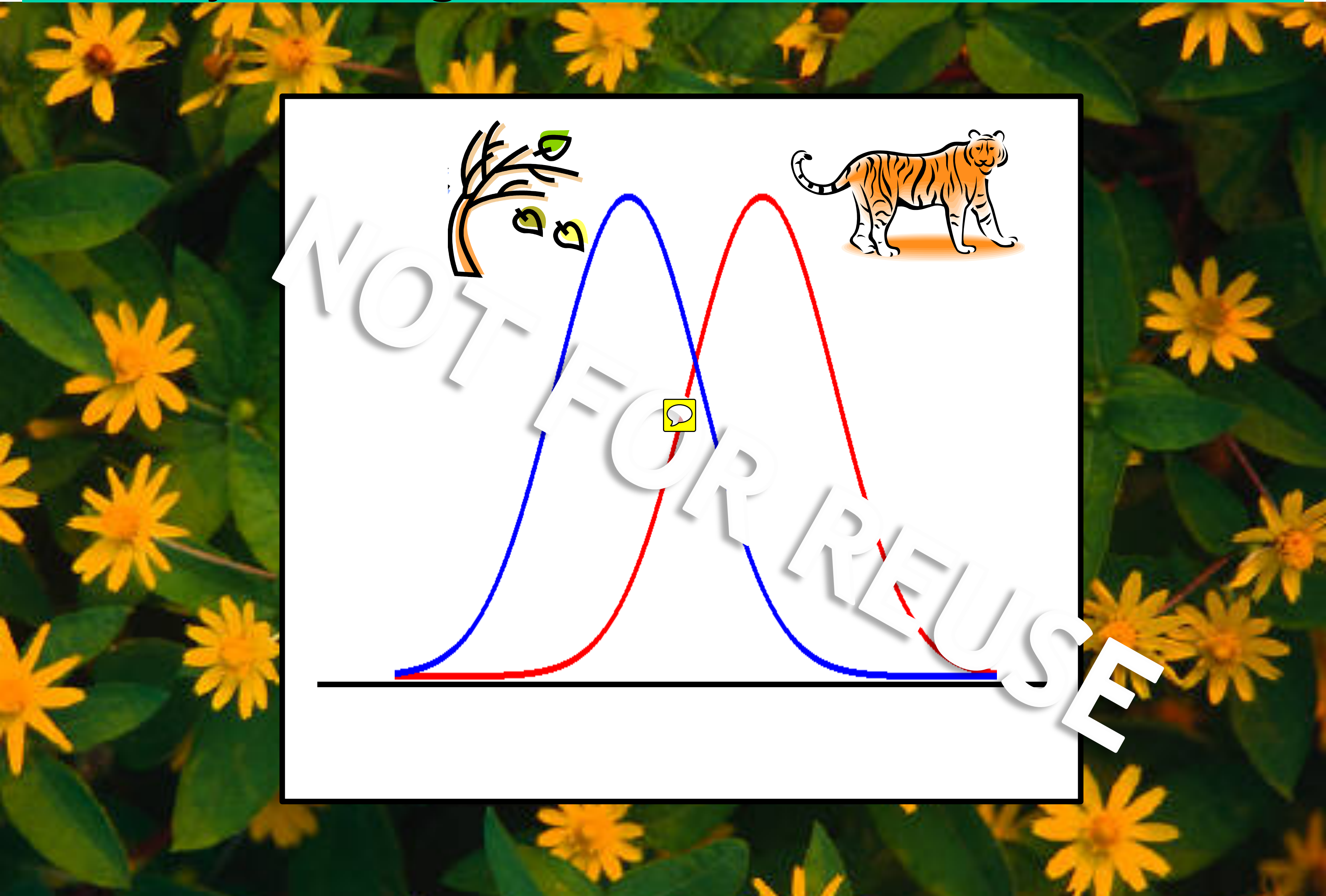
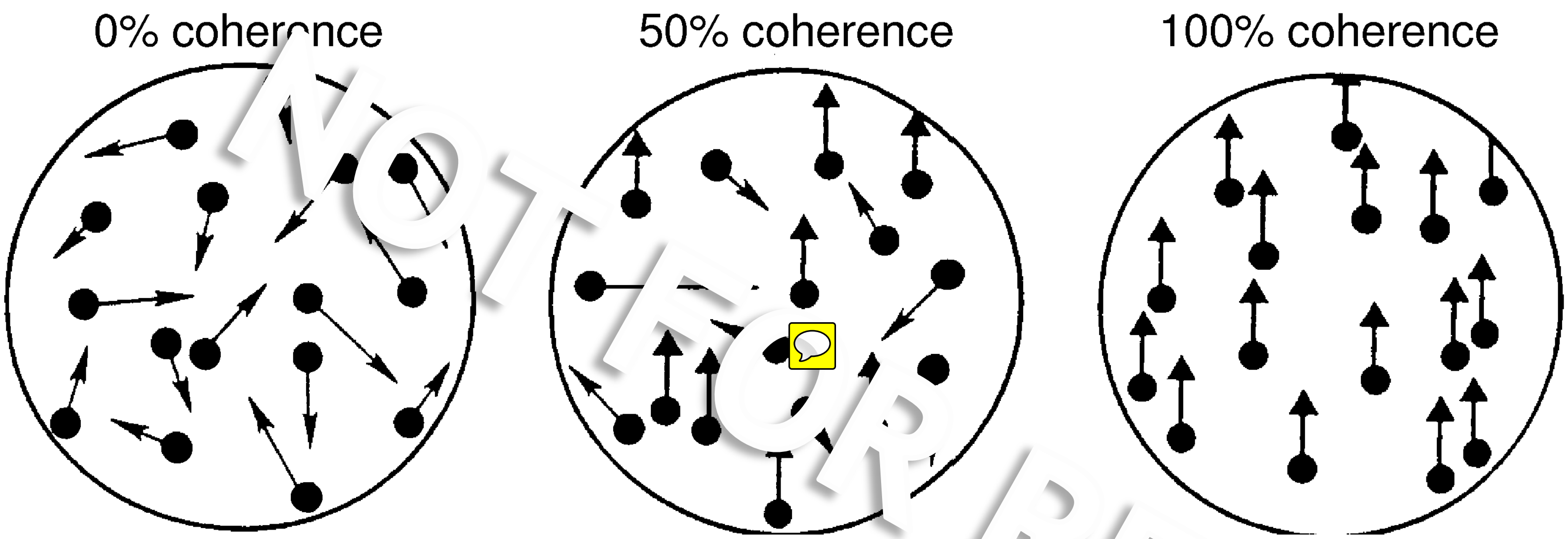
Decoding

How well can we learn what the stimulus is by looking at the neural responses?

Do I stay or do I go?

