

Mapping cone fields in the macaque visual system

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Abstract

In Old World primates, the three cone photoreceptor classes provide the starting point for trichromatic vision. These cone classes are characterized by differences in spectral sensitivity, in density with respect to distance from the fovea, and in relative abundance across individuals (Hofer et al., 2005). How neural signals originating from the cones lead to colour perception is still not understood. For example, there is controversy over the chromatic structure of the receptive fields of the midget class of retinal ganglion cells, which give rise to the parvocellular visual pathway. To distinguish colours, the responses of different cone types must be compared. It is uncertain if the centres and surrounds of midget ganglion cell receptive fields are composed of inputs from only one cone type, or from cone mixtures. These options lead to different colour-coding schemes in the retina, and thus dictate how colour must be processed downstream. To solve this and other problems concerning visual perception, it would be useful to have a way to directly map the cone fields that initially define every receptive field.

The main impediments to achieving this goal have been the inability to resolve and stimulate individual cones in the living retina. To begin to overcome these difficulties, we used an adaptive optics scanning laser ophthalmoscope (AOSLO) to visualize and stimulate the cones in vivo in the macaque (Roorda et al., 2002; Arathorn et al., 2007). We made extracellular recordings in the lateral geniculate nucleus to map the cones providing excitatory input to single parvocellular neurons, and assessed the efficacy of each cone's input for eliciting responses (Sincich et al., 2009). We found that parvocellular neurons can be mapped reliably by this method, and that the probability of evoking a spike with each stimulus flash varied considerably from cone to cone. This variability appeared to have two sources: a high sensitivity to the position of stimuli relative to each cone, and more variation in the synaptic weighting of cones than would be predicted if each class had a characteristic weight. For receptive field centres comprised of multiple cones, we also found that stimulation of just one of these cones leads to geniculate transmission with high probability. This result suggests that activation of a single cone within a large receptive field is sufficient for perception.

Although our studies are at an early stage, cone imaging with an AOSLO, performed in conjunction with traditional electrophysiology, is a promising way to study the inputs to the visual system at the elemental level of the single cone. Receptive fields recorded at any level of the visual system can then be mapped by what they are truly made of - cone fields.

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Do power functions describe spatial sensitivity of cells in the parvocellular pathway better than DOGs?

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Abstract

The spatial sensitivity of primate cone-opponent parvocellular (PC) cells is usually described mathematically as a difference of Gaussians (DOG). This has some unwanted consequences in the modelling of colour vision. In particular, DOG functions imply that the ratio of inhibition to excitation of a single cell changes drastically as a function of stimulus size. This would be expected to lead to a large hue change in the stimulus that is not observed psychophysically. In dealing with this problem we have analysed the area responses of some PC-cells in the lateral geniculate nucleus (LGN) of the macaque monkey.

The receptive fields of the recorded M/L and L/M PC-cells were around 5–10 degrees parafoveal. The firing rates were recorded in response to achromatic and chromatic stimuli of different wavelengths, relative intensity and size. Stimuli were generated by opto-mechanical means, thus allowing an extensive range of luminance and chromaticity variation. Test stimulus duration was 300 ms and alternated with a white 110 cd/m² adaptation field of 1200 ms duration. The size of the adaptation field was 4° x 5°. The size of the test stimulus was varied from 0.2° in diameter to 4° x 5°.

The spatial sensitivity profile of the classical receptive field (Wiesel et al., 1966) of several Type II L/M PC-cells (co-extensive excitatory and inhibitory fields) clearly followed a power function as a function of area (Lee, 1996). The power was approximately -1. When area increments of the test stimulus attenuated the response, it did not change the balance between the excitatory and inhibitory components for the cells studied here. This means that

the L/M excitation ratio of a particular cell was the same for all test field sizes (Rodieck, 1991). The same interpretation accounts for the fact that adding a steady peripheral white annulus around the classical receptive field simply shifts the same intensity-response curve towards higher values on the log luminance ratio axis.

