

Computational Neuroscience at the Neuromuscular Junction

Informatics Jamboree 20th May 2004

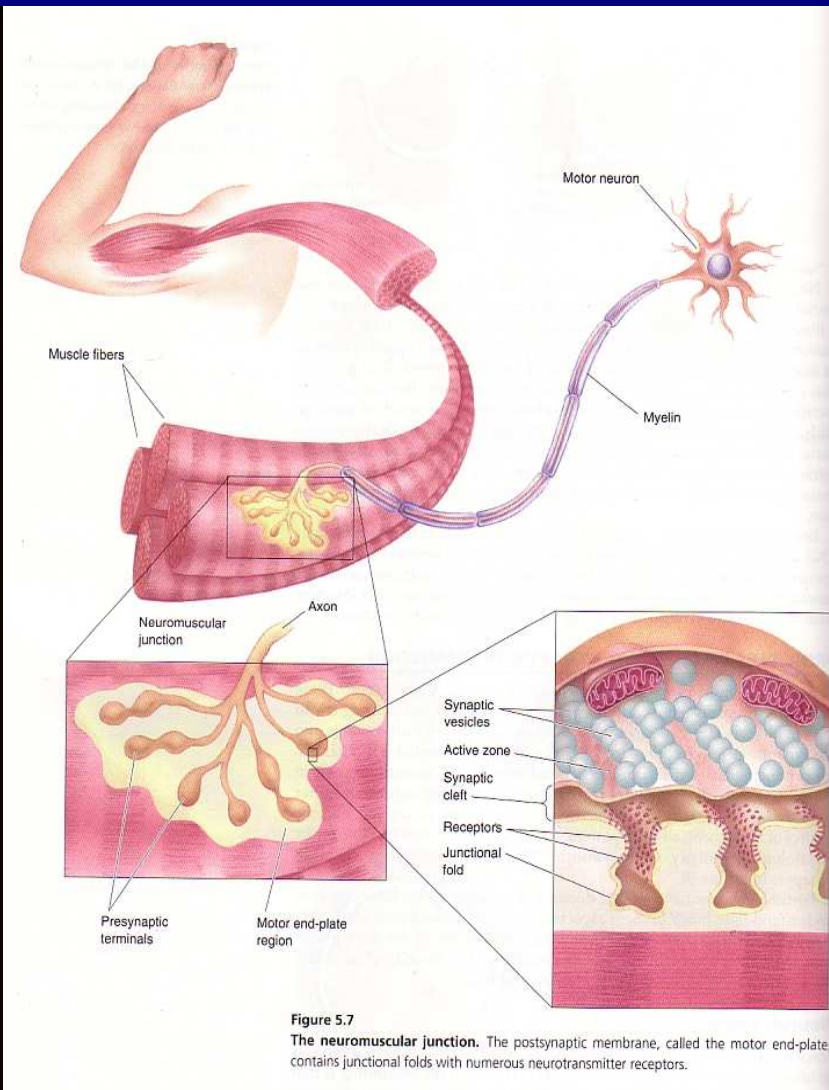
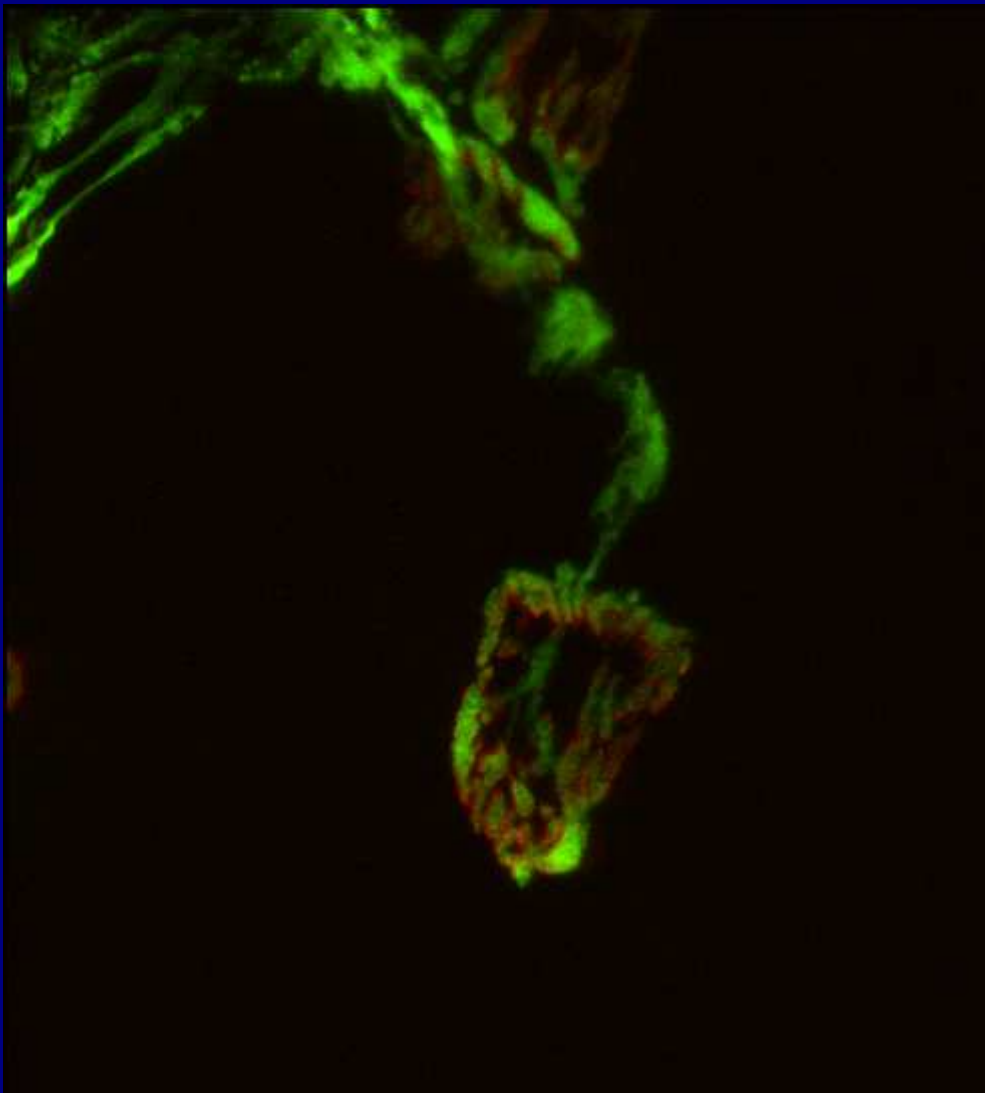
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The Neuromuscular Junction

