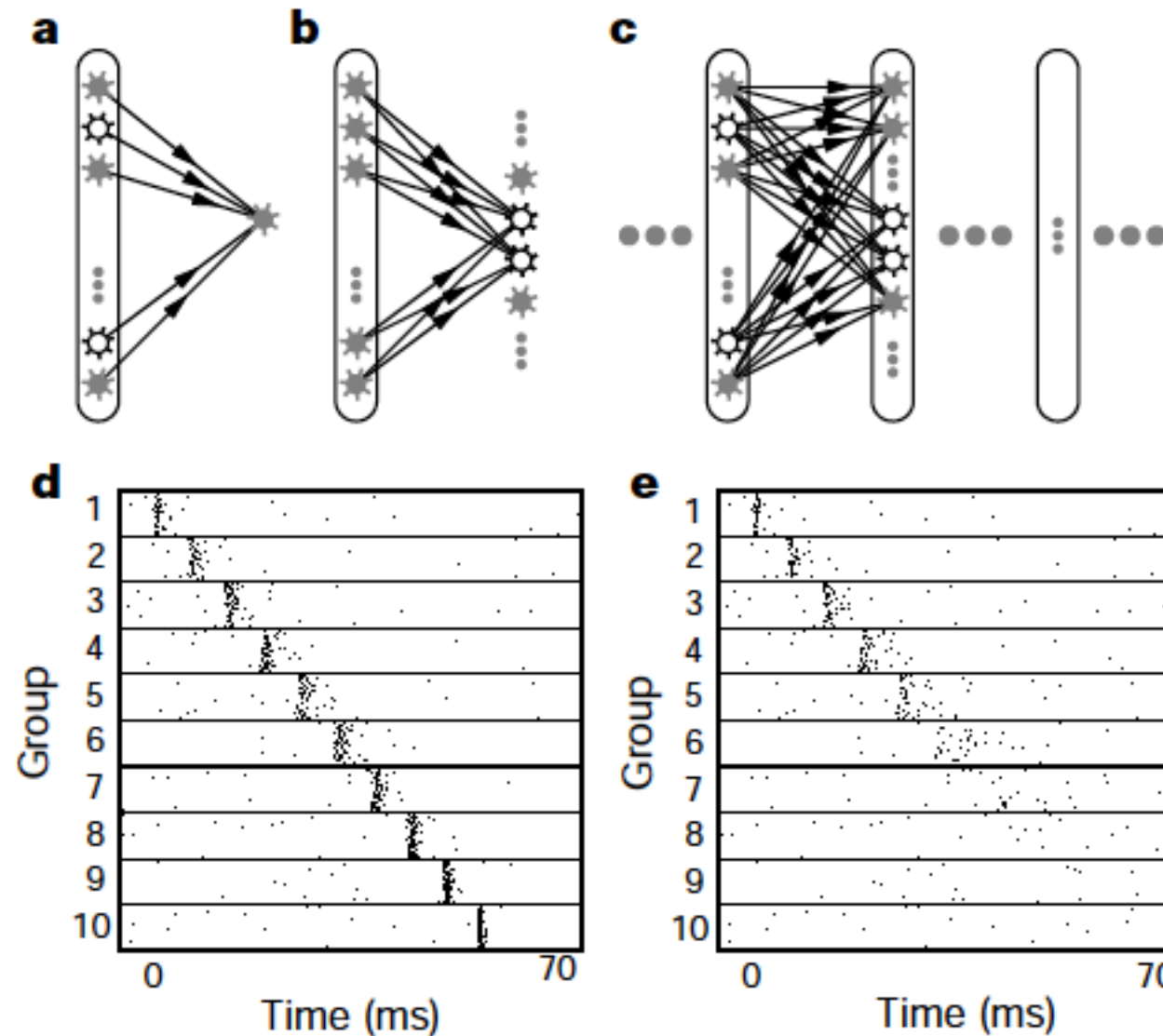# Nonparametric Statistics for Spike Data Analysis

Jonathan Platkiewicz
Department of Mathematics, City College of New York
Neuroscience Institute, New York University

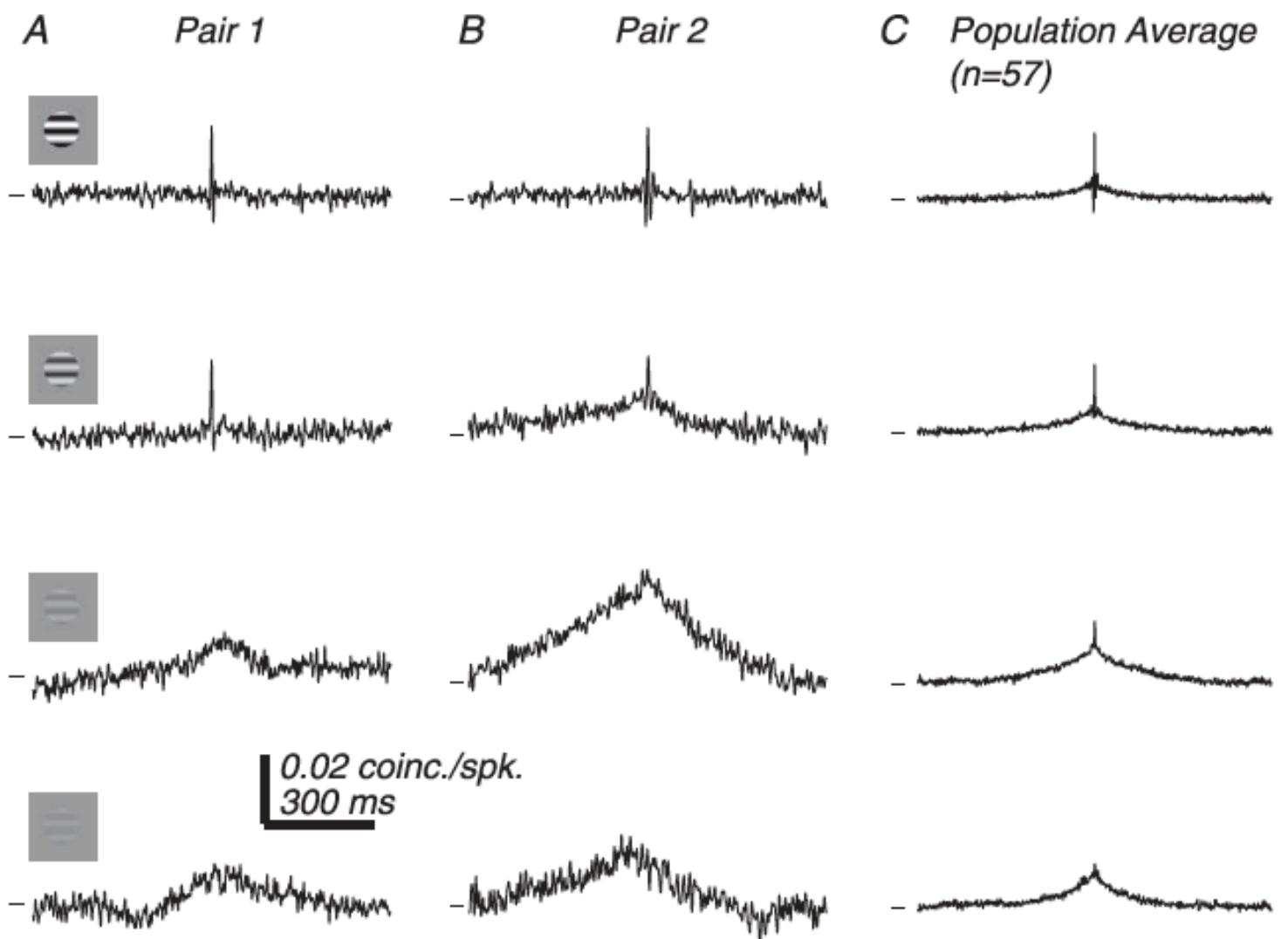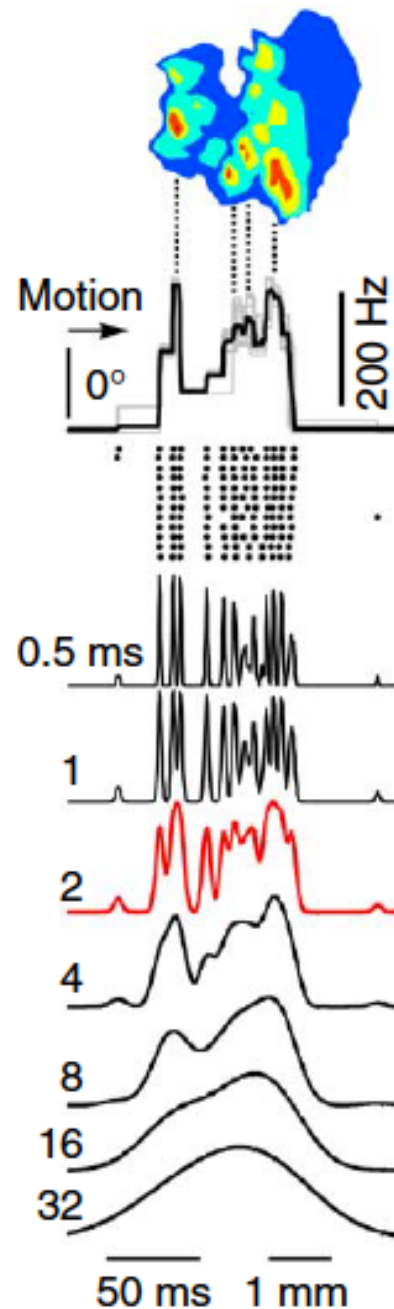Theoretical Neuroscience Workshop
Janelia, Sept 30, 2016