Theoretically, it can be shown that the opponent cone excitation ratio is constant for L/M Type II cells, favouring a power law, and that for Type I cells the same ratio varies much less than predicted for DOG functions (Valberg et al., 1985).

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Simultaneous colour contrast and the gamut expansion effect: Correlation across observers suggests a common mechanism

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Abstract

Context effects play a central role in colour science because they are considered to reflect the action of basic underlying mechanisms of colour processing. The primary subject of interest is of course not to understand the directly observable context effects themselves, but rather the underlying visual mechanisms. A major challenge to the study of these mechanisms is the fact that multiple mechanisms may contribute to the net effect measured in a given experimental setting. Correct assumptions about which mechanisms contribute to a given context effect and how they can be studied in isolation are therefore a prerequisite for determining the characteristic properties of each mechanism.

We present the results of an experiment aiming to clarify the relation between simultaneous colour contrast and Brown and MacLeod's (1997) gamut expansion effect. These two context effects are often thought to be due to two different mechanisms. Simultaneous contrast, which is generally described as a translation in colour space, is attributed to a mechanism adapting absolute sensitivity to the mean colour of the surround, while the gamut expansion effect, which was described as an expansion in colour space, is attributed to a second mechanism adapting contrast sensitivity to the colour variance in the surround (Webster, 2003). Thus, it should be possible to study the former mechanism in isolation by using zero-variance (uniform) surrounds with different mean co-

lours (simultaneous contrast experiment), while the second mechanism could be isolated by keeping the mean colour of the surrounds constant and manipulating the colour variance of the surrounds (gamut expansion experiment).

Previous work of ours (Ekroll & Faul, 2009), however, suggests that a common mechanism of crispening (Whittle, 1992) influences the results in both experimental settings. More specifically, the results of the gamut expansion experiment may be due to the crispening mechanism only, while the results of the simultaneous contrast experiment seems to originate from the combined influence of the crispening mechanism and a second mechanism of von Kries adaptation. We tested the hypothesis of a common mechanism by performing parallel simultaneous contrast and gamut expansion experiments using the same observers. Using the model presented in Ekroll and Faul (2009) we estimated an individual parameter representing the amount of crispening based on each experimental paradigm separately. These parameter estimates correlated across observers, suggesting the existence of a common mechanism, which is more strongly developed in some individuals than in others.

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Rate dynamics of leaky integrate-and-fire neurons with strong synapses

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Abstract

The function of the brain relies to a large extent on its ability to reliably track transient sensory and internal signals. A plethora of theoretical and experimental studies has therefore been dedicated to investigating the dynamic response characteristics of populations of neurons (Knight, 1972; Lindner & Schimansky-Geier, 2001; Brunel et al., 2001; Fourcaud-Trocme et al., 2003; Silberberg et al., 2004; Naundorf et al., 2005; Koendgen et al., 2008; Boucsein et al., 2009). The majority of these studies are based on the assumption that neurons receive input spikes at a high rate through weak synapses (diffusion approximation). For most biological neural systems, however, this assumption cannot be justified: in the early visual pathway, for example, single action potentials emitted by retinal ganglion cells initiate response spikes in postsynaptic thalamic cells with a high probability (Cleland et al., 1971). Also within the neocortex and the hippocampus, a considerable fraction of synapses have moderately strong weights (Fetz et

al., 1991; Bannister & Thomson, 2007). Previous studies typically consider modulations in either the mean or the variance of somatic input currents as input signal. In general, however, modulations in the presynaptic firing rate cause modulations in both parameters simultaneously. So far, it is unclear how a population of neurons transmits time-varying presynaptic firing rates if the diffusion assumption is dropped.

In the present study, we numerically investigate the stationary and non-stationary response properties of leaky integrate-and-fire (LIF) neurons receiving input spikes through arbitrarily strong excitatory synapses. Input spike trains are modelled as inhomogeneous Poisson point-processes with sinusoidal rate. Modulation amplitudes and phases of the trial-averaged spike responses are measured for a broad range of stimulus modulation frequencies and synaptic weights.