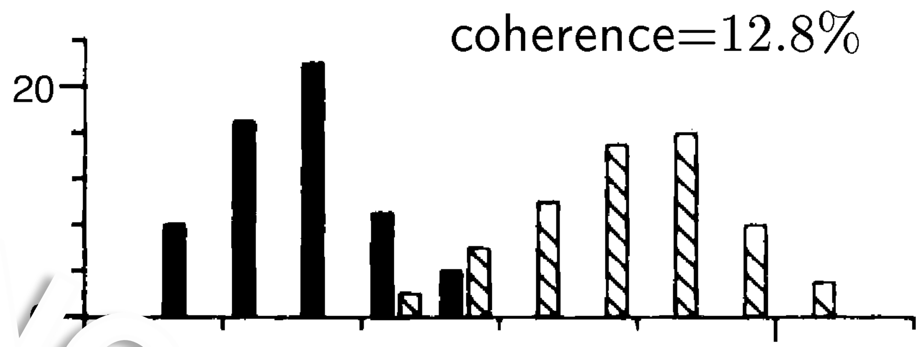


Making a decision



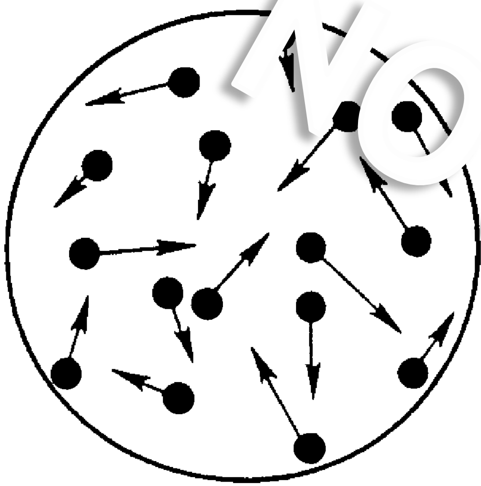
Britten et al. '92

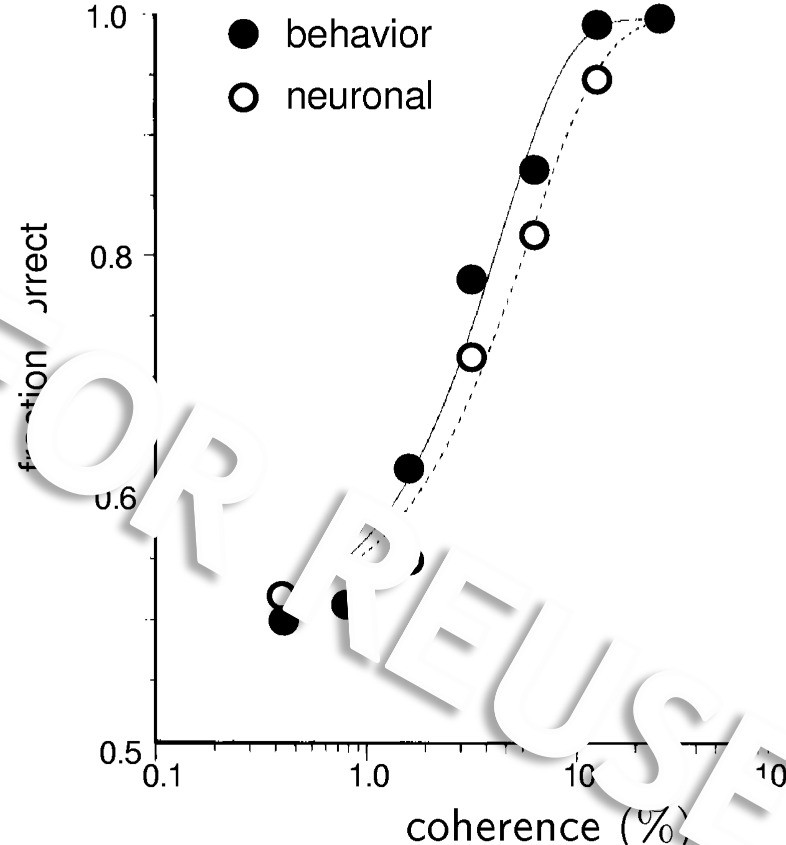
Predictable from neural activity?