Bienenstock Thought Experiment

Diesmann, Gewaltig & Aertsen (1999), Nature
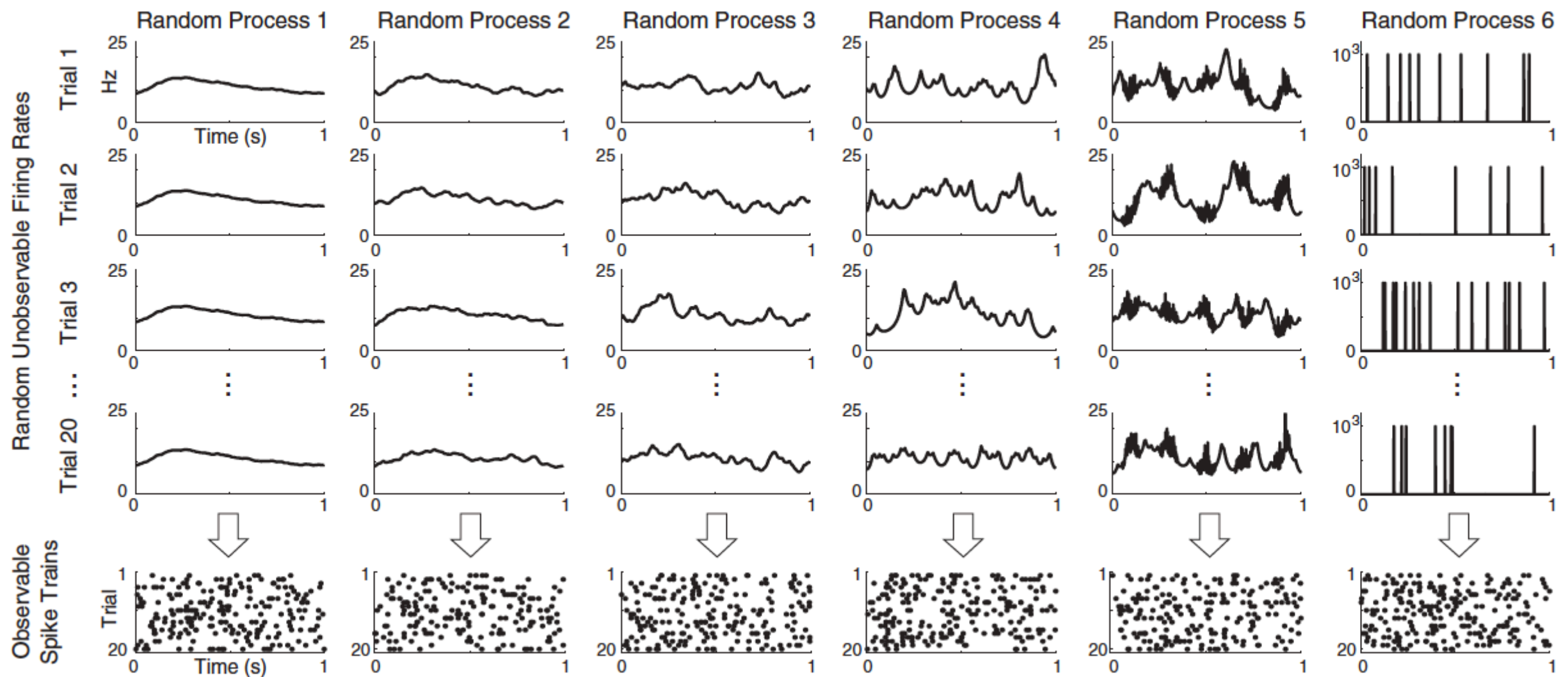Amarasingham, Harrison, Hatsopoulos & Geman (2012), J Neurophysiol

The Importance of Temporal Resolution

Pruszynski & Johansonn (2014), Nat Neurosci
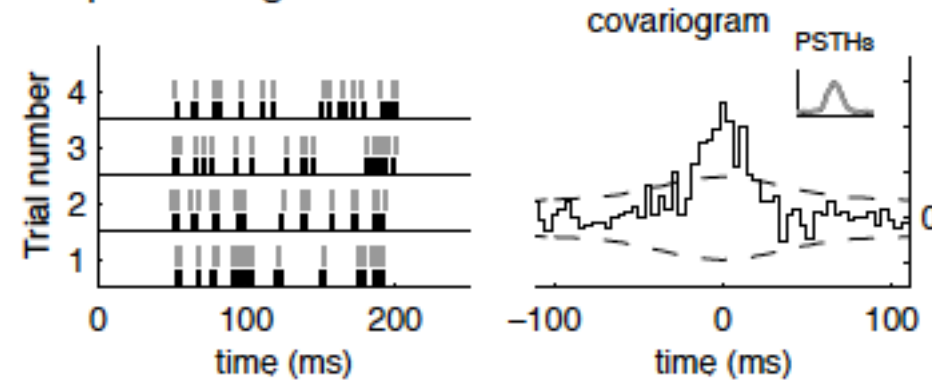Kohn & Smith (2005), J Neurosci

The Problem With Firing Rate Estimation

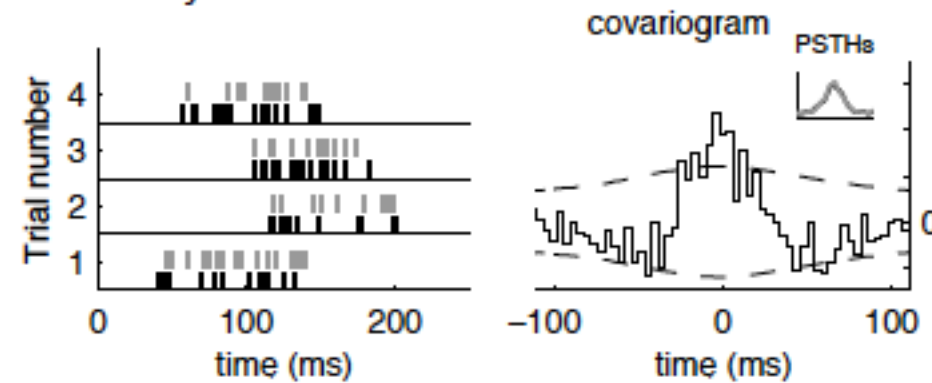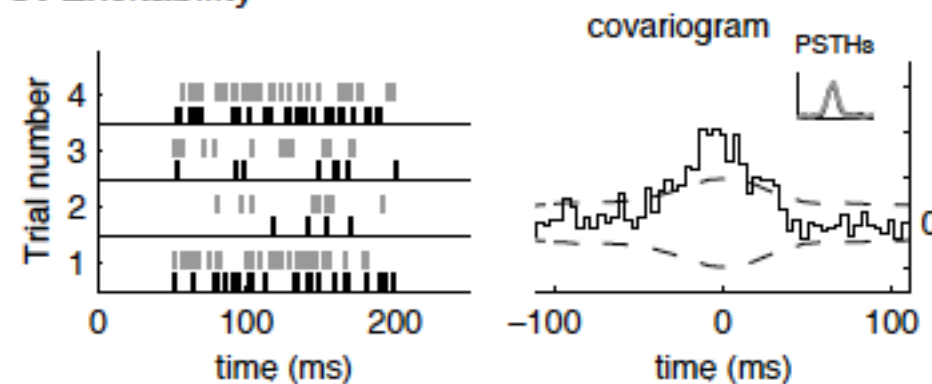Different Random Firing Rate Processes Can Create Identical Spike Train Processes

