

# Sektion Funktionelle Sehforschung/ Elektrophysiologie: Projects

[basic](#) [clinical](#) [collaborations](#) [history](#)

## Basic research

### Our projects from the university research database

#### Mechanisms of ambiguous perception ([Dr. Jürgen Kornmeier](#))

Ambiguous figures are a class of optical illusions that impressively demonstrate the constructive nature of our perception: Prolonged observation of such a figure (e.g. the Necker cube) leads to spontaneous perceptual reversals (e.g. of the 3D-orientation) although the figure stays unchanged. We found electrophysiological evidence that the perceptual reversal is initiated already during early visual processing (120 ms). [#More details](#) on our analysis of what happens in the brain when a Necker cube reverses.

#### Functional imaging of the retina ([Fabrice Moret](#), [Michael Bach](#))

Neural activity induces changes in local blood flow through a mechanism referred to as neurovascular coupling. The eye is a unique organ which simultaneously allows selective physiologic stimulation of neural activity, recording of electrical responses by electroretinography, and of vascular responses by optical imaging, all in a non-invasive way, thus applicable in humans. We have developed a novel instrument which allows stimulating and assessing the neurovascular coupling chain. We are using this instrument to study the mechanisms of neurovascular coupling in healthy eyes, to shed light on the pathogenesis of glaucoma and to aid early diagnosis of this disease.

#### Binocular vision ([Guntram Kommerell](#), [Joanna Otto](#), [Michael Bach](#))

Advantage of binocular over monocular viewing, and optimisation of binocular cooperation: The advantage of binocular over monocular viewing consists not only in the ability for stereoscopic depth perception, but also in the summation of the signals from two, rather than from one sensor. This summation improves the signal/noise ratio. In the literature, binocular summation has been extensively studied with respect to the intrinsic neuronal noise between the retina and the brain. We investigate binocular summation in the presence of external noise in the form of particles between object and eye. In every-day life, sources of external noise are for instance rain drops or snow flakes, or a dirty windscreen. We are trying to quantify the disadvantage that subjects with only one functioning eye have under such viewing conditions. We also investigate to what extent strabismic eyes contribute to the binocular percept, and whether prismatic spectacles can improve the binocular cooperation.

#### Methodological research

- Efficient stimulation and recording schemes for event-related potentials.
- Time series analysis and statistics. How sure are we that an apparent effect in the data is really there?

#### Pattern ERG (PERG): Physiological and pathophysiological properties ([paper list](#))

- Little effect of ambient room lighting ([Bach & Schumacher 2002](#))
- PERG standard ([Bach et al. 2000](#))
- Dependence on check size ([Bach & Holder 1997](#))
- Effects of optic atrophy ([Bach et al. 1988](#), [Gerling et al. 1991](#), [Bach et al. 1992](#))
- Reproducibility ([Otto & Bach 1997a](#) {english}, [Otto & Bach 1997b](#))

- {deutsch})
- An unexpected interaction of contrast and temporal frequency ( [Zapf & Bach](#) )
- Alterations in early glaucoma (and even earlier) [see below](#)

## Clinical research

### Visual Acuities ([list of acuity-related papers](#))

#### Subjective acuity (psychophysics)

Visual acuity is one of the most common ophthalmological examinations. Using advanced computer technology, we have developed a computerized, semi-automatic self-paced test to measure visual acuity and contrast sensitivity ([Freiburg Visual Acuity Test, Bach 1996a](#) ). Currently we probe extension of quantitative acuity measures to very-low vision.

For a German review of acuity measures see [Bach & Kommerell 1998](#) (on-line version).

#### Objective acuity (electrophysiology)

- Robust VEP-based acuity estimation. We are using steady-state VEPs combined with a heuristic algorithm to obtain objective estimates of visual acuity in patients.
- 'Cognitive' visual acuity. What, if the reason for visual loss is located in higher cortical areas or a result of a somatoform disorder? We would like to identify these cases as well.

