defects

Purpose: Vascular dysregulation (VD) is a major factor in glaucomatous visual defect progression. However, little is known if neurovascular coupling (NVC) is impaired in glaucomatous retinal vessels and how it relates to vessel morphology and altitudinal visual field defect depth. To better predict the glaucomatous visual defect progression and possible vision restoration and establish personalized intervention, we need to further study the role of VD and NVC in glaucoma.

Methods: Using a dynamic vessel analyzer (DVA) we quantified retinal vessel diameters and dilation responses following neuronal activation by flickering light stimulation in primary open angle glaucoma (POAG) patients (n=30) and age-matched, healthy controls (n=22). Vessel dilation dynamics was measured as a function of vessel branch level (diameter) and degree of visual field impairment.

Results: In larger blood vessels average arterial and venous retinal vessel diameter was significantly smaller in glaucoma. However, when inducing neuronal activity by exposing the retina to flickering light, both arterial and venous dilation reached normal values despite having smaller diameters. This was largely independent of visual field depth.

Conclusions: Because dilation/constriction is normal, VD in glaucoma cannot be explained by impaired NVC but is rather caused by vasoconstriction. This may permanently limit energy supply to retinal (and brain) neurons and, depending on the extent of deprivation, lead to either long-term hypo-metabolic, surviving "silent" neurons or to cell death. The results we found will help with the establishment of predictive model based on VD in glaucoma progression and possible restoration in follow-up studies.

Projektleitung: Prof. Dr. Bernhard Sabel
Projektbearbeitung: Dr. rer. nat. habil. Mirela Bîlc
Förderer: Haushalt - 01.10.2021 - 30.04.2023

Treatment of patients with optic nerve damage with electrical stimulation: a home stimulation study

The overall aim of the current project is to investigate the efficacy and safety of long-term treatment of glaucoma by transorbital alternating current stimulation with a home-stimulation device (SASm). We hypothesize that tACS home-stimulation significantly improves vision and associated biomarkers compared to sham-controls. Our secondary aim is exploratory, namely to investigate possible mechanisms of action. The current study will be a double blind, parallel group interventional study. Participants (N=45) will be randomized to one of two intervention arms following a 2:1 scheme: (1) arm 1 - intervention group receiving tACS; (2) arm 2 - placebo group receiving sham (no tACS, only phosphene threshold measured at study entry). The primary endpoint of this clinical investigation is improved near-threshold Humphrey Visual Field Index of the worse eye/solely available eye following active tACS stimulation compared to sham, as indicated by relative change over baseline at end of treatment.

According to our goal of investigating the long-term tACS efficiency, participants will undergo 30 stimulation sessions. Endpoints will be assessed before, immediately after and 2 and 6 months after the end of treatment. To our knowledge, this would be the longest stimulation duration and follow-up period investigating the effect of tACS. It would allow us not only to collect information on long-term effects, but also to compare it with short-term interventions (i.e., 10 days). The study will be considered completed after the last follow-up measurement of the last patient.

To examine the retinal blood vessel dynamics, we want to use a CE-approved "Dynamic Vessel Analyzer" in an additional "open label" feasibility study on a sample of patients (N=20) from an outpatient care center to determine the effect of electrical stimulation on the blood supply. These patients will undergo 10 electrostimulation sessions using a device which is equivalent to the devices used for the other two-arms. As part

of our study we will have two measurement points to investigate the effect of the electrical stimulation on the blood supply, namely before and after therapy.

Projektleitung: Prof. Dr. Bernhard Sabel
Förderer: Stiftungen - Sonstige - 01.05.2020 - 31.03.2023

Microsaccades in normal vision and in glaucoma and its treatment with eye movement training

Microsaccades are fast, jerk-like eye movements that happen once or twice per second. They are profoundly involved in visual perception. Microsaccades show also high clinical relevance e.g. alterations of microsaccades can cause symptoms such as diplopia, reduced visual acuity and blurred vision, which are reported in a series of ophthalmological and neurological diseases. The study addresses if microsaccade and microsaccade-related potentials are stable in normal aging. This explores the usefulness of microsaccades as a potential biomarker to monitor and better understand di erent diseases with oculomotor symptoms.

Projektleitung: Prof. Dr. Bernhard Sabel
Projektbearbeitung: Zheng Wu
Förderer: Haushalt - 16.11.2015 - 31.03.2023

Spacetime in the Brain: rapid brain network reorganization in visual processing and recovery

Purpose: Although it is known that optic nerve damage, for example after glaucoma or optic neuropathy, a *local* event, alters *global* functional connectivity networks (FCN) in the brain resting state, it is unknown if and how visual deprivation a ects the dynamics of transient and rapid brain FCN changes. The synchronization between brain regions is essential for the integration between visual and non-visual modalities in time and space, and if a patient detects - or fails to detect - visual stimuli is rather variable and may depend on the FCN response to visual stimuli.

Methods: In patients with optic nerve damage (n=19) and healthy subjects (n=14), the ability to detect super-threshold stimuli was related to parameters of the "event related network analysis (ERNA) based on graph theory immediately following successful (hits) or unsuccessful stimulus detections (misses). Graph-based features of transient and dynamically synchronized networks where described following stimulus onset to compare di erent visual field states of normal and partially damaged visual field sectors (areas of residual vision, ARVs).

Results: Compared to controls, hits in the *intact* visual field sector in patients where associated with connectivity topology changes characterized by less cluster, but more large scale connections with low e ciency. In areas of residual vision, hits in patients evoked a network dynamic change with weaker node strength and less clustering, shorter characteristic path length and poorer small-world-ness than hits in their intact field. These rapid FCN topology changes happened primarily in high alpha and beta band in the late "cognitive processing stage (300-600 ms).

Conclusion: Patients with optic nerve damage have a weaker processing balance of functional integration and segregation during the cognition which reduces local and global information interactions. FCN fluctuations are thus a physiological correlate of response variability of visual functions and network modulation might be a possible target for modulating visual performance.

7. VERÖFFENTLICHUNGEN

BEGUTACHTETE ZEITSCHRIFTENAUFSÄTZE

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