Amarasingham, Geman & Harrison (2015), PNAS

The Problem with Correlation Analysis
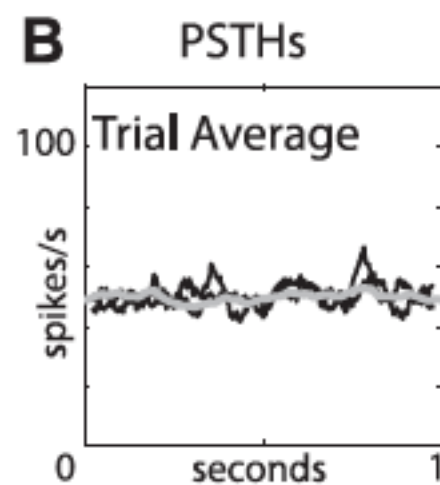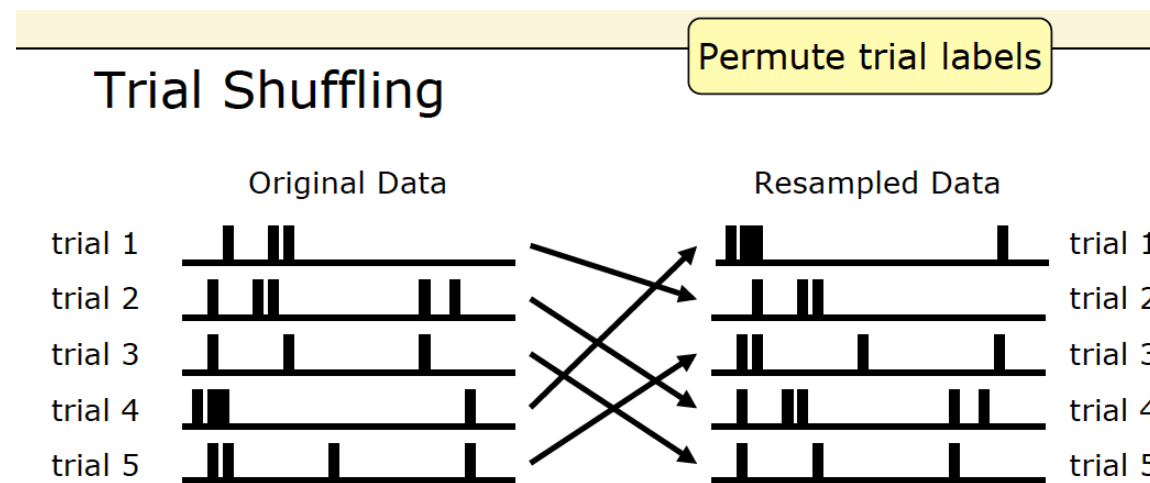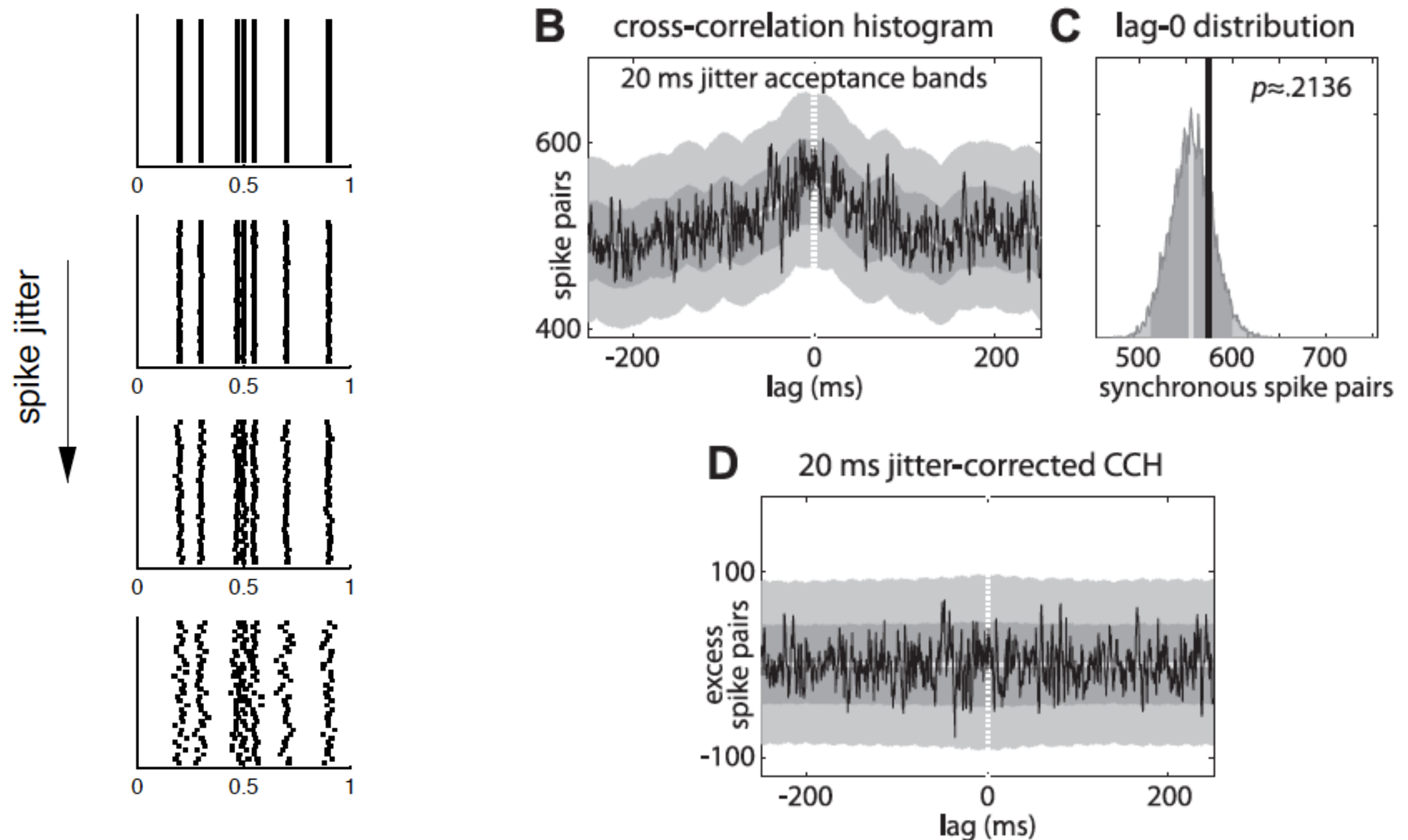
Toward a Statistical Definition of Temporal Resolution

