Identifying