For small modulation depths, the transfer function can be well modelled by a linear low-pass filter. Below a critical synaptic weight, the cut-off frequencies are approximately constant and limited by the synaptic time constants. Only for synapses with unrealistically strong weights beyond the critical one, the cut-off frequencies can increase significantly. To account for stimuli with larger modulation depths, we combine the measured linear transfer function with the nonlinear response characteristics obtained for stationary inputs. The resulting nonlinear-linear model accurately predicts the responses for arbitrary stimuli.

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When synaesthetic and real colours compete for attention

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Abstract

Some individuals claim to perceive illusory colours when reading symbols, a phenomenon called colour synaesthesia (Baron-Cohen & Harrison, 1997). What is most puzzling is that these synaesthetes report that one object, for example the letter A, can have two colours at the same time (i.e. the colour of the ink—black, and an additional illusory colour—red). We first obtained CIE1931 (x, y) values of each synaesthetic colour by asking synaesthetes to colour each symbol (in MS Word 2000). We then explored the neural correlates of this phenomenon with a Stroop-like colour-naming task (Rich & Mattingley, 2002) during event-related fMRI measurements. In the fMRI scanner, symbols could be shown in colours that were different (incongruent) from the originally reported synaesthetic colours. We then computed the chromatic distance in CIE1931 (x, y) chromaticity space between the colours of the symbols presented on screen and the symbols' illusory colours and used the distance as a parameter to identify which brain regions showed co-varying activity. It was found that activity in known colour-processing areas of the brain (e.g. Morita et al., 2004) was modulated by the chromatic distance between illusory and presented colours. We suggest that the same neural substrate that supports the conscious experience of colour also supports the experience of synaesthetic colours.

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Is CFF Perimetry affected by the learning effect?

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Abstract

Critical Flicker Fusion (CFF) Perimetry modulates the frequency of the flickering stimulus from slow (1-5 Hz) to fast (towards 50 Hz) and measures the maximum frequency at which flicker can be perceived. CFF Perimetry, as a diagnostic method, principally tests the functioning of the retinal ganglion cells that project to the magnocellular pathway. As a consequence, the technique may be useful in the detection of functional damage in open angle glaucoma (OAG). Standard automated perimetry (SAP) and short-wavelength automated perimetry exhibit a clinically important learning effect whereby the differential light sensitivity improves within and between the initial examinations. CFF perimetry has recently become commercially available and it is important to determine the utility of the technique. However, before this can be undertaken, it is essential to determine the characteristics of any learning effect for CFF Perimetry.

The aim of this study was to determine the learning effect for CFF perimetry in normal individuals and in individuals with cataract, naïve to both SAP and CFF perimetry, and in individuals with either ocular hypertension (OHT) or OAG and experienced in SAP, but naïve to CFF perimetry.

The cohort comprised 71 age-matched individuals: 28 normal individuals [mean age 62.46 yrs (SD 8.7)] and 22 individuals with cataract [mean age 69.72 yrs (SD 9.07)] all naïve to both SAP and CFF Perimetry; and 10 individuals with OHT [mean age 63.6 yrs (SD 9.6)] and 11 individuals with OAG [mean age 66.3 yrs (SD 6.6)] all experienced in SAP but naïve to CFF Perimetry. Cataract type and severity were classified by LOCS III. All individuals underwent a clinical examination at baseline including SAP and CFF Perimetry using Program G1, stimulus size III and Tendency Orientated Perimetry of the Octopus 311 perimeter. After an interval of one (individuals with cataract) or two weeks (normal individuals and individuals with either OHT or OAG), CFF Perimetry was again undertaken in an identical manner and subsequently repeated on three further occasions, (or two in the case of those with cataract) each separated by one week. The right eye was always examined before the left eye. The results over the 4 or 5 visits were principally analysed in terms of the Mean Defect (MD) and Loss Variance (LV) indices.