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Amarasingham, Harrison, Hatsopoulos & Geman (2012), J Neurophysiol
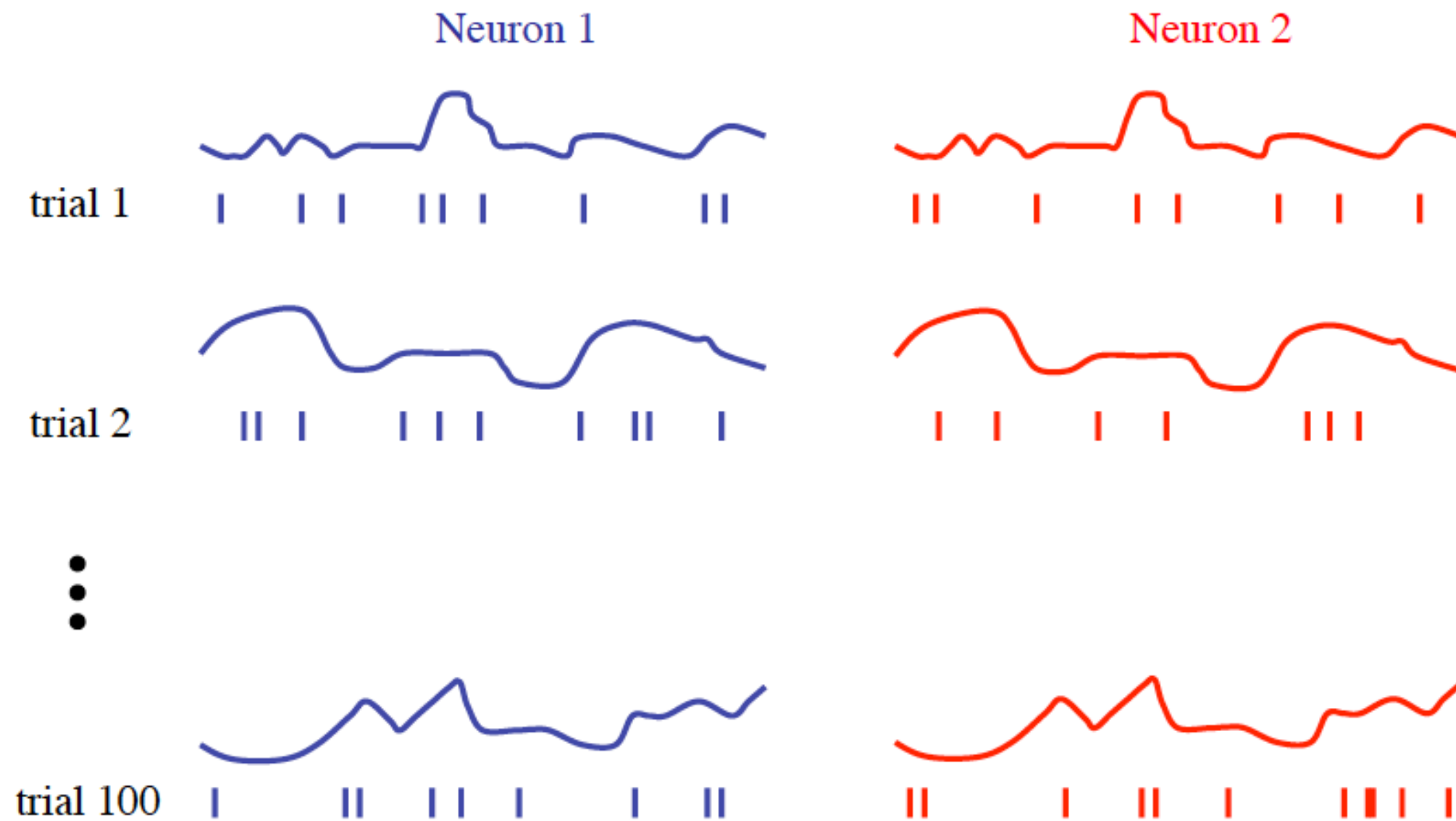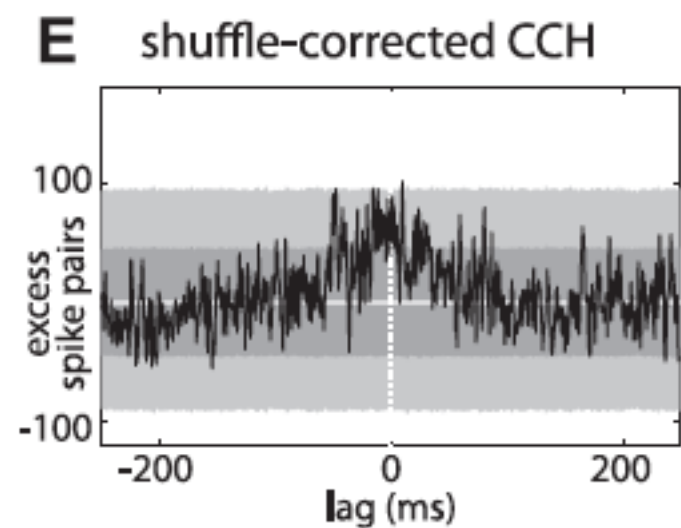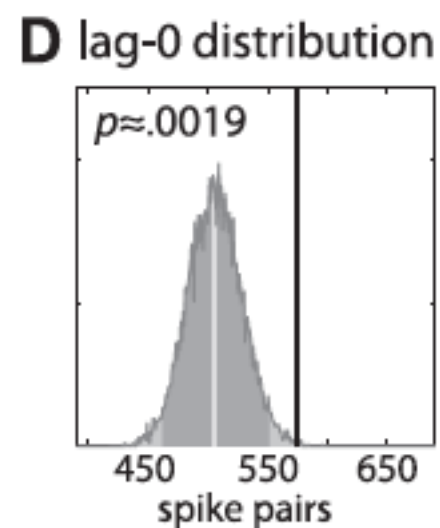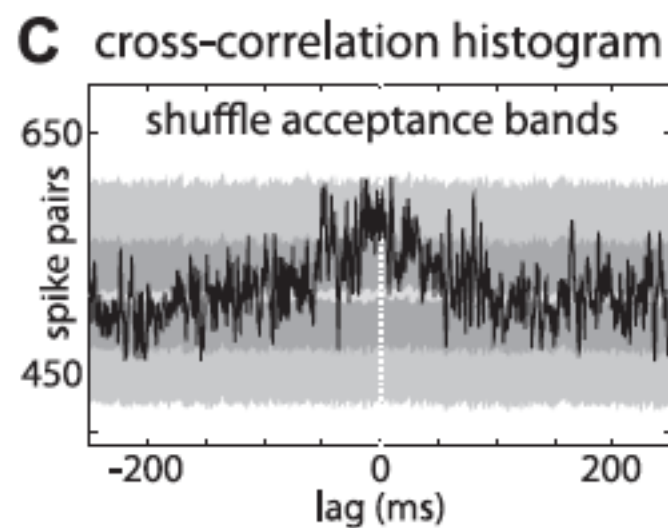
Resolution of the Temporal Resolution Problem: The Jitter Method