The neuromuscular junction is the axon/muscle interface in the peripheral nervous system



The Problem

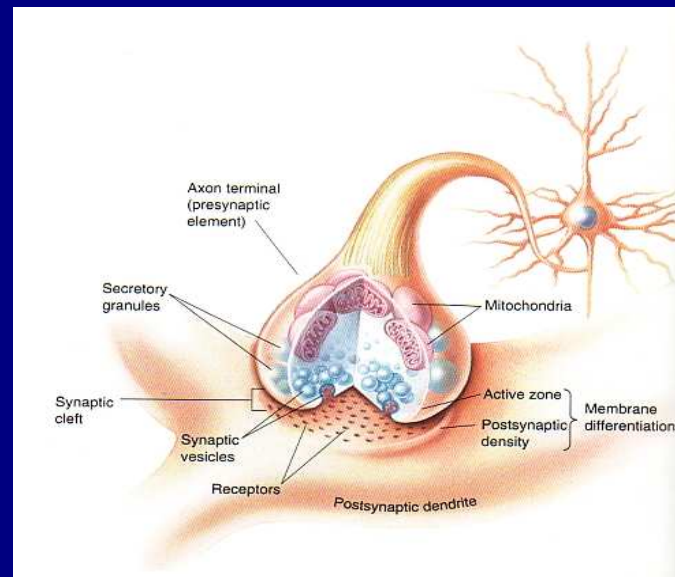


Figure from 'Neuroscience Exploring the Brain' Bear, Connors & Paradiso

The quantal content of synaptic signal transmission is an important physiological assay

However synaptic vesicles tend to sum sublinearly

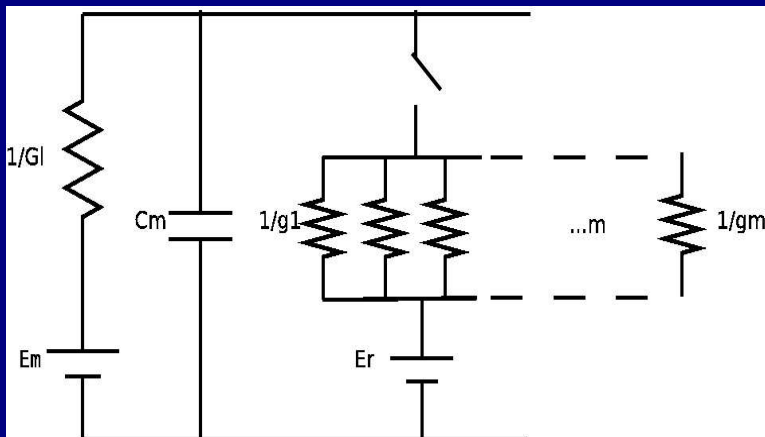
- Can correct empirically but not always efficient
 - Can also try to correct theoretically
- ... (and then test predictions)

Neurocomputation of the NMJ

In general, model using cable theory...