Britten et al. ‘92

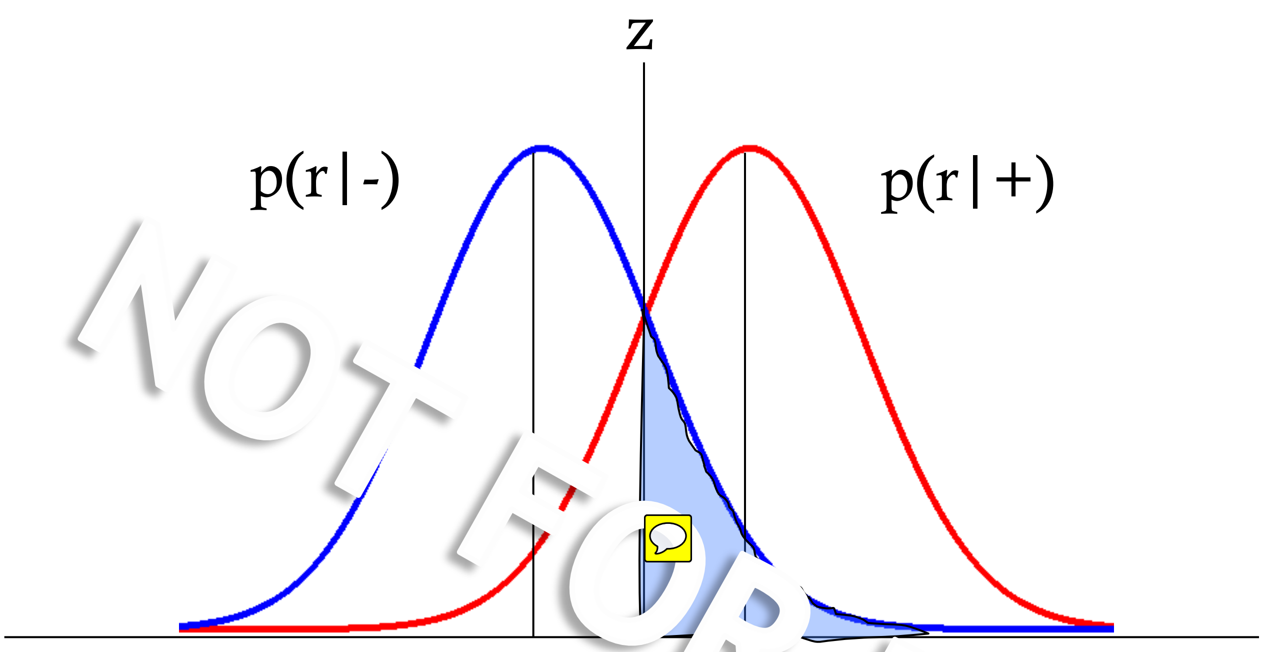
Behavioral performance





Britten et al. '92

Signal detection theory

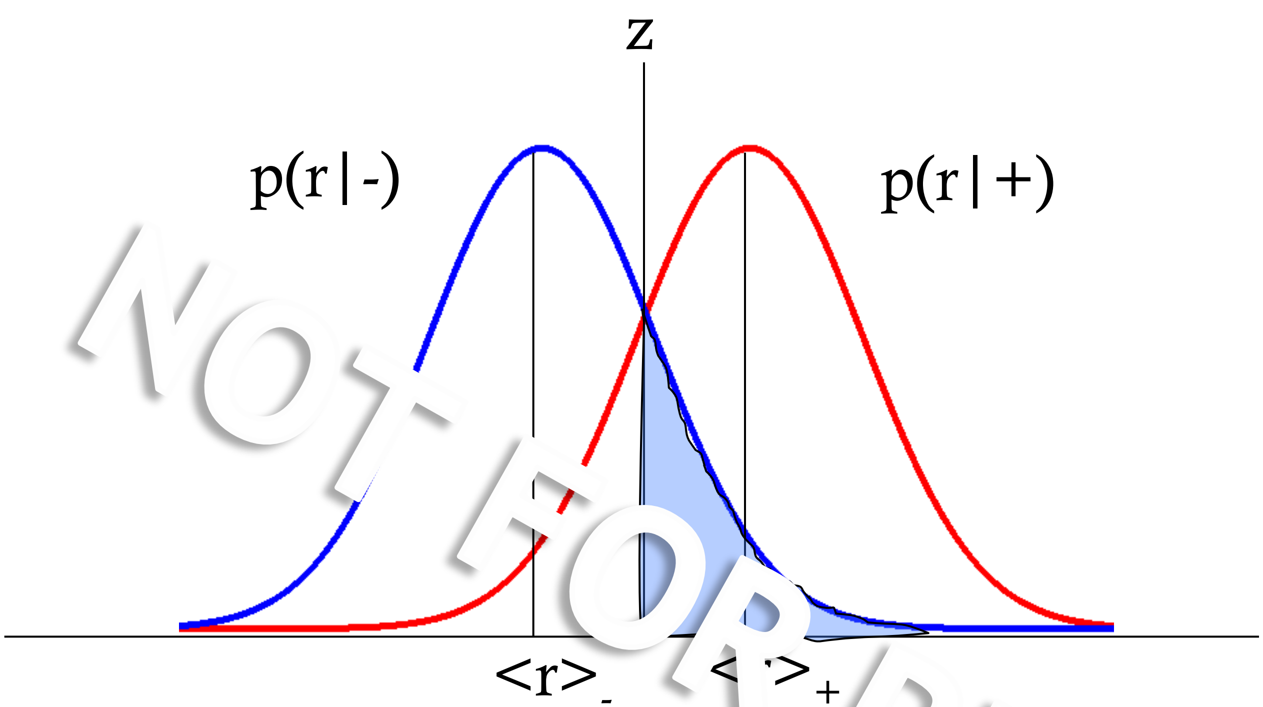


How many errors are you going to make?

False alarms: P[r ≥ z|-]
Good calls = P[r ≥ z|+]

This choice of z maximizes P[correct]

Likelihood ratio

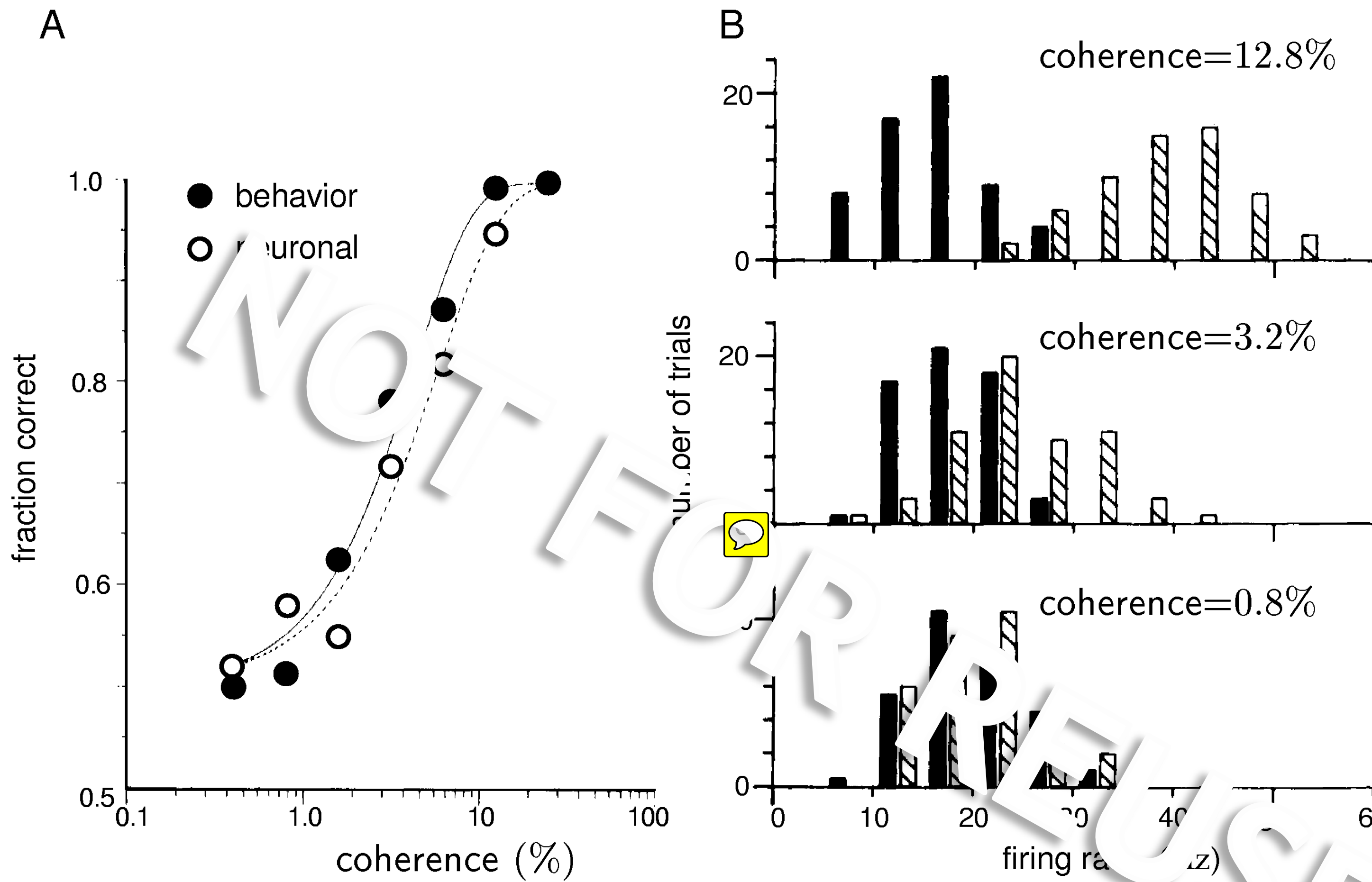


The likelihood ratio test is the most efficient statistic, in that it has the most power for a given size.