B cross-correlation histogram

20 ms jitter acceptance bands

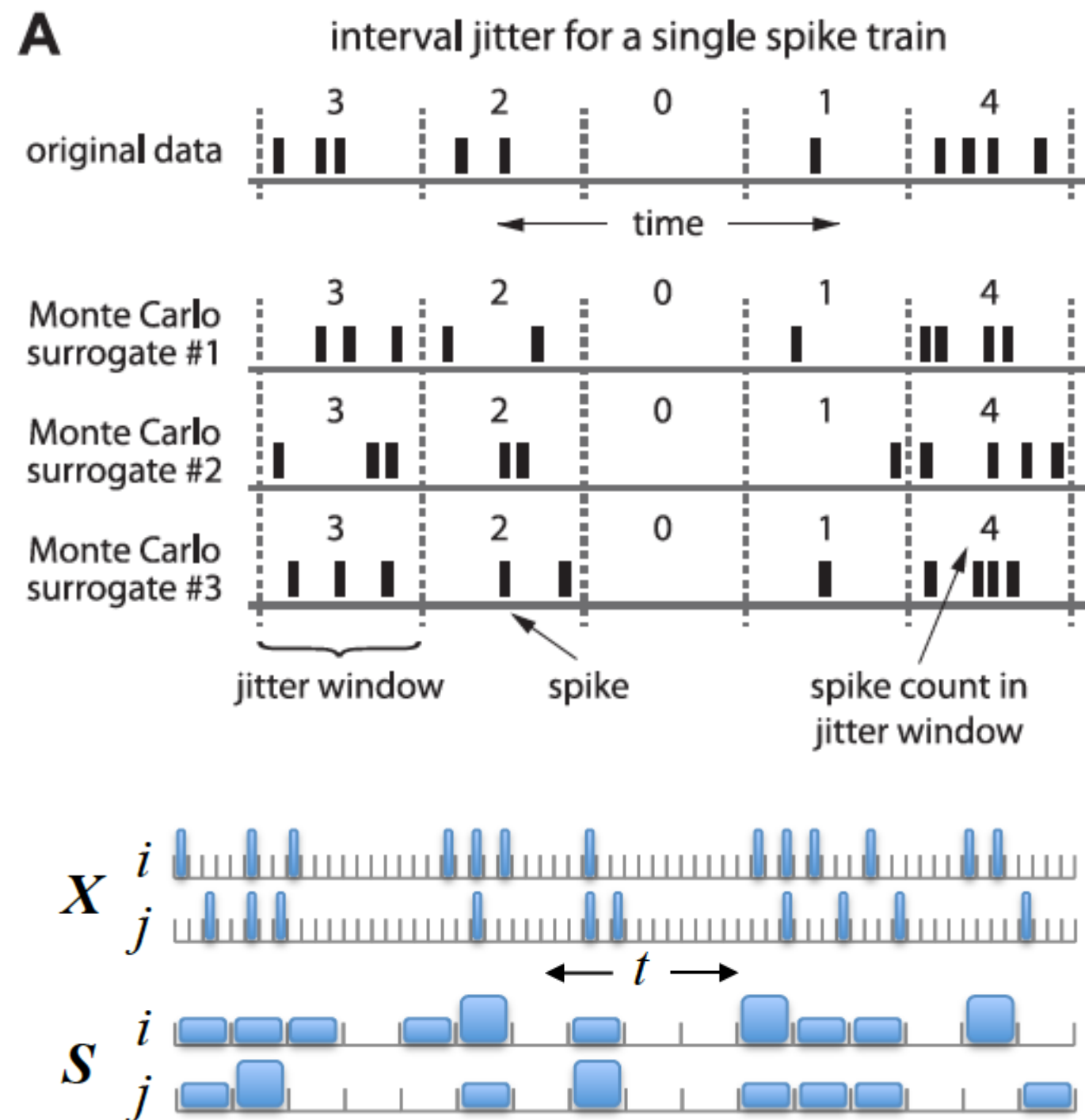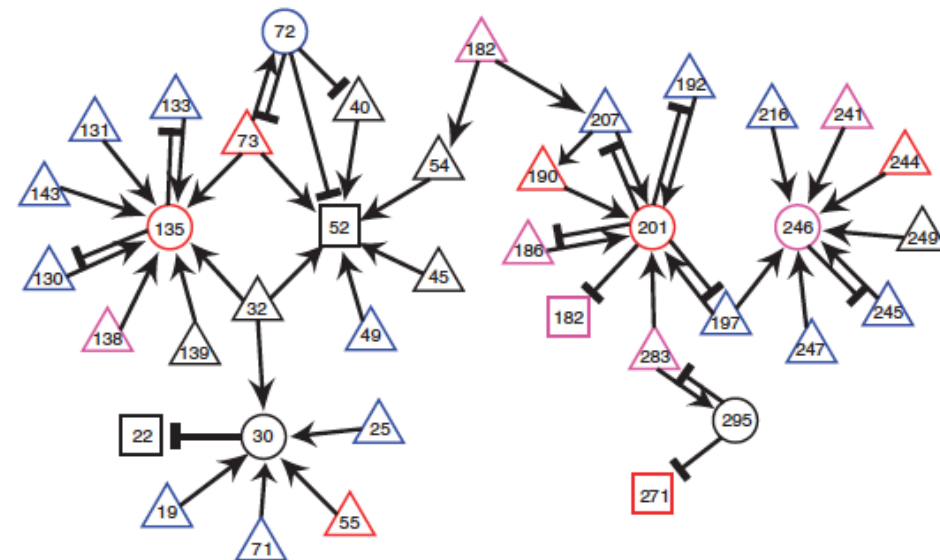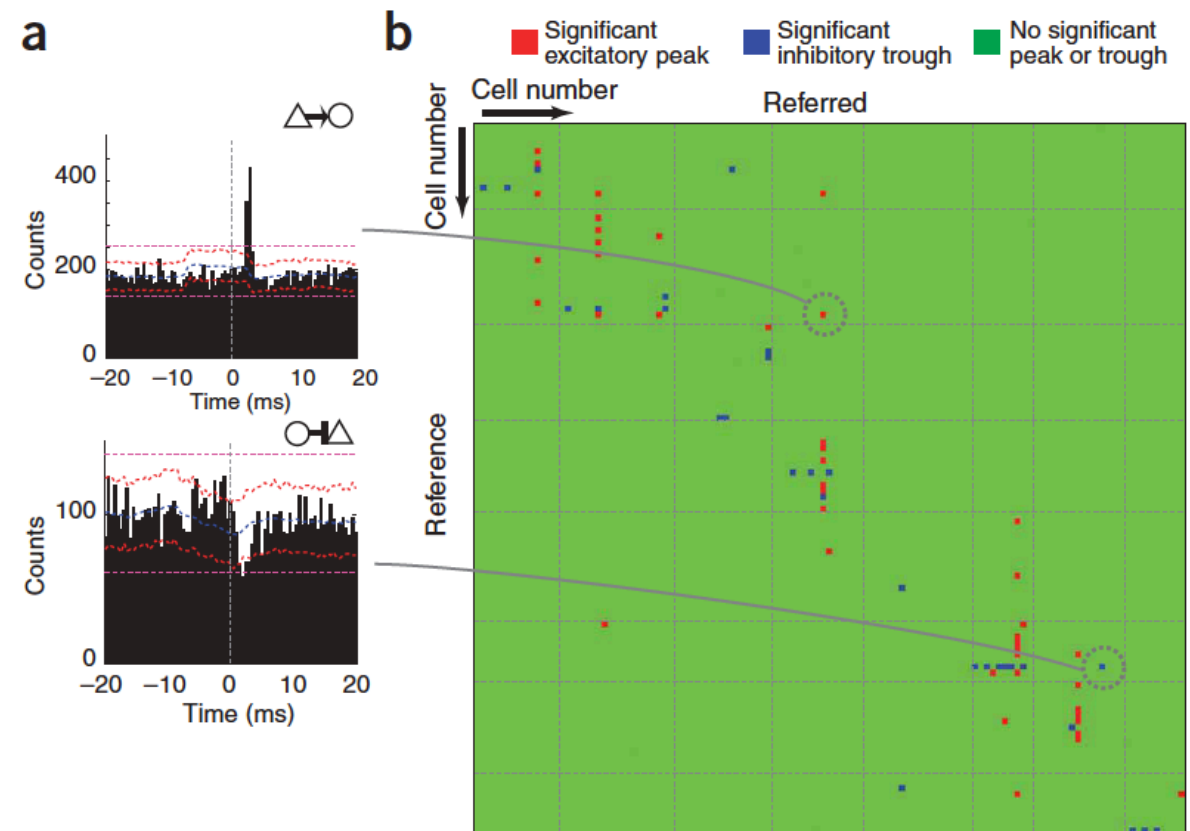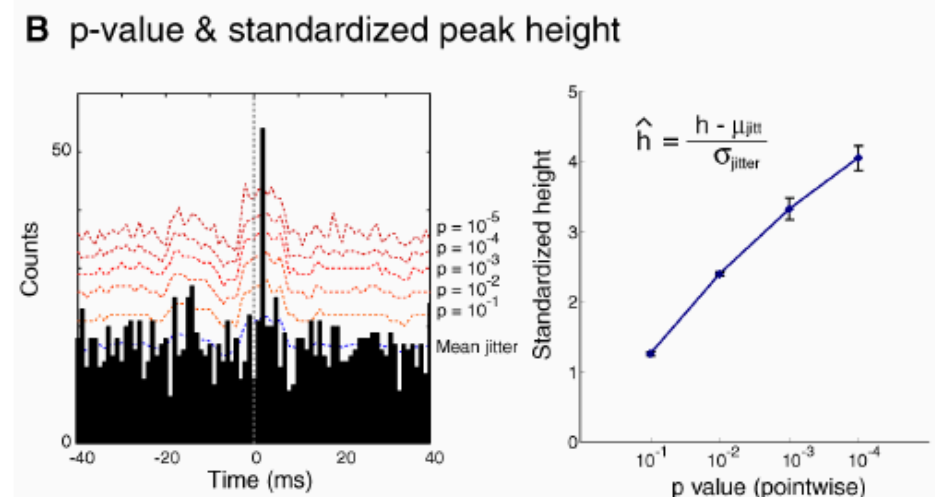**C** lag-0 distribution

