
Some of Adrian's first recordings from very small numbers of individual nerve fibres. Each spiky deflection is a single nerve impulse. These records were taken from the sensory nerves of a cat's toe. The toe was flexed slowly, more quickly and very rapidly to produce these three traces. The frequency of firing depends on the strength of the stimulus – Adrian's law.
Macaque visual cortex

V1 V2 V3 V4 MT MST PO PP TEO IT

Landmark discrimination

Object discrimination

Ungerleider & Mishkin, 1982
Hubel and Wiesel, 1968
Coherence controls visibility
Figure 6. The psychophysical effects of an ibotenic acid injection into MT in experiment w1. Solid line and error bars in A–D indicate the mean prelesion threshold and standard deviation for each condition tested; dashed line, postlesion thresholds obtained 24 hr after the MT injection. A. Motion thresholds for 5 different spatial intervals in the test (contralateral) hemifield. Again, the MT lesion caused striking elevations of motion thresholds in the test hemifield. B, Motion thresholds were within the normal range in the control (ipsilateral) hemifield. C, The MT injection had no effect on contrast thresholds in the test hemifield.
Visual stimulus

Neuronal response

Behavioral judgement
Fix Pt

Dots

Targets

1 sec
Britten, Shadlen, Newsome & Movshon, 1992
Barlow, Levick & Yoon, 1971

Britten, Shadlen, Newsome & Movshon, 1992
Britten, Shadlen, Newsome & Movshon, 1992
Neuronal threshold, choice (%) vs. Neuronal threshold, fixation (%)

Britten, Shadlen, Newsome & Movshon, 1992
Visual stimulus

Neurometric function
Neuronal response

Psychometric function
Behavioral judgement
Shadlen, Britten, Newsome & Movshon, 1996
Britten, Newsome, Shadlen, Celebrini & Movshon, 1996
Response ratio ("preferred"/"null")

Choice probability

Proportion of trials

Britten, Newsome, Shadlen, Celebrini & Movshon, 1996
Britten, Newsome, Shadlen, Celebrini & Movshon, 1996
Britten, Newsome, Shadlen, Celebrini & Movshon, 1996
Visual stimulus

Neurometric function

Psychometric function

Neuronal response

Behavioral judgement

Choice probability
COLUMNAR ORGANIZATION OF MT IN MACAQUE

Albright, 1984
Salzman, Murasugi, Britten and Newsome, 1992
Difference in preferred direction (deg)

Interneuronal correlation

Zohary, Shadlen and Newsome, 1994
Shadlen, Britten, Newsome & Movshon, 1996
Computing the likelihood of each direction

Threshold (% of coherence)

log L (\( r = 0 \))

log L (\( r \neq 0 \))

Choice probability

Number of neurons

\( \Delta \theta = 180^\circ \)

Shadlen, Britten, Newsome & Movshon, 1996
Jazayeri & Movshon, 2006
Fixate 350 msec

Targets appear 500 msec

Random dot motion 2 sec

Delay 500-1000 msec

Saccade

Shadlen and Newsome, 2001
Shadlen and Newsome, 2001
Responses in a reaction-time version of the direction discrimination task
Average LIP activity in a reaction-time task shows evidence of integration to a “decision boundary”

Roitman & Shadlen (2002)
MT neurons represent ongoing motion, while LIP neurons seem to represent the output of a neural integrator that accumulates evidence for decision making.

MT – sensory evidence
Motion energy “step”

LIP – decision formation
Accumulation of evidence “ramp”

Mike Shadlen
Diffusion to bound model

Momentary evidence
\( \Delta \text{Spike rate: } MT_{\text{Right}} - MT_{\text{Left}} \)

Accumulated evidence for Rightward and against Leftward

Criterion to answer “Right”

\( \mu = kC \)

\( C \) is motion strength (coherence)

Palmer et al (2005)
Responses in a reaction-time version of the direction discrimination task are well described by the “race” model of integration to a decision boundary.

\[ P = \frac{1}{1 + e^{-2k|C|^B}} \]

\[ t(C) = \frac{B}{kC} \tanh(BkC) + t_{nd} \]