Power = probability of a false negative
Size = probability of a false positive

Neyman-Pearson lemma

Neurons vs organisms

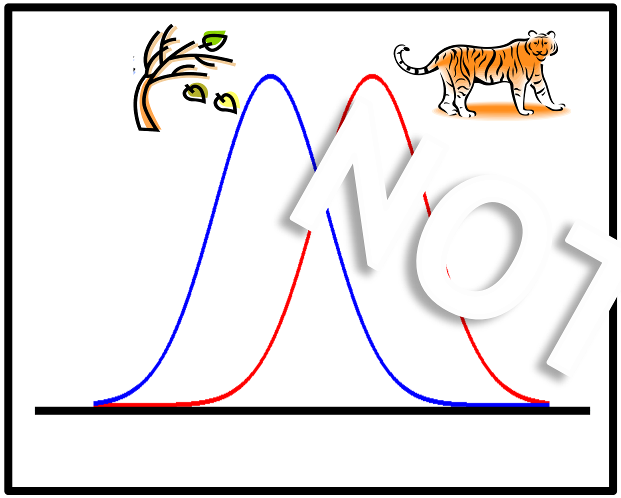


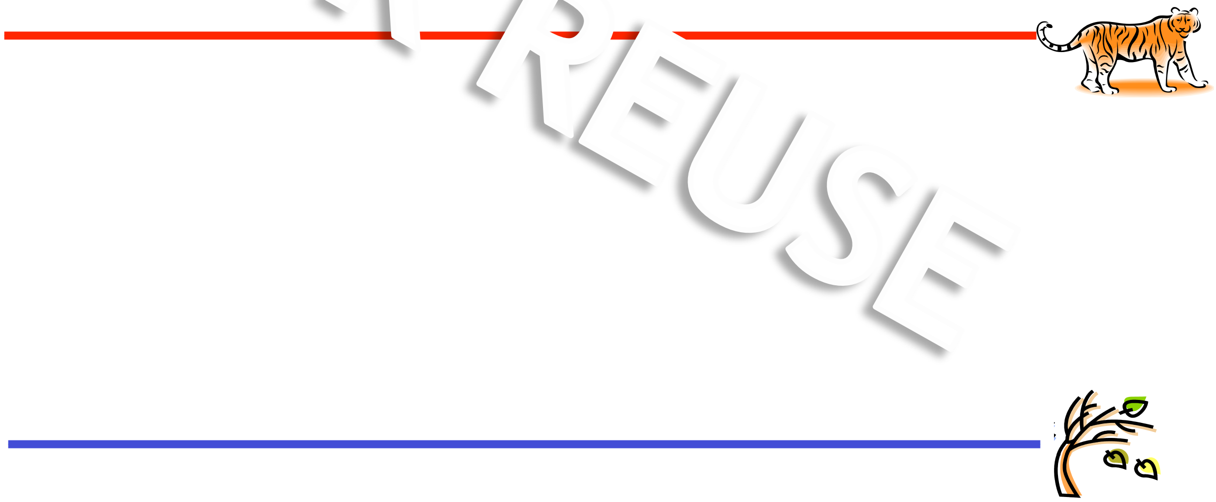
Close correspondence between neuron decoding and behavior..

So why so many neurons?