p≈.2136

D 20 ms jitter-corrected CCH

But, There Is a Problem
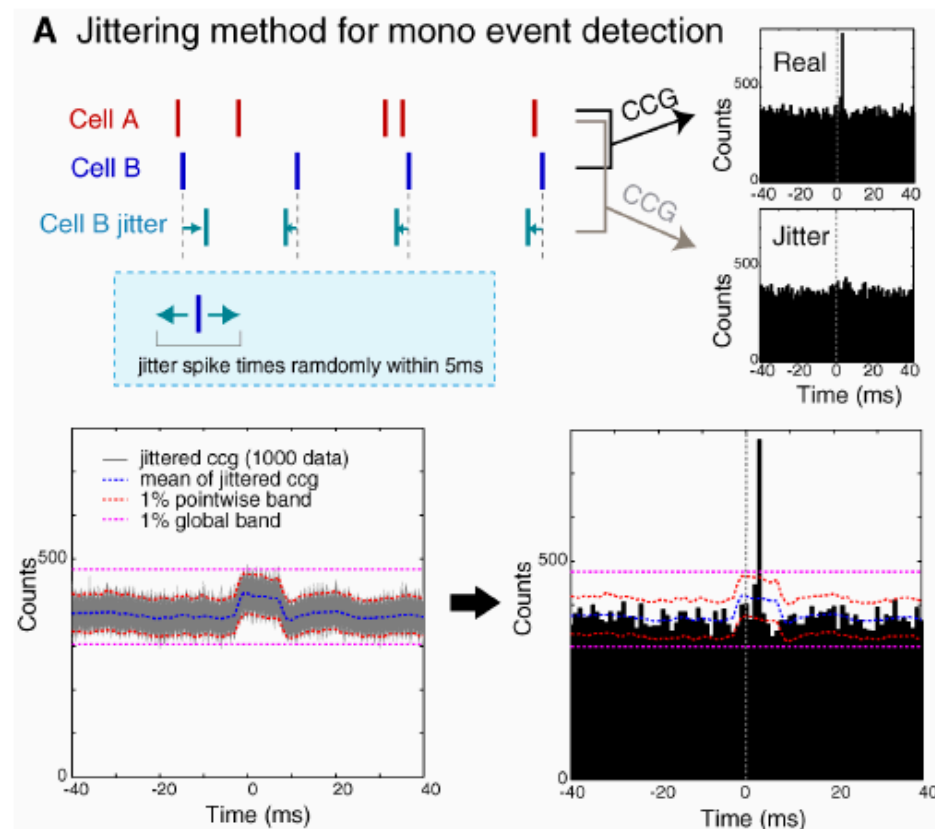# With Our Naive Way of Thinking
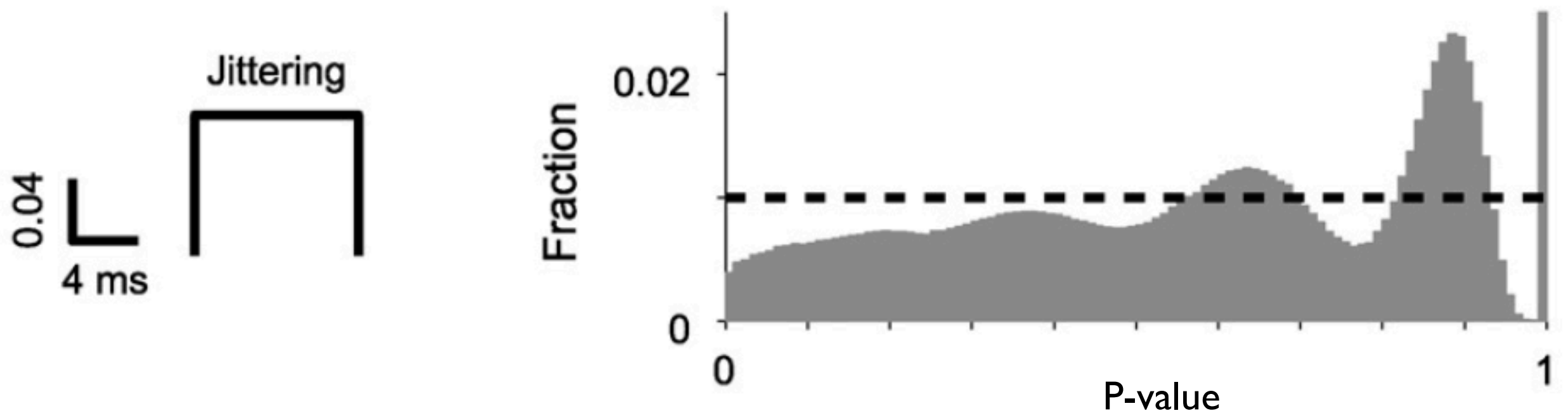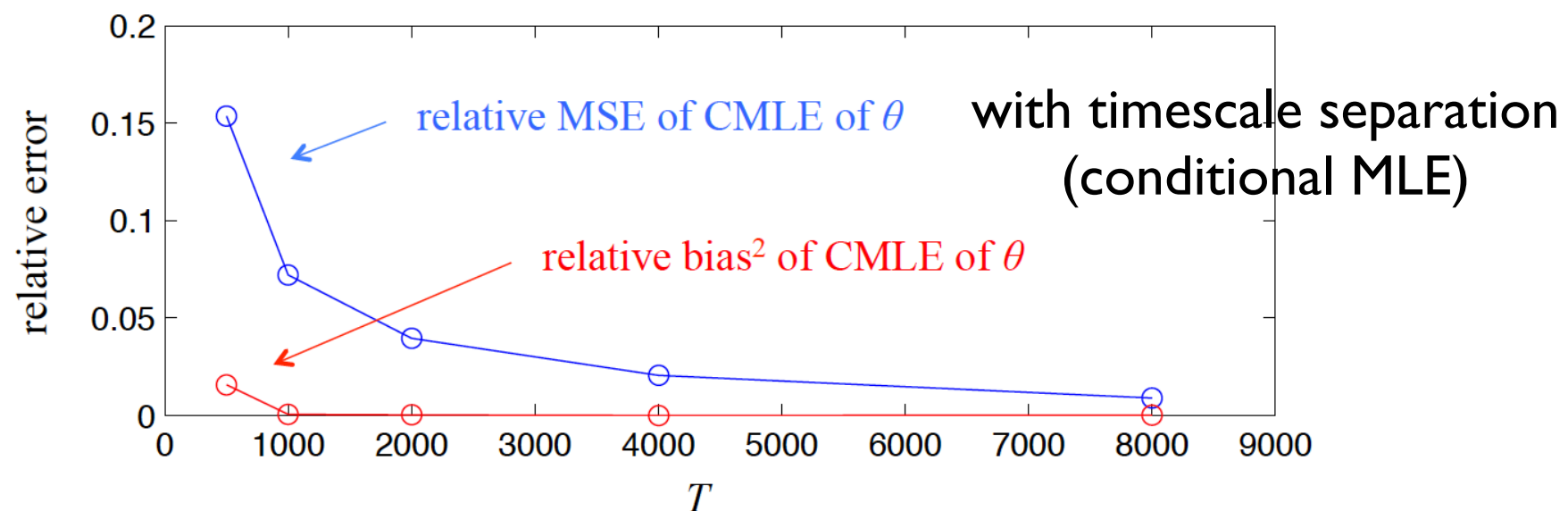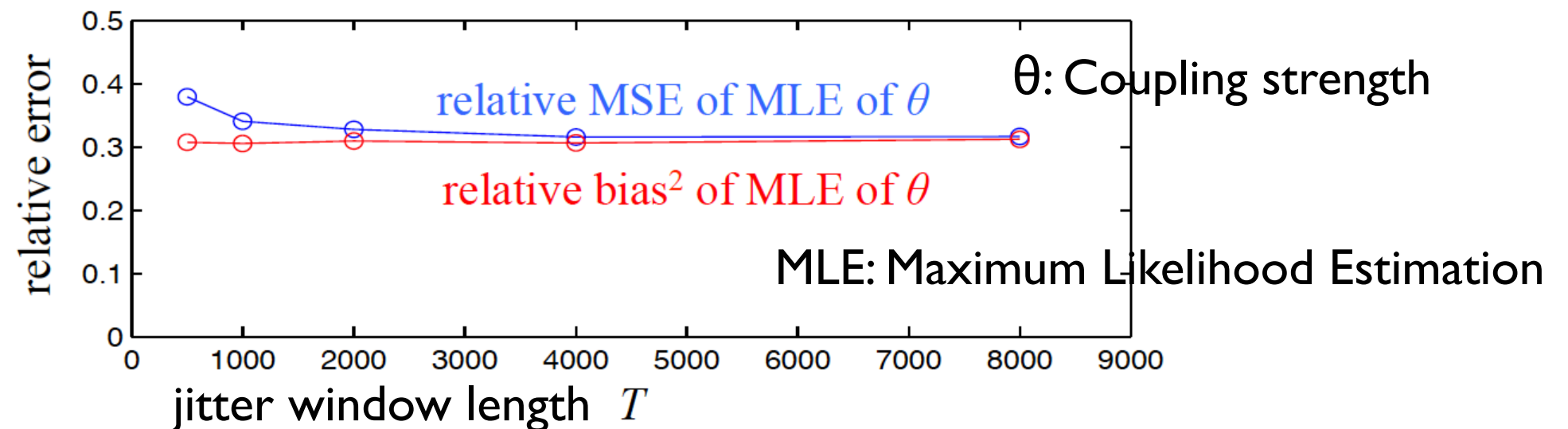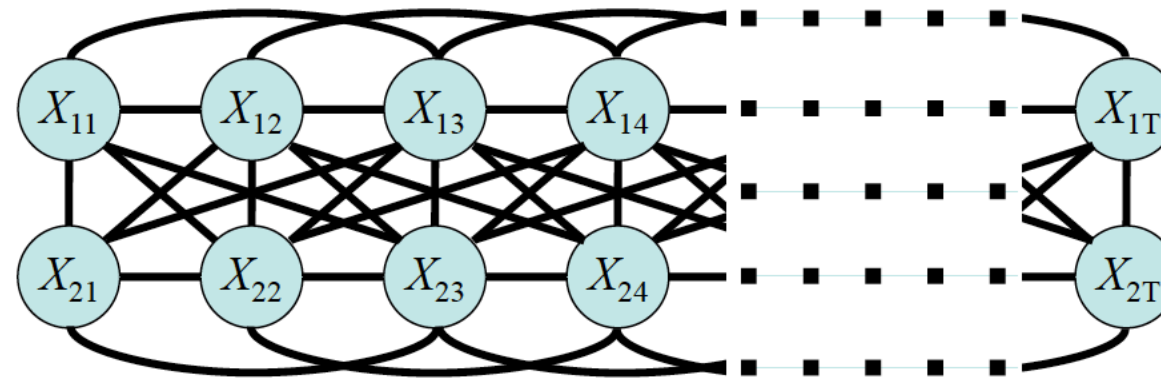
But, There Is a Problem
With Our Naive Way of Thinking
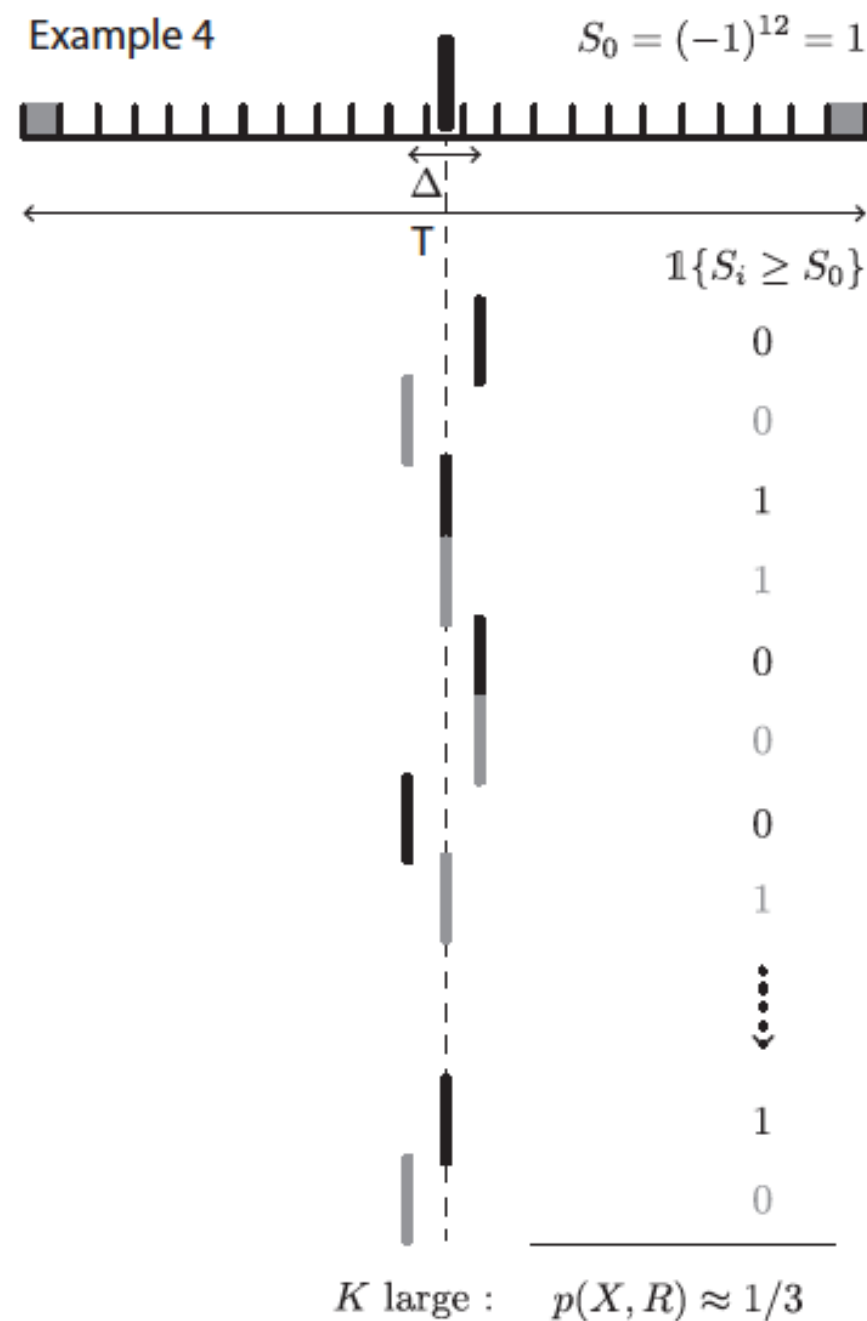
Resolution: A Rigorous Formulation of Spike Perturbation Through Conditional Modeling