Large between-individual variation in performance was present within and between each diagnostic group. The group mean MD changed for the right and left eye respectively by 0.14 Hz (SD 4.46) and 1.53 Hz (SD 5.46) for the normal individuals, by 5.72 Hz (SD 6.07) and 3.56 Hz (SD 5.95) for those with OHT, by 1.82 Hz (SD 6.88) and 2.1 Hz (SD 8.33) for those with OAG and by 1.19 Hz (SD 3.4) and 0.92 Hz (SD 3.91) for those with cataract. The LV exhibited qualitatively similar dif-

ferences within and between visits and diagnostic groups. The between-individual variation in performance will not facilitate the interpretation of field loss by CFF perimetry. In general, CFF perimetry is too difficult a task to make it clinically viable.

Accommodative variability in early onset myopia

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Abstract

While it has been accepted that image blur is a possible cause of early onset myopia, the source of this blur is still poorly understood. One possibility that we have been investigating is the role of variability in accommodation as a potential causal factor. In a series of two experiments, we investigated the temporal relationship between accommodative variability and early onset myopia. We predicted that children under the age of 15 with myopia would have greater accommodative variability than an age-matched control group. We also predicted that if the accommodative variability were a causal factor, the differences in variability at an early age would predict myopia at a later age.

In the first experiment (Visit 1), 23 children with myopia [spherical equivalent (SE) \leq -0.50 in both eyes] were tested, along with 18 control children (SE \geq 0.25). In the second experiment (Visit 2), which took part two years later, 16 children with myopia and 13 control children returned for testing. All children were younger than 15 yrs at Visit 1. Measures of accommodation were made with an eccentric infrared auto refractor (PowerRefractor II, PlusOptiX, Nürnberg, Germany). The refractive status of the eyes was recorded dynamically at a frequency of 0.25 Hz. The children were instructed to focus on highly accommodative targets set at three different distances (accommodative demands of 0.25, 2.0 and 4.0 D). Each target was viewed in a pseudo-random sequence designed so that all distances were tested twice.

In this study, we were interested in whether accommodative variability measured two years earlier at Visit 1 was related to refractive error at Visit 2. When participants were grouped according to their refractive status at Visit 2, the myopic children were found to have had significantly greater accommodative variability at Visit 1 than the emmetropic children. In contrast, when participants were grouped by the refractive status at Visit 2 the difference in accommodative variability at the concurrent Visit 2 was not significant. In addition, refractive error measured at Visit 2 was more highly correlated with accommodative variability at Visit 1 than at Visit 2.

The results indicate that accommodative variability might precede the actual development of myopia, and might therefore be a predictive value in determining myopic progression.

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Impaired motion sensitivity in normal ageing and in patients with glaucoma and age-related macula degeneration

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Abstract

Age-related macular degeneration (AMD) and primary open angle glaucoma (POAG) are two primary causes of irreversible adult blindness and progressive visual field loss. In AMD high-resolution central vision is lost, but peripheral vision is spared. In POAG peripheral vision is lost, but central vision is generally spared. Both AMD and POAG are age-related eye diseases, and as the elderly population is growing the morbidity associated with these conditions will rise. A leading problem for these patients is the visually-guided task of mobility, which gets steadily worse with advancement of visual field loss (e.g. Turano et al., 2004). Traditionally, optic flow is thought to be important for mobility and navigation. We have previously shown that motion-coherence thresholds and speed-discrimination thresholds to radial optic flow dot patterns remain unchanged with eccentricity in normally-sighted and AMD, but decline in POAG (Falkenberg & Bex, 2004, 2008). This study uses a signal to noise motion sensitivity task to investigate how motion sensitivity changes with age and central and peripheral visual field loss.

The sensitivity to the direction of expanding and contracting optic flow was determined in normal ageing and patients with peripheral (POAG) and central (AMD) visual field loss. Contrast discrimination thresholds to the direction of heading motion were measured as a function of level of added external noise at different retinal eccentricities. The observers were required to discriminate whether the motion of a real-scene driving movie was forward or backward. Feedback was given and fixation was monitored with an eye-tracker (Cambridge Research System Ltd., Rochester, UK). An equivalent noise paradigm was used to examine the underlying changes in internal noise and sampling efficiency with eccentricity.