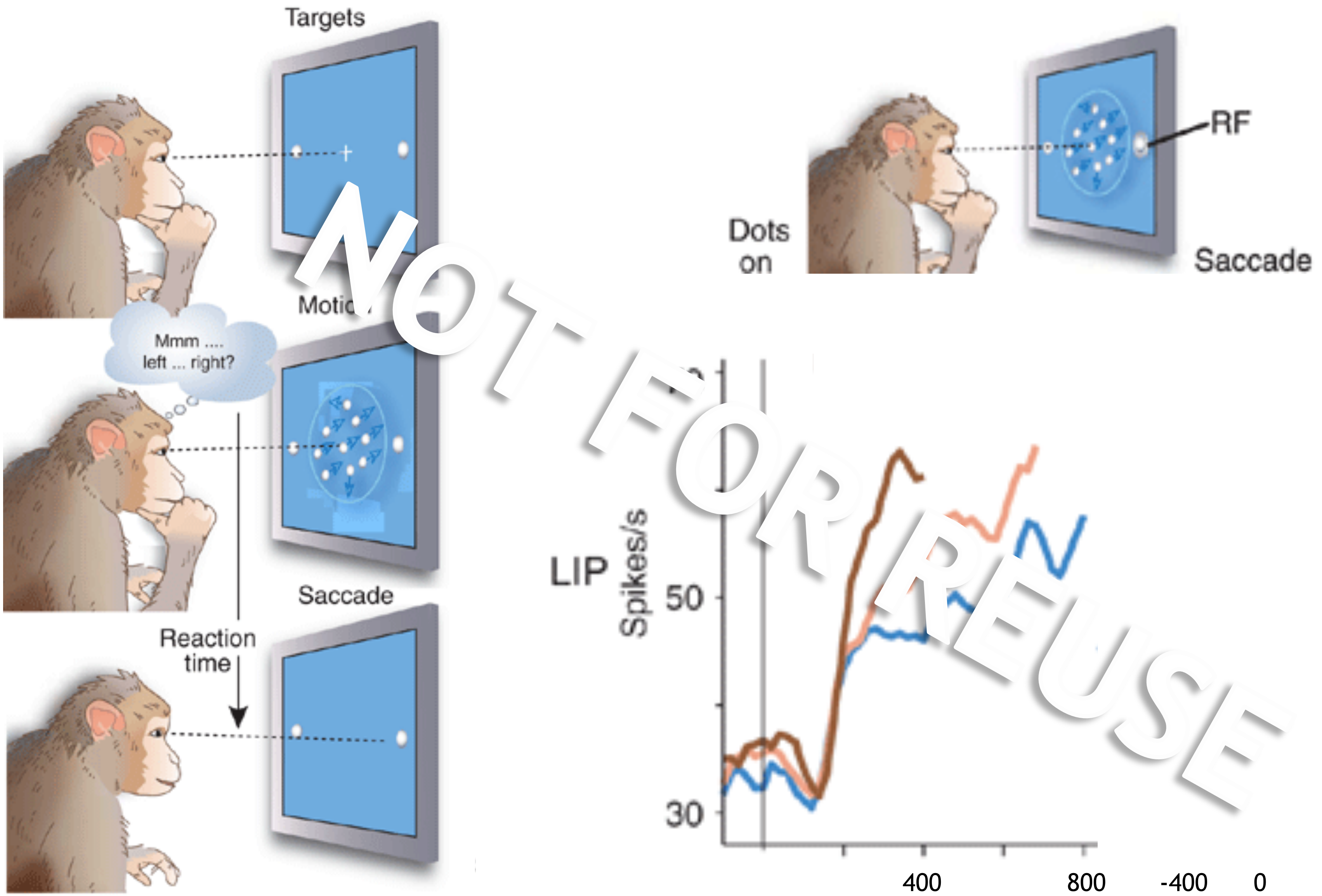
Let's just consider for a moment

Now let's say we don't have to decide immediately…



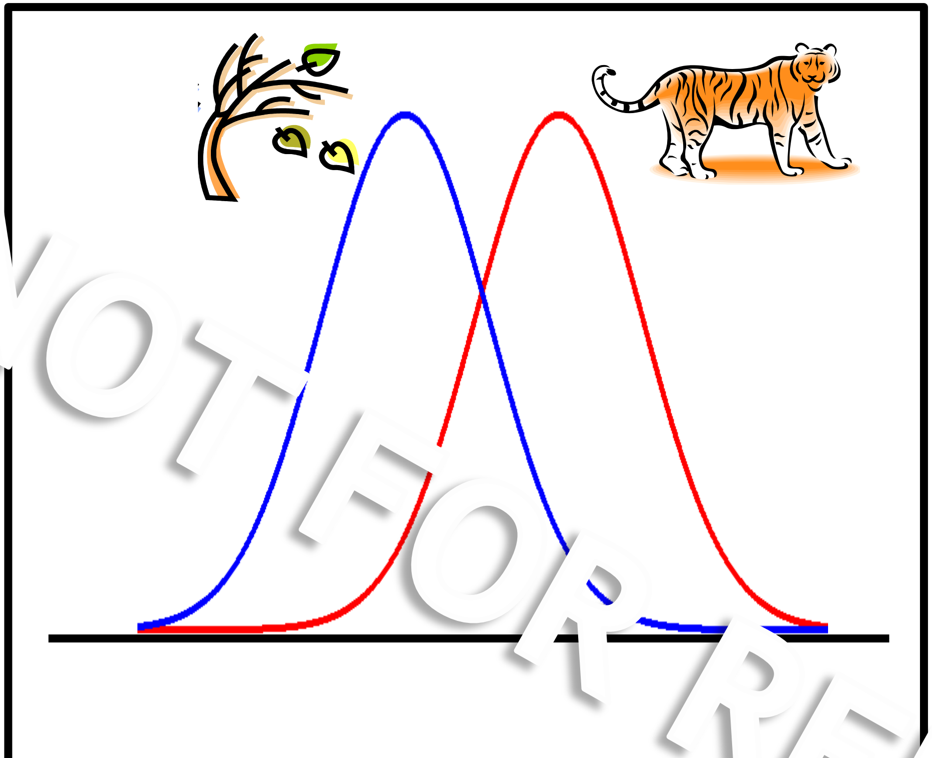


Accumulated evidence for accumulated evidence



Kiani, Hanks & Shadlen, Nature Neuroscience (2006)

Back to one trial: building in what we already know

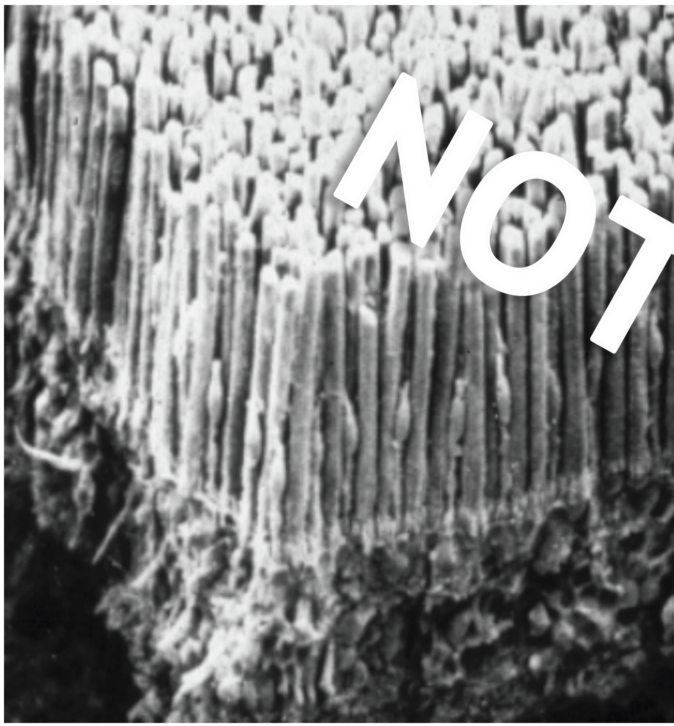


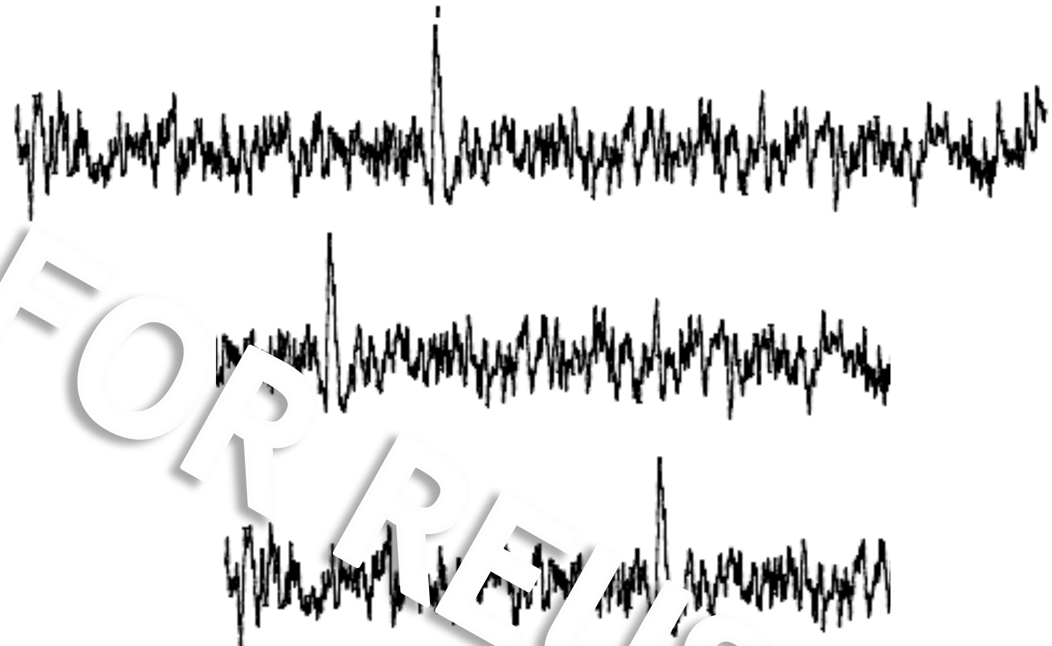
Role of *priors*:

Find z by maximizing P[correct] = p[+] b(z) + p[-](1 – a(z))

The wind or a tiger?