... but muscles used for electrophysiological tests can be chosen to have short-fibres... (FDB muscle)

So in this case we can model using a simple single compartment model:

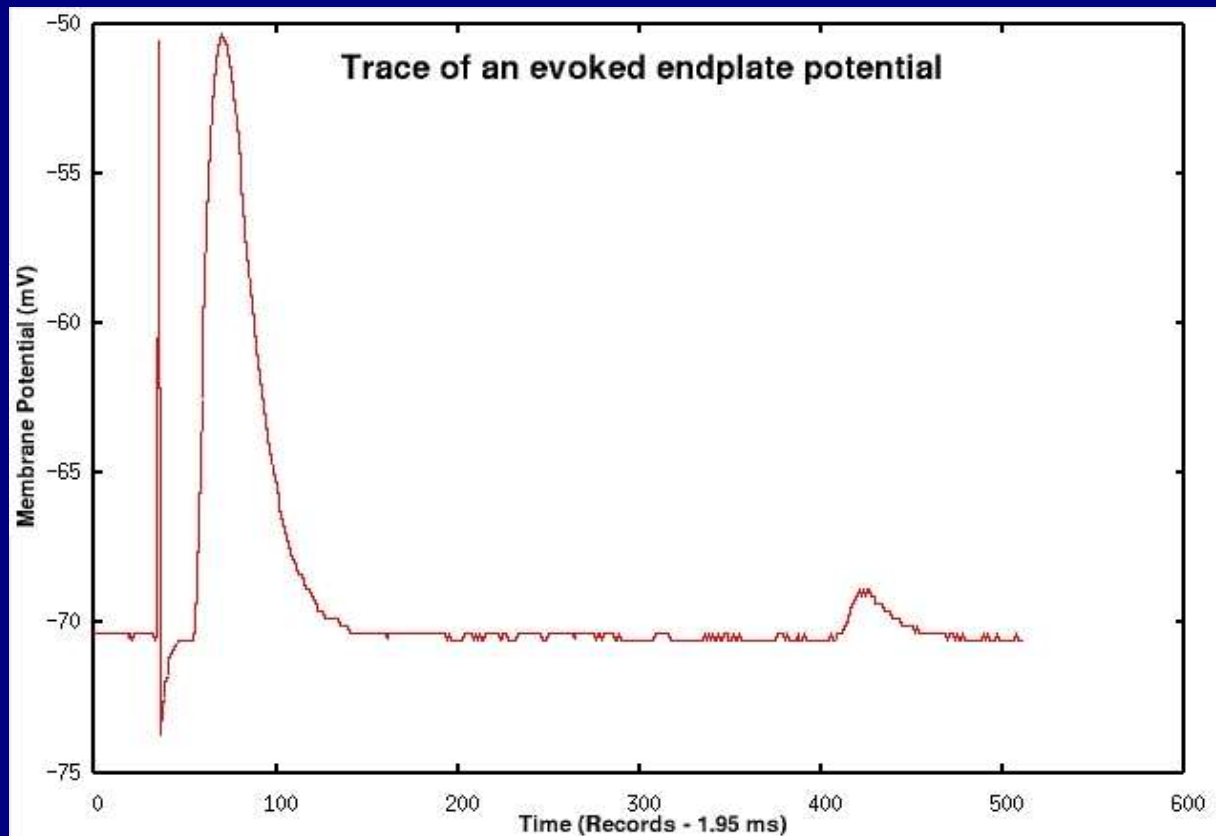


$$v_{ec} = v_e \left(1 - f \frac{v_e}{v_m} \right)^{-1}$$

for $\frac{v_e}{v_m} < 0.6$ and $0.1 \leq \frac{\Delta t}{\tau} \leq 2$ where f is a function of conductance and capacitive timecourses $\left(\frac{\Delta t}{\tau} \right)$

We can test these predictions empirically and statistically...

Statistical verification of the correction regime



Assume that vesicle release is a Poisson process

If vesicles sum linearly then c.o.v of MEPPs should equal c.o.v of EPPs

i.e. c.o.v $\frac{1}{\sqrt{n}}$

Correction should restore this c.o.v

Finally....

Future work:

Experimental

- Empirically verify correction using voltage/current clamping for FDB muscle

Informatics

- Compare to NEURON FDB simulation?

Work being undertaken at:

Dr Richard Ribchester's lab
Centre for Neuroscience
1 George Square

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