Our results showed that contrast sensitivity to the direction of optic flow fell with retinal eccentricity for all observers, and decreased with both age and visual field loss. Equivalent noise analysis showed that the reduced sensitivity with eccentricity was primarily due to reduced sampling efficiency, with little increase in the level of internal noise, and that the fall-off

with age was attributable to both sources of error. Compared with age-matched control observers, patients with POAG and AMD have similar levels of internal noise but significantly lower sampling efficiency (Falkenberg & Bex, 2007).

Motion sensitivity impairs with age, eccentricity and visual field loss. This loss can arise from higher levels of internal noise and lower sampling efficiency. In patients with POAG and AMD, the loss is mostly attributable to a reduction in sampling efficiency. This suggests that retinal ganglion cells are non-functional rather than dysfunctional, at least in glaucoma (Falkenberg & Bex, 2007).

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Contrast sensitivity, colour vision and cone coupling

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Abstract

The arrangement of L- and M-cones in the human retinal mosaic is of importance with regards to spatial and chromatic vision. Here, contrast sensitivity was measured at a range of spatial frequencies for groups of observers with varying degrees of colour-discrimination ability. Eight normal trichromatic males, eight normal trichromatic females, five deuteranomalous trichromatic males, and five female carriers of a deutan colour-vision defect were classified with a battery of colour-vision tests. Spatial contrast sensitivity was tested with horizontally oriented Gabor patches (full-width-at-half-height of 1 deg) at ten different spatial frequencies from 1.2–31.0 c/deg. Observers were corrected to best logMAR letter acuity and viewed the stimuli monocularly through a 2.8 mm artificial pupil from a distance of 6 m. Average luminance of the Gabor patch was 35 cd/m².

There were distinct group differences between normal trichromats, carriers and deuteranomalous observers with regards to colour discrimination. There was no difference in contrast sensitivity for high or medium spatial frequencies between the groups. There was, however, a difference in performance for the lower spatial frequencies. Normal trichromatic females showed the highest contrast sensitivity of all at 1.2 and 2.0 c/deg. Deuteranomalous males had the lowest contrast sensitivity for the same spatial frequencies, whereas normal males and carriers had contrast sensitivity that fell in between these two groups.

An artificial pupil of 2.8 mm excludes optical effects; hence observed differences must be neural in origin. The human retina has an arrangement of L- and M-cones that is random, forming patches with cones of the same type, either L- or M-cones. This gives rise to increased coupling between cones of the same type. Modelling has shown that coupling between cones of the same type improves achromatic contrast sensitivity for stimuli of low spatial frequencies (Hsu et al., 2000). There are differences in the retinal mosaic between the four groups of observers that may explain the results. One difference is related to L/M-cone ratios; it is likely that normal trichromatic females have a higher density of M cones than the others (Miyahara et al., 1998). Another difference is that the retinal mosaic in females is governed by X-chromosome-inactivation (Lyon, 1972) and it comprises patches made up of cells expressing either the maternal or the paternal L- and M-cone photopigments. It is hypothesised that variation in human retinal mosaics gives rise to differences in coupling strength between cones of the same type and that this correlates with variation in contrast sensitivity at low spatial frequencies.

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A model of bottom-up and top-down processing in the columnar architecture of the neocortex

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Abstract

Experimental data suggests that a first hypothesis about the content of a complex visual scene is available as early as 150 ms after stimulus presentation. Other evidence suggests that recognition in the visual cortex of mammals is a bidirectional, often top-down driven process.

Here, we present a spiking neural network model that demonstrates how the cortex can use both strategies: Faced with a new stimulus, the cortex first tries to catch the gist of the scene. The gist is then fed back as a global hypothesis to influence and redirect further bottom-up processing. We propose that these two modes of processing are carried out in different layers of the cortex. A cortical column may, thus, be primarily

defined by the specific connectivity that links neurons in different layers into a functional circuit.