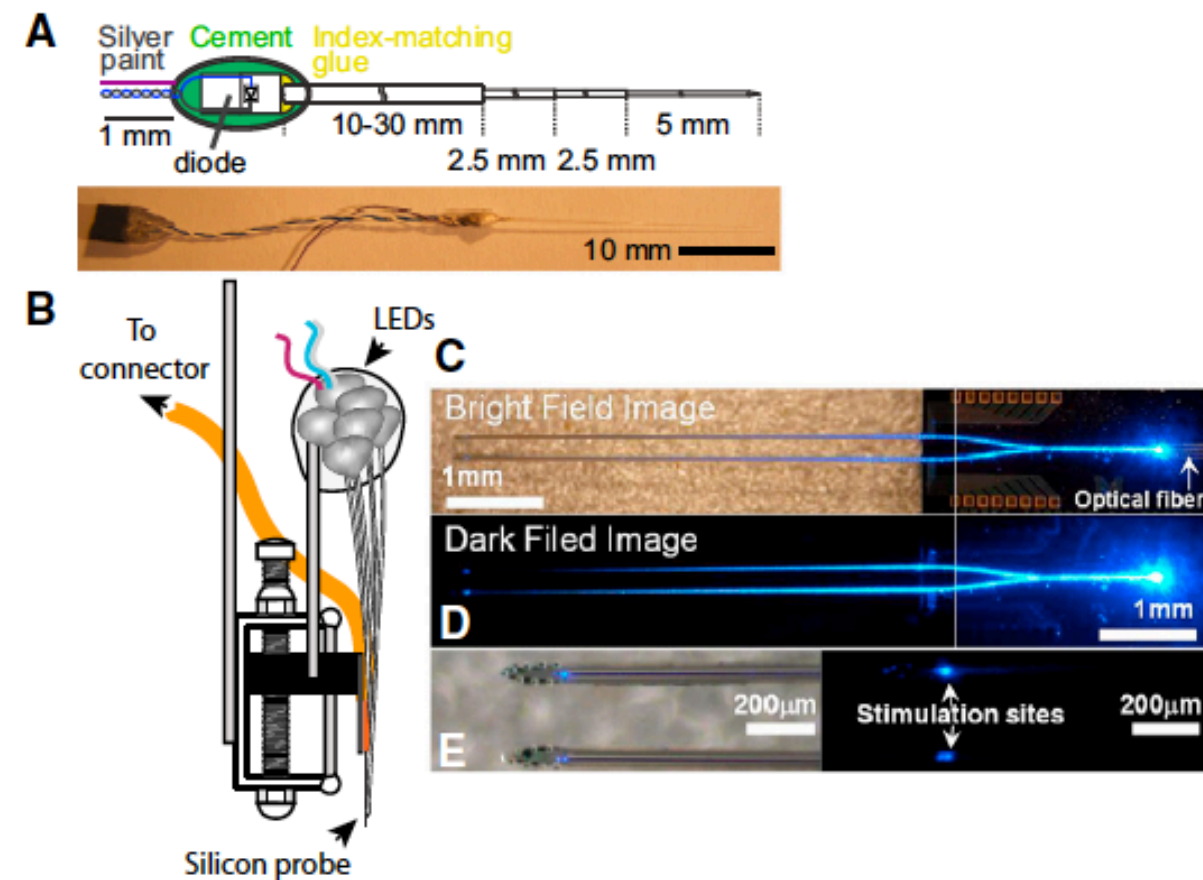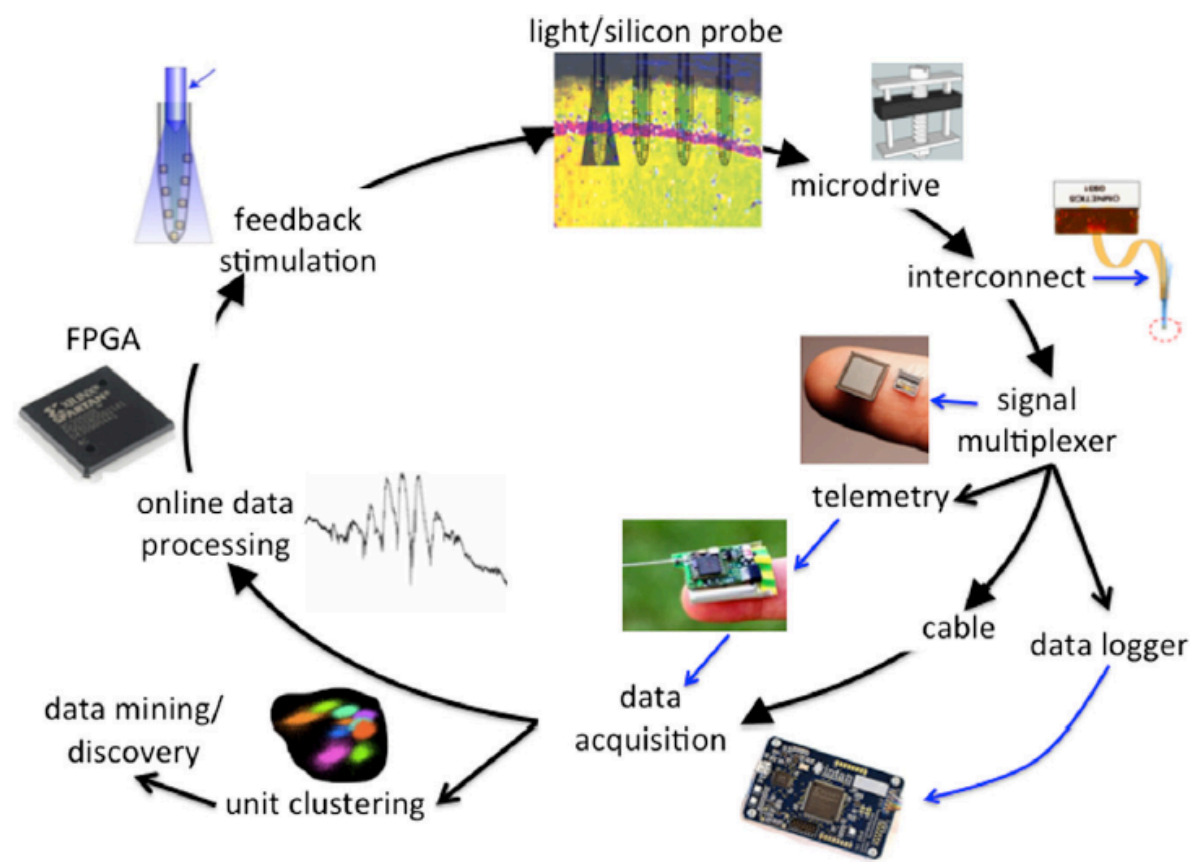Amarasingham, Harrison, Hatsopoulos & Geman (2012), J Neurophysiol

