CROSS TALK

CrossTalk rebuttal

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I would like to congratulate Màtè on his eloquent and persuasive article, which makes an excellent defence of Marr's 'Three Levels' framework (Lengyel, 2024). I wholeheartedly agree with his contention that we should seek to understand the brain at multiple levels of description, and I am glad that our field contains such a broad spectrum of theoretical approaches. I have certainly encountered neuroscientists in my career who did not embrace this ecumenical spirit (e.g. 'You shouldn't call it a model if it doesn't have conductances').

Perhaps our most salient point of disagreement is over the degree to which Marr's framework asserts the dominion of the Computational over the other levels. We have quoted competing passages from Marr's book, and I concede that Marr explicitly denied holding the Computational level above the others in several passages. However, I cannot help but feel that this is a belated apology for the book's many attacks on neuroanatomy and physiology (including, if I may add one more: 'One has to exercise extreme caution in making inferences from neurophysiological findings about the algorithms and representations used, particularly until one has a clear idea about what … processes need to be implemented.'; Marr, 1982). Setting aside Marr's own views, perhaps my resistance stems from the degree to which Marr's admirers seem to brandish the Three Levels to assert this primacy (or so it often seems to me!).

I would raise one additional (minor) point of disagreement regarding the discovery of the action potential: 'Finally, at the computational level, one can also ask questions about the functional (dis)advantages of the action potential.' (Lengyel, 2024). My reading has been that Marr viewed the action potential as fundamentally tied to mechanism (e.g. 'Neuroanatomy, for example, is clearly tied principally to the third level, the physical realization of the computation. The same holds for synaptic mechanisms, action potentials, inhibitory interactions, and so forth.'; Marr, 1982).

However, if we replace 'computational' by 'normative', I would agree wholeheartedly with Màtè's suggestion. *Certainly* it is interesting to consider the normative advantages of computing with spikes instead of graded potentials! My reservation is simply that – in my view – Marr's notion of 'Computational' level refers to the information processing goals of the organism, and is thus committed to overlooking the details of biology.

Setting this minor point aside, I was extremely heartened to read that Màtè also prefers 'normative', 'descriptive' and 'mechanistic' to Marr's original levels. If we can agree to make these two classifications synonymous (while suspending any hierarchy between them), we will surely have nothing more to debate!

References

Lengyel, M. (2024). CrossTalk proposal: Marr's three levels of analysis are useful as a framework for neuroscience. *The Journal of Physiology*, **602**(9), 911–914.

Marr, D. (1982). *Vision: A computational approach*. Freeman & Co.

Additional information

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Supporting information

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