Classification of noisy data: single photon responses

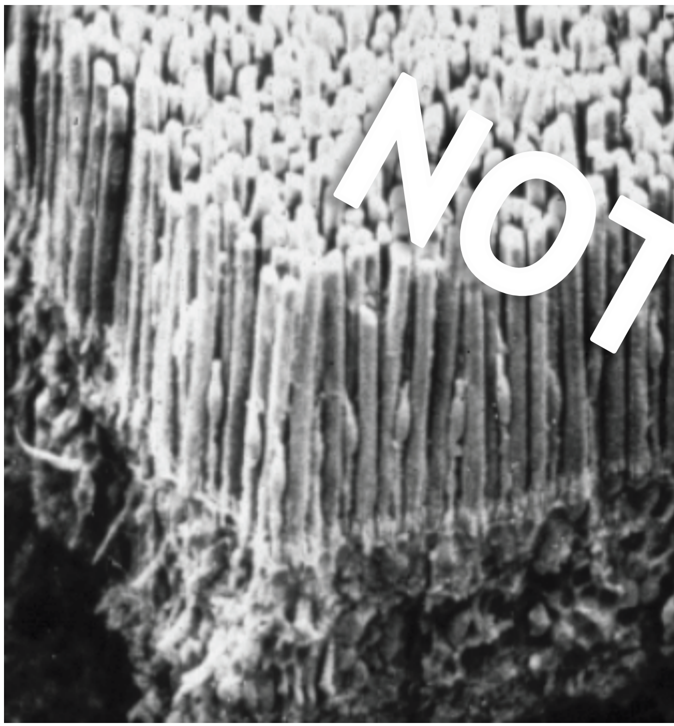


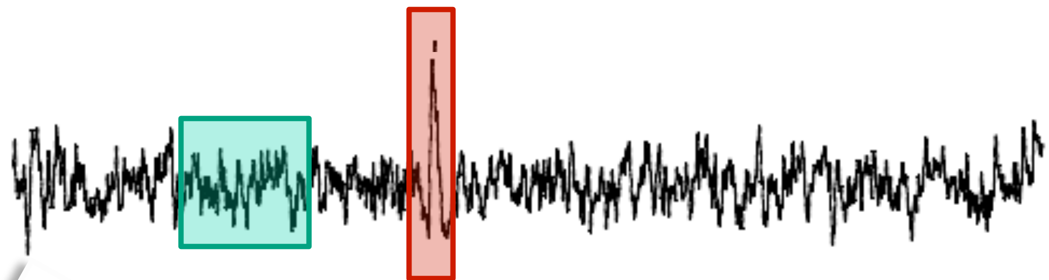


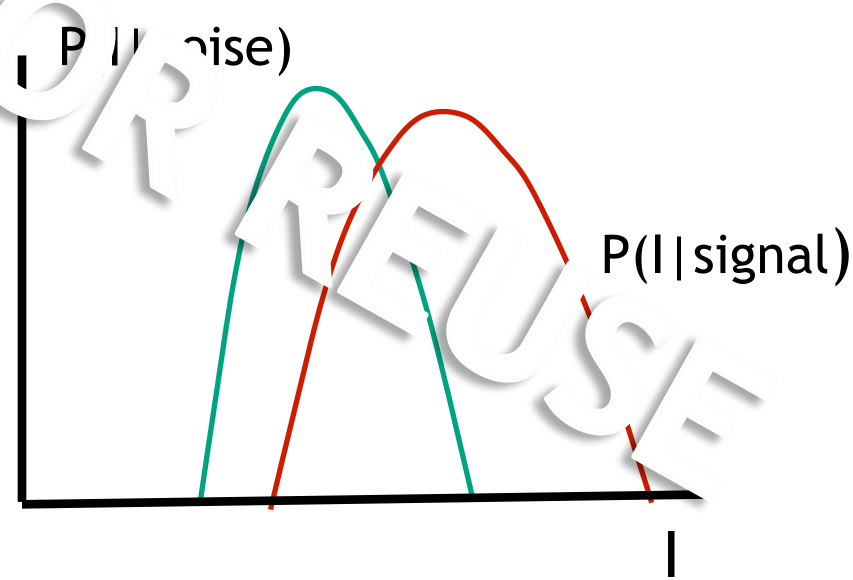
Rieke

Nonlinear separation of signal and noise

Classification of noisy data: single photon responses



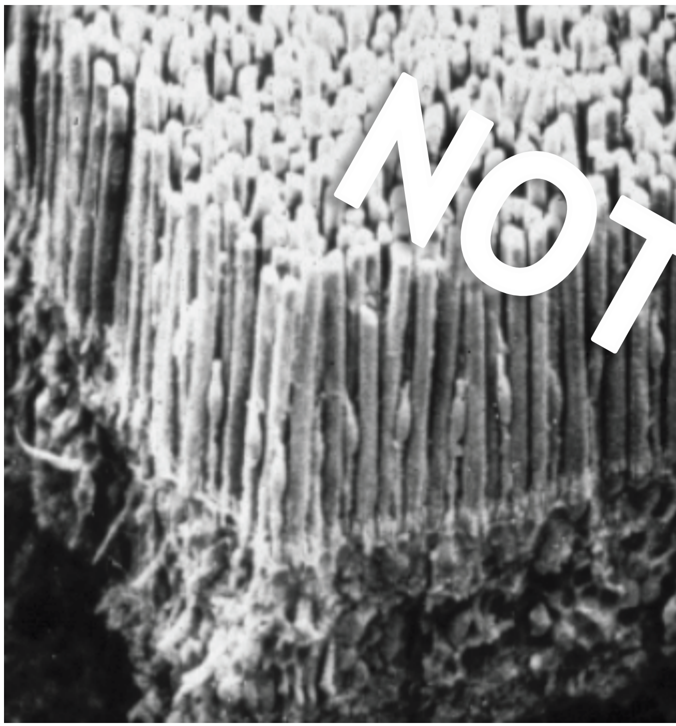


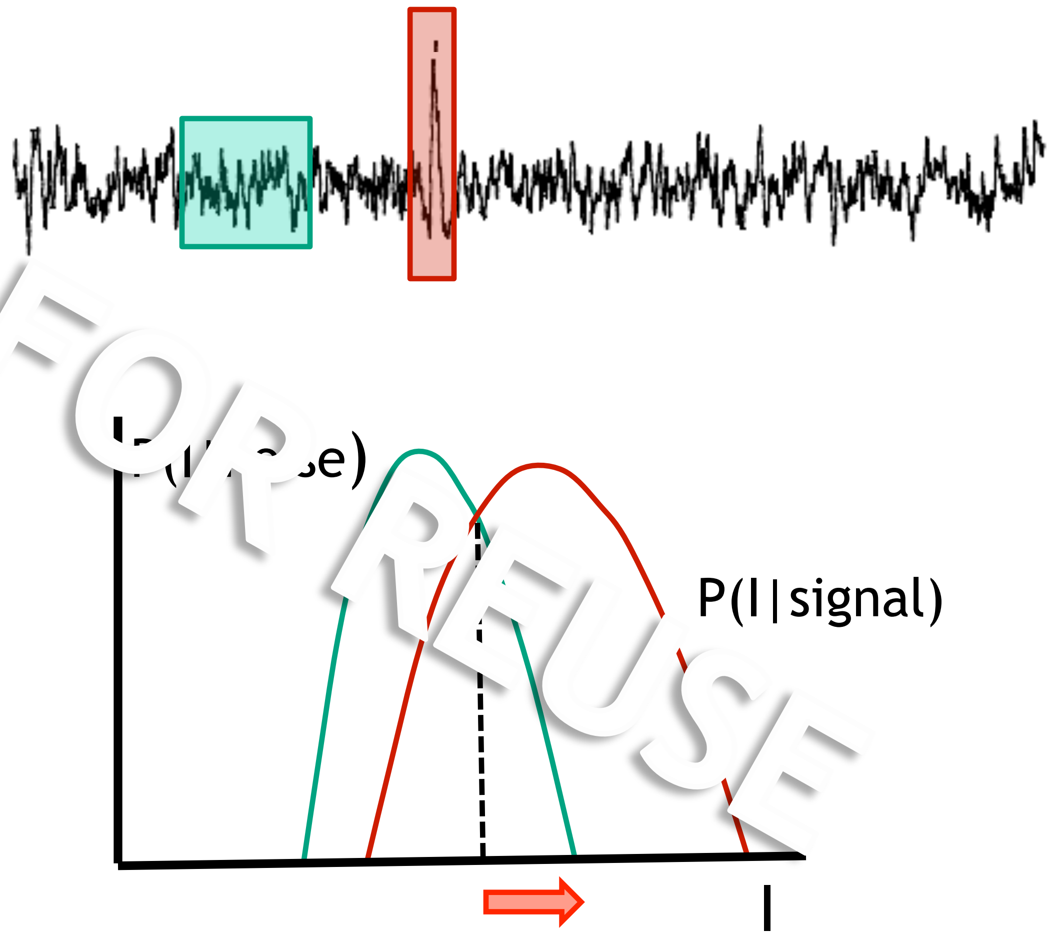