Applications: Dynamical Connectivity Analysis

Fujisawa, Amarasingham, Harrison, Buzsáki (2008), Nat Neurosci

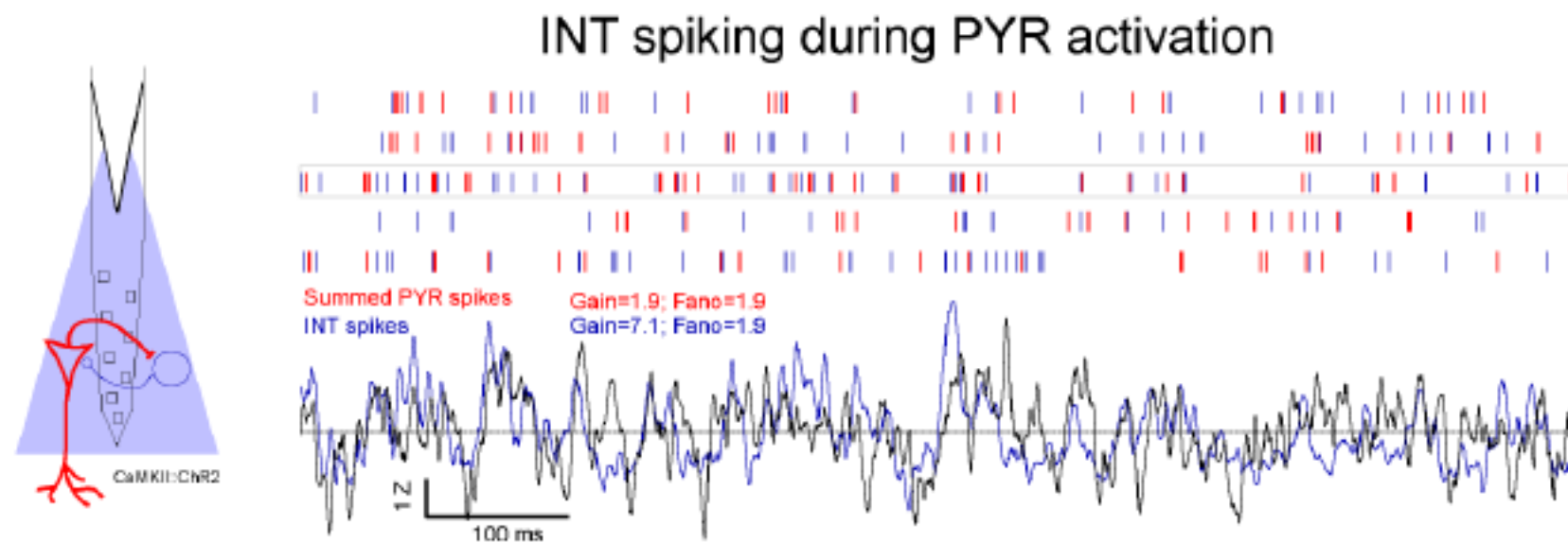# From Hypohtesis Test to Conditional Inference

The Future (Present): Closed-Loop Optogenetics

The Future (Present): Closed-Loop Optogenetics

Stark, English, Senzai, Roux, Eichler & Buzsáki (2014), SFN