Given an input, our model generates an initial hypothesis after only a few milliseconds. The first wave of action potentials travelling up the hierarchy activates representations of features and feature combinations. In most cases, the correct feature representation is activated strongest and precedes all other candidates with millisecond precision. Thus, our model codes the reliability of a response in the relative latency of spikes. In the subsequent refinement stage where high-level activity modulates lower stages, this activation dominance is propagated back, influencing its own afferent activity to establish a unique decision. Thus, top-down influence de-activates representations that have contributed to the initial hypothesis about the current stimulus, comparable to predictive coding. Features that do not match the top-down prediction trigger an error signal that can be the basis for learning new representations.

Corticogeniculate feedback can increase input to visual cortex by facilitation of thalamocortical neurons and depression of inhibitory interneurons

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Abstract

The dorsal lateral geniculate nucleus (LGN) is the thalamic gateway which regulates the transmission of signals from the retina to the visual cortex. The nucleus performs complex integrative functions and regulates the transmission to the cortex in a state-dependent manner (sleep, wakefulness, arousal, attention, vigilance) based on modulatory input from various state-related nuclei in the brainstem. Interestingly, the transmission through LGN is also regulated in a two-way dialogue with the visual cortex. The mechanisms for cortical control of the flow of visual information to the cortex from the LGN are poorly understood. We addressed this question by studying cortical modulation of synaptic short-term plasticity (facilitation or depression) at corticogeniculate synapses on LGN neurons.

The LGN contains two types of neurons: thalamocortical (TC) neurons and local interneurons. Both types receive their primary excitatory input from retinal afferents. Interneurons send inhibitory output to TC neurons, while TC neurons send excitatory output to neurons in the visual cortex. Cortical feedback-control of LGN neurons is provided by cortical neurons with axons that have excitatory synapses on both TC neurons and interneurons. It is known that short-term plasticity of corticogeniculate synapses on TC neurons is characterized by facilitation, which is considered to amplify input to the cortex from the LGN. However, the kinetics of the facilitation, and how it develops by different patterns of activity in the cortical afferents, is not well understood. Type and kinetics of

short-term plasticity of corticogeniculate synapses on interneurons is unknown.

We compared characteristics of short-term plasticity at corticogeniculate synapses on interneurons and TC neurons in acute thalamic slices, and studied effects evoked by different patterns of firing (paired-pulse, pulse trains) in the corticogeniculate afferents induced by electrical pulse-stimulation. We studied postsynaptic integration of AMPA-receptor mediated currents evoked by the various stimulation patterns, using a whole-cell voltage-clamp technique.

Stimulation of corticogeniculate afferents elicited pronounced depression in interneurons in contrast to the facilitation of TC neurons. The depression of interneurons and the facilitation of TC neurons increased with increasing pulse-frequency and increasing duration of pulse trains. Moreover, the accumulation of depression in interneurons occurred at a faster rate than the accumulation of facilitation in TC neurons. These different properties of synaptic plasticity indicate an interesting cortical control mechanism. Longer-lasting and high-frequency trains of action potentials in the corticogeniculate afferents simultaneously induce strong facilitation of the TC neurons and pronounced depression of interneurons. The depression of the interneurons implies reduced inhibition of TC neurons. Thus, the gain of the transmission is increased through the increased facilitation and decreased inhibition of the TC neurons. Short-lasting bursts of action potentials or single spikes in the afferents, however, generate only weak depression of the interneurons such that strong inhibition of the TC neurons is maintained. This, combined with weak facilitation of the TC neurons, results in reduced gain of the transmission. Thus, by changing the pattern of firing in the cortical afferents, the corticogeniculate feedback may regulate the transmission of signals from the LGN to the cortex in a graded manner between amplification and attenuation.

