Suspicious Coincidences
In the Brain

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UCSD
HHMI
Levels of Investigation

1 m
  CNS

10 cm
  Systems

1 cm
  Maps

1 mm
  Networks

100 μm
  Neurons

1 μm
  Synapses

1 Å
  Molecules
Hubel and Wiesel, circa 1969
“Sparse and Reliable Visual Cortical Activity during Nonclassical Receptive Field Stimulation”

Haider Krause, Duque, Yu, Touryan, Mazer and McCormick, 2010
“Sparse and Reliable Visual Cortical Activity during Nonclassical Receptive Field Stimulation”

Haider Krause, Duque, Yu, Touryan, Mazer and McCormick, 2010
On Center Response

Kuffler, 1953
Vernier Hyperacuity

A.    

B.    

Gerald Westheimer
Stereo Correspondence Problem

Julesz, 1971
Synchronized Firing in Retinal Ganglion Cells

Field and Chichilnisky, 2007
Neuromorphic Engineering

Carver Mead

Indiveri, Liu, Delbruck, Douglas
Neuromorphic Camera

Lichtsteiner, Posch and Delbruck, 2008
Dynamic Vision Sensor

Lichtsteiner, Posch and Delbruck, 2008
Stereo DVS Cameras

Bensoman et al., 2011
3D Tracking

Bensoman et al., 2011
Retinotethalamic Inputs to the Cortex
Thalamic Inputs to Spiny Stellate Neuron

Kara, Reinagel and Reid, 2000

Wang, Spencer, Fellous and Sejnowski, 2010
Predicting Synchrony from Reliability

Wang, Spencer, Fellous and Sejnowski, 2010
Dendrite Branch Synaptic Integration

Losonczy and Magee, 2006
Spike-Time Dependent Synaptic Plasticity

Bi and Poo (1998)
Sparse and Reliable Visual Cortical Activity during Nonclassical Receptive Field Stimulation

Haider Krause, Duque, Yu, Touryan, Mazer and McCormick, 2010
Reliability of Spike Timing

Mainen and Sejnowski, 1995
Reliability of Spike Timing
“To generate reasonably economical representations of the current scene the directly represented features should be suspicious coincidences – combinations of signals from lower levels that occur frequently but would be rarely expected by chance.”

Horace Barlow, 1994
Steve Kuffler
Horace Barlow
Tobi Delbruck

Zach Mainen
Ping Wang
Jean Marc Fellous
Don Spencer

Paul Tiesinga
Emilio Salinas