### Glaucoma, early detection ([paper list](#))

Glaucoma is one major reason for blindness in Germany. We examine electrophysiological and psychophysical tests for their viability to detect glaucoma in an early stage. Currently, our results indicate that the pattern ERG (PERG) combined with a multidimensional analysis is the most sensitive tool. Review: [Bach M \(2001\) Electrophysiological approaches for early detection of glaucoma. European J Ophthalmol 11:S41-S49 \(Suppl. 2\)](#)

Early POAG affects the PERG most at a check size of 0.8° ( [Bach et al. 1988](#) ), this effect is more pronounced at 16 rev/s as compared to 8 rev/s ( [Bach & Speidel-Fiaux 1989](#) ).

The PERG might help to identify those patients with elevated pressure, but without visual field damage (OHT patients), which are at high risk to actually develop glaucoma ( [Pfeiffer et al. 1993](#) ,

[Pfeiffer & Bach 1992](#) ).

PERG reduction is correlated with loss of neuroretinal rim area, but the PERG does not simply mirror the optic disc area or the rim area ( [Bach & Funk 1993](#) ).

The PERG seems to reflect a ganglion cell damage mechanism that is not spatially correlated with field damage ([Bach, Pfeiffer & Birkner-Binder 1992](#); [Bach, Sulimma & Gerling 1996](#); [Bach, Sulimma & Gerling 1998](#) ).

### Clinical Electrophysiology in Vision ([paper list](#))

Visual Electrodiagnostics is our “bread and butter”. Methods include: luminance ERG (scotopic and photopic), multifocal ERG (mfERG), EOG, Pattern ERG, VEP, mfVEP and ENG. These are utilized to aid in diagnosis of a wide variety of diseases, including: Retinitis pigmentosa in its many forms, cone dystrophies, hereditary macular diseases, toxic diseases, Best’s disease, M. Stargardt, glaucoma, optic neuritis, amblyopia and albinism. There is a [German introduction on line](#), and a [DTL tutorial](#).

## Collaborations and Guests (in reverse historical sequence)

- HD Dr. Günter Meinhard (texture segregation)
- Dr. Andra Pálffy, ophthalmologist (mfVEP)
- Fanni Molnár, ophthalmologist (motion)
- [Claus Normann, Psychiatry](#)  
(LTP / LTD in psychiatric patients)
- Julie Lachapelle & Michelle McKerral, Montréal, Canada (texture segregation)
- [Schaeffel Group](#)  
, University of Tübingen (contrast, gain control and myopia)
- W.B. Spatz, ENT University of Freiburg (stimulation methodology in animal experiments)
- [Ad Aertsen](#)  
, Biologie III, University of Freiburg (higher order EEG analysis)
- [Jürgen Hennig](#)  
, Kernspintomographie, University of Freiburg (functional MRI)
- Klaus Lieb, Dept. of Psychiatry, University of Freiburg (texture perception in psychiatric patients)
- [Hans Strasburger](#)  
(VEPs, methodology in stimulation and analysis)
- [Fahle Group](#)  
, Bremen (texture segregation and more)
- [Sabine Kastner](#)  
, now in Princeton (texture segregation)
- [Jens Timmer](#)  
, Freiburg (EEG analysis, modeling)
- Friedemann Simon, Hamburg (pattern ERG, laser interference)
- Graham E. Holder, London (pattern ERG)
- Bob Snowden, Cardiff (motion)
- [Thomas Meigen](#)  
, Würzburg (cooperation in everything)
- [Mark W. Greenlee](#)  
, Freiburg (Psychophysics, Electrophysiology in Parkinson's disease, fMRI advice)

## Old stuff and things that we work on once in a while

- Texture segregation
- Motion processing
- Albinism
- Color
- Various forms of adaptation
- Oscillations in the EEG
- Chaos in the EEG