Four-Layer Closed-Loop Neural Networks

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It is of general interest as to study the properties of activity propagation during information transmission between cell assemblies. As it is difficult to manipulate networks in vivo, computational modeling studies are a productive substitute, although they are often limited by the dependence of results on parameter settings. Here we show that in vitro engineered neuronal networks show promise as model systems for information propagation. Microtunnel devices combined with Multi-electrode Arrays have been reported to be a good platform to study interactions between two neuronal culture networks or brain slices, which gives us a better understanding of information transmission in a two-layer network. Their success invites further development of more complex multi-layer networks. In this report, four-layer closed-loop neural networks are created on MEAs with the assistance of four-well microtunnel devices. Cells from rat brains were seeded in all four wells at the same time with cell density of 3000 cells/ mm2. Tapered microtunnels help create preferentially unidirectional growth of axons from one well to another, instead of equally bidirectional connections. Bursting activities were recorded during the third week in vitro.

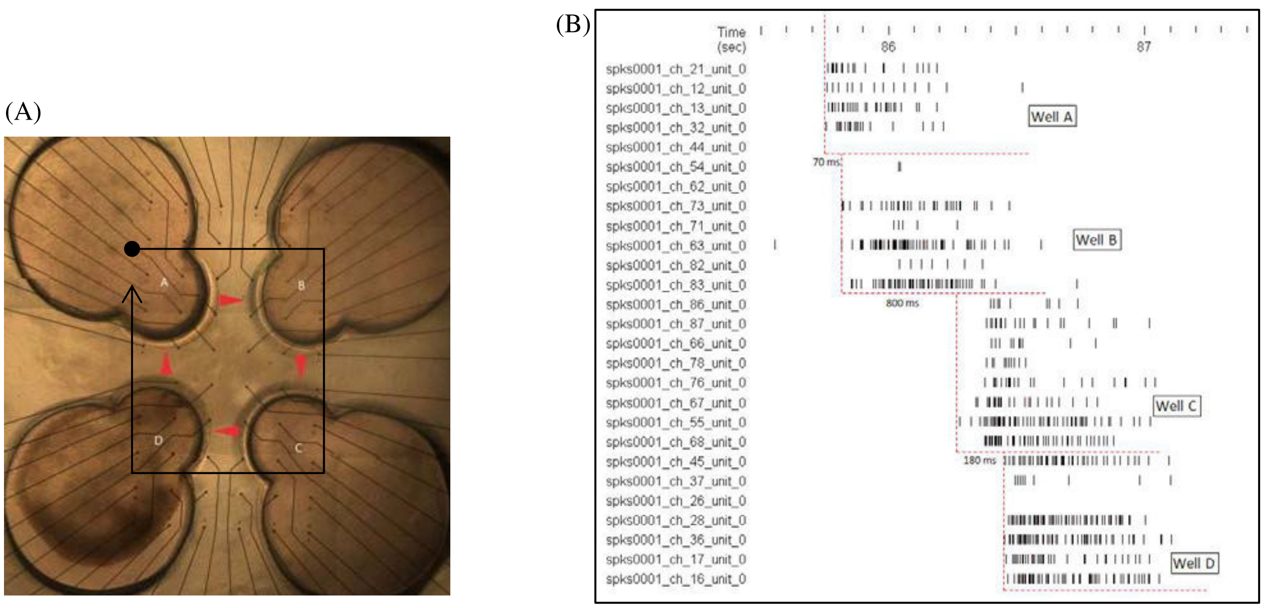

Figure 1. (A) Four-layer close-loop neural culture networks on an MEA with a microtunnel device. (B) An example of a burst unidirectionally propagating across four layers.

As shown in the figure, unidirectional propagation is seen from the first layer to the last with various delays between neighboring layers. In future studies, information coding through multiple layers and the feedback feature of the closed-loop architecture will be addressed.

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