Compartmental modeling of LGN interneuron

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Abstract

The lateral geniculate nucleus (LGN) is a part of thalamus, which receives visual signals from retinal ganglion cells and transmits processed information to the visual cortex. The processing involves refinement of the receptive field, and temporal decorrelation of visual input. However, the function and dynamics of the LGN are state dependent, and differ between sleepy and awake states. The main cell types of the LGN are excitatory relay cells, which project to the cortex, and inhibitory, more local interneurons.

A full mechanistic understanding that explains the LGN activity on the basis of neuronal morphology, physiology and circuitry is currently lacking. Here, we develop a compartmental model of the LGN interneuron, which has been less

studied than the relay cell. LGN interneurons are GABAergic, and are thought to shape the information flow from relay cells to the cortex by refining the receptive field and controlling the number of visually evoked spikes (Acuna-Goycolea et al., 2007). They are unusual in that their dendrites are both post- and pre-synaptic, and form rare triadic synapses with thalamocortical cells. It is believed that these triads may perform independent computations, which are functionally decoupled from the soma (Zhu & Heggelund, 2001; Briska et al., 2003).

Our model will include a detailed dendritic morphology, based on our own experimental data. Given the diverse roles of the interneuron dendrites, we expect that active dendritic conductances will be crucial for understanding the function of the LGN interneurons. By including dendritic ion-channels, we will go beyond previous modelling efforts, which typically use the simplification that the dendrites are passive (Zhu et al., 1999; Briska et al., 2003; Perreault & Raastad, 2006). The presence and kinetics of specific ion-channels will be deduced partly from previous literature (Zhu et al., 1999; Zhu & Heggelund, 2001; Acuna-Goycolea et al., 2007), and partly from our new experiments, including whole-cell voltage-clamp, and calcium imaging. The simulation tool NEURON (<http://neuron.duke.edu/>) will be used. Model parameters will be fitted to experimental data using some optimization algorithm. In this interplay between modelling and experiments, we wish to deduce the responsible mechanisms behind essential features in the LGN interneuron activity. Particular emphasis will be placed on detecting mechanisms that can explain shifts between different modes of activity, such as the shifts between bursting and regular spiking activity observed in LGN interneurons (Zhu et al., 1999), and the functional decoupling of the distal dendrites from the soma (Zhu & Heggelund, 2001).

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Simulation and visualization of models of the early visual pathway using PyNEST and ConnPlotter

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Abstract

We present the PyNEST simulator (Eppler et al., 2009) and the NEST Topology Module (Plesser & Austvoll, 2009) as tools for the efficient description and creation of large-scale, layered models of the early visual pathway. We demonstrate the possibilities of these tools by implementing a model of the visual thalamocortical system presented by Hill and Tononi (2005), which reproduces the transition between sleeping and waking state. We will further show how our new tool, the ConnPlotter, can be used to visualize network connectivity directly from the simulation scripts as connection pattern tables (Nordlie & Plesser, 2009), which are extended versions of connectivity matrices used by neuroanatomists (Felleman & Van Essen, 1991).

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The International Neuroinformatics Coordinating Facility (INCF) fosters international activities in neuroinformatics and related fields. The organization was established in 2005 through the Organization for Economic Co-operation and Development (OECD) Global Science Forum, and now includes 14 member countries, including Norway. The Secretariat offices are located in Stockholm, at Karolinska Institutet and the Royal Institute of Technology. The INCF web site (www.incf.org) is now effectively an international hub for neuroinformatics and in particular dissemination of neuroinformatics tools (software.incf.org).

The Norwegian national node of the INCF was established at the University of Oslo (UiO) in 2007 and is lead by professors Gaute T. Einevoll (UMB, Ås) and professor Johan Storm (UiO). The main role for the node is to promote neuroinformatics in Norway and, in particular, facilitate that the Norwegian neuroscience community benefits maximally from the Norwegian membership of INCF. The node is predominantly funded by a grant from the Research Council of Norway, and an important activity is the funding of small projects to engage the neuroscience community in neuroinformatics. For information about the node and the small-projects program, see www.cmbn.no/incf.

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