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Dissecting estimation of conductances in subthreshold regimes

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We study the influence of subthreshold activity in the estimation of synaptic conductances when linear regression methods based on the current-voltage relationship are used. It is known that differences between actual conductances and the estimated ones using such methods can be huge in spiking regimes, so caution has been taken to remove spiking activity from many experimental data before proceeding to linear estimation. However, not much attention has been paid to the influence of ionic currents active in the non-spiking regime. We use a conductance-based model endowed both with an afterhyperpolarizing current and a low subthreshold current to show that the activity of these currents during subthreshold activity can lead to significant errors in synaptic conductance estimation (see Table 1 and Figure 1). More precisely, we found errors higher than 100% in the

Table 1 Statistics of relative errors in the estimation of total, excitatory and inhibitory conductances.

		I_{AHP} – dominated	I_{LTS} – dominated
Mean / Std deviation	g_{syn}	8.6% / 6.45%	-11.23% / 9.69%
	g_E	27.82% / 35.14%	-2.85% /30.48%
	g_I	10.12% /9.07%	-13.87% / 16.30%
Maximum relative error	g_{syn}	21.18%	-22.59%
	g_E	109.07%	63.67%
	g_I	24.75%	-32.34%

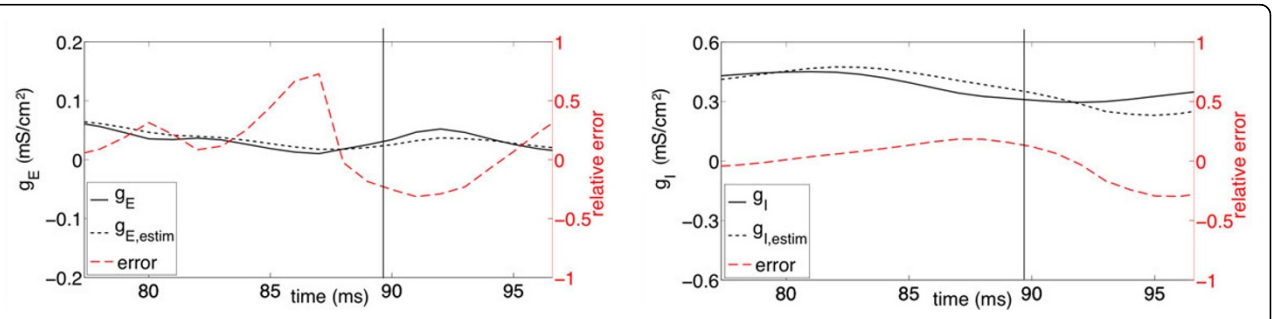

Figure 1 Representation of the relative errors in the I_{AHP} and I_{LTS} dominance phases. The pair of figures shows the relative error (dashed red), the estimated value (dotted black) and the actual value (solid black) of the synaptic, excitatory and inhibitory conductances, respectively, in the subthreshold regime. Vertical lines show the border between the I_{AHP}-dominance (left) and I_{LTS}-dominance (right) phases. The curves have been smoothed for a clearer plot. The actual values can be found in Table 1.

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estimation of excitatory conductances and up to 30% approximately for inhibitory conductances, mean errors being also significantly large. Therefore, conclusions obtained from experimental data by means of this estimation procedure need to be properly reanalyzed.

Our results add a new warning message when extracting conductance traces from intracellular recordings and the conclusions concerning neuronal activity that can be drawn from them. It also stimulates challenging questions in developing theoretical efficient methods to properly estimate synaptic conductances from voltage traces.

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