Rieke

Nonlinear separation of signal and noise

Classification of noisy data: single photon responses





Rieke

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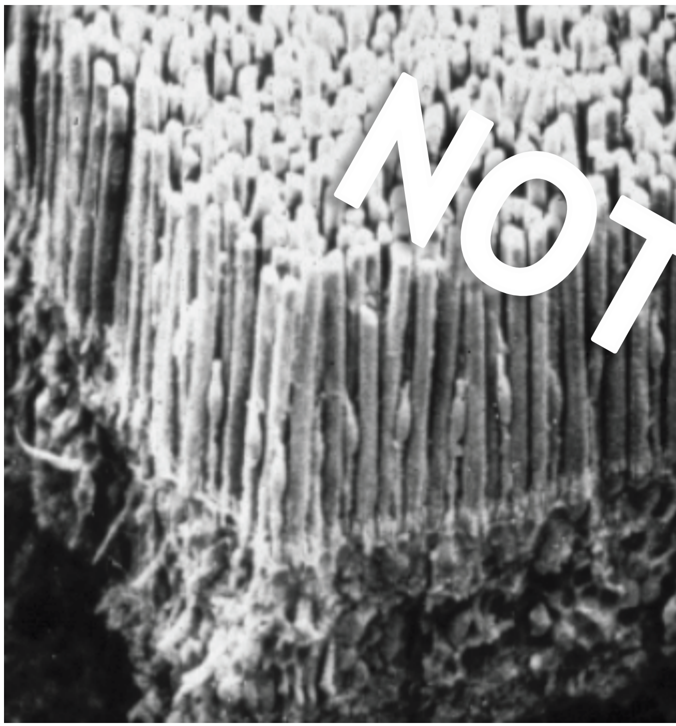
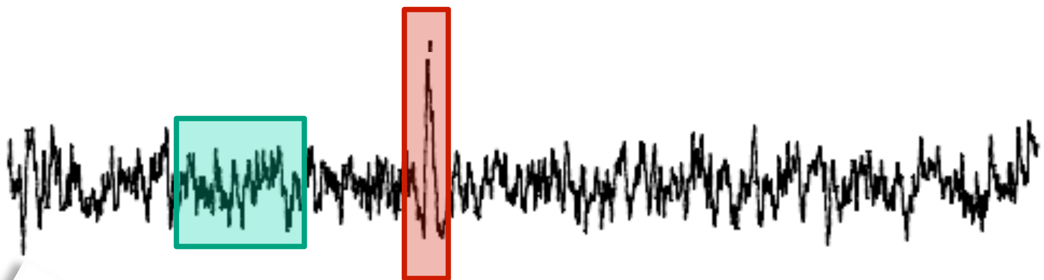
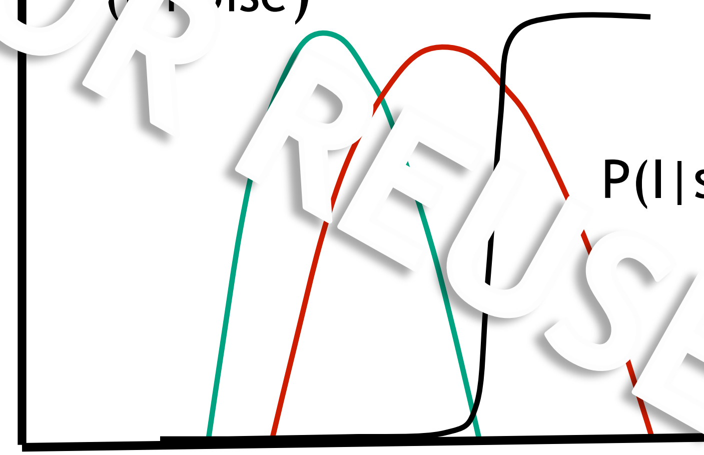
Classification of noisy data: single photon responses



