Receptive fields and suppressive fields in the lateral geniculate nucleus

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The lateral geniculate nucleus

Contralateral eye





Ipsilateral eye



The receptive field of LGN neurons

LGN receptive field resembles that of retinal ganglion cells





Receptive field varies with space and time



A movie of an LGN receptive field

DeAngelis, Ohzawa & Freeman (1995)





Receptive field operates as a linear filter





R(x,y)



$\partial \partial U dv F(u,v)I(x+u,y+v) = R(x,y)$



Receptive field prediction of responses to complex stimuli



Gain control mechanisms





Retinal ganglion cells signal contrast – but not linearly



Troy and Enroth-Cugell, 1993







The need for adaptive responses



Contrast

Luminance

The need for adaptive responses







Luminance and contrast in natural vision



Luminance and contrast in natural images





Independence is a specific property of natural images



Modeling the adaptation mechanisms









Effects of luminance and contrast on temporal weighting function



Effects of luminance and contrast are independent





Effects of luminance and contrast are independent














How is local contrast computed?





The computation of local contrast













Model predicts size tuning and its contrast dependence



Jones & Sillito (1991) Jones & *al* (2000) Solomon, White & Martin (2002)

Model predicts contrast saturation and its size dependence



What are the visual preferences of the suppressive field?







The visual preferences of the suppressive field			
	Retina	LGN	V1
Spatial frequency		?	No
Temporal frequency			No
Orientation			?

Spatial extent of suppressive field



How does the suppressive field combine its inputs?





Textures with different statistics



LGN responses to texture stimuli



Estimating the temporal weighting function





Contrast gain cares only for standard deviation







Putting it all together











Testing the model on complex video sequences













Gain control corrects the shortcomings of the receptive field





Philosophy

Developing, constraining, and testing a model

Simple stimuli





Complex stimuli





Summary

- The receptive field of LGN neurons
- Gain control mechanisms for luminance and contrast
- Luminance and contrast in natural scenes
- Modeling the gain control mechanisms
- The computation of local contrast: the suppressive field
- Computations performed by the suppressive field
- Combining mechanisms into a model that operates on images
- Testing the model on complex video sequences