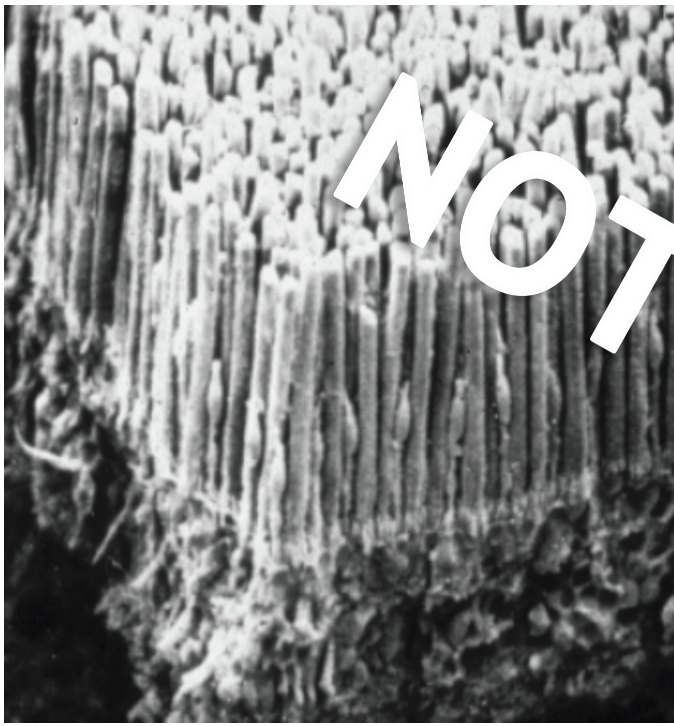


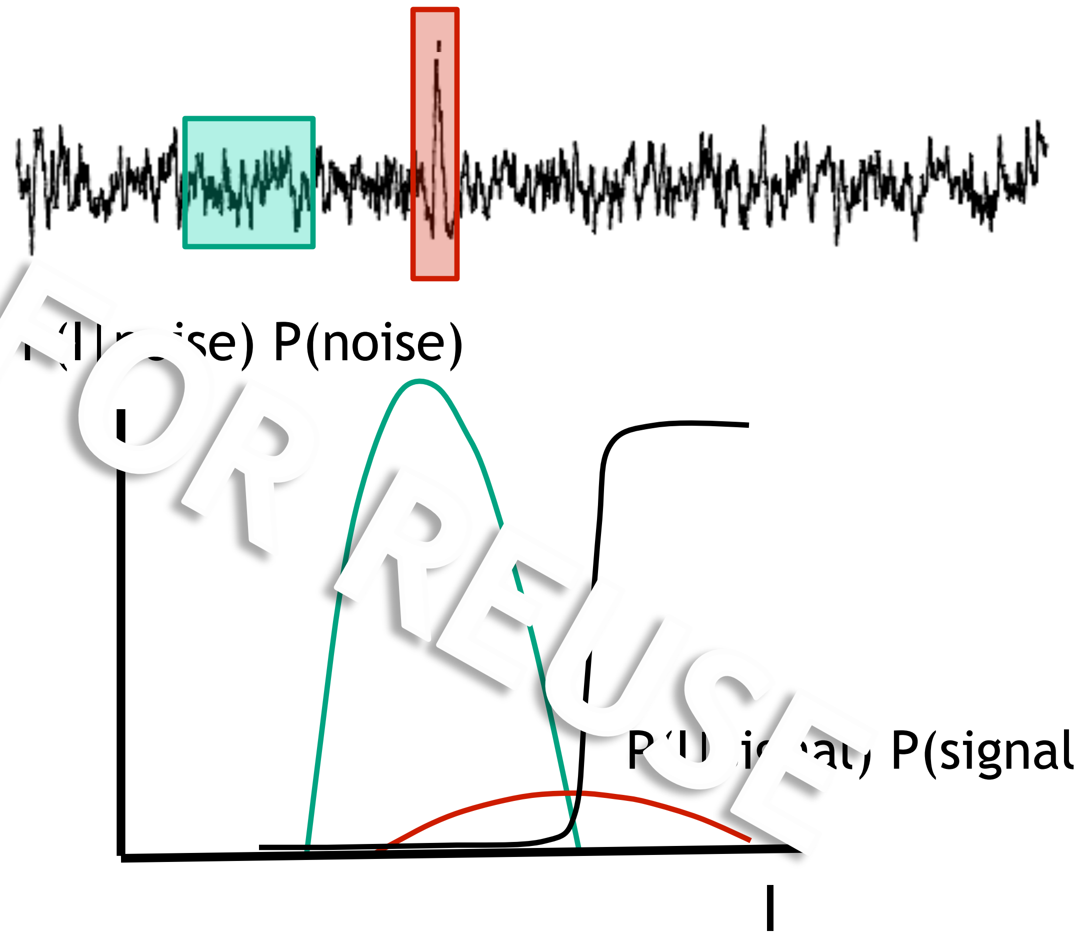


Rieke lab

Nonlinear separation of signal and noise

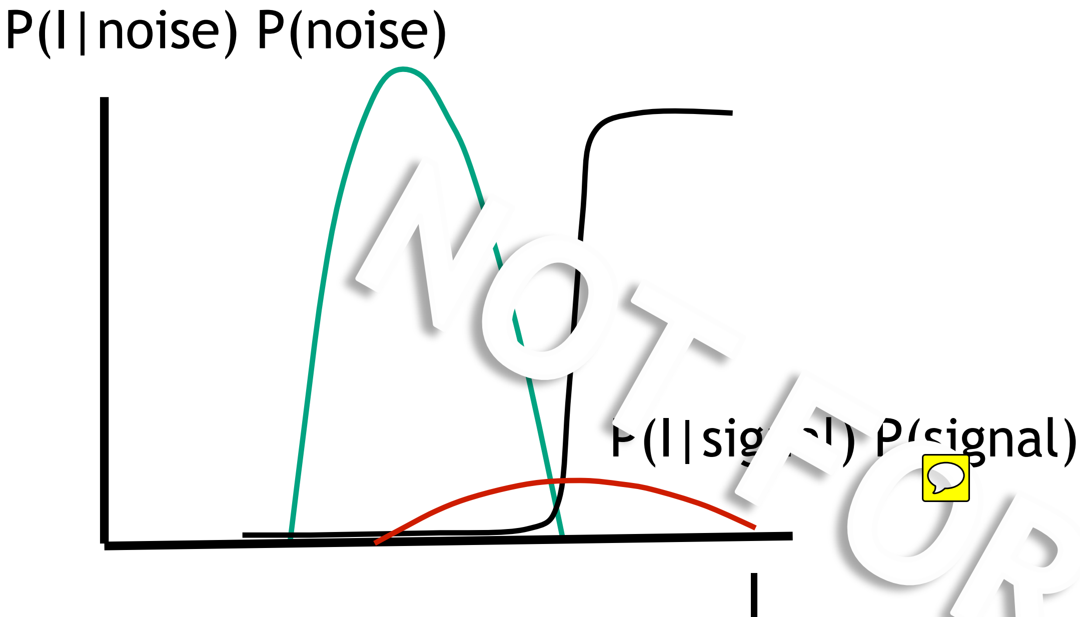
Classification of noisy data: single photon responses

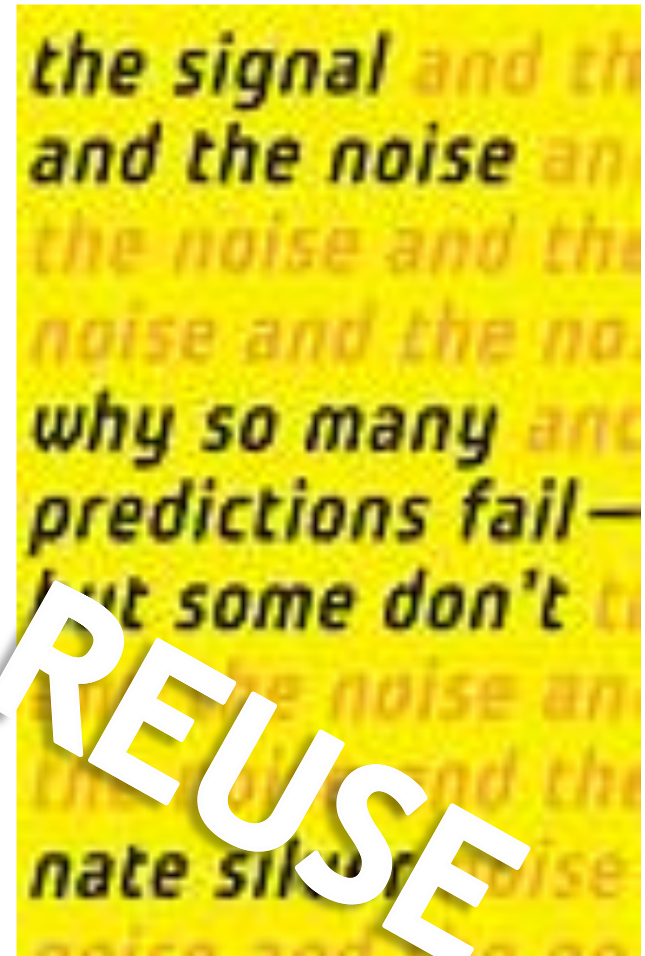




Rieke lab

That’s prior knowledge: how about costs?





Building in cost

$\mathrm{Loss}_- = L_- P[+|r]$

$\mathrm{Loss}_+ = L_+ P[-|r]$

Cut your losses: answer + when $\mathrm{Loss}_+ < \mathrm{Loss}_-$

i.e. $L_+ P[-|r] < L_- P[+|r]$.

$\rightarrow \quad p[r|+]/p[r|-] \; > \; L_+ P[-] \,/\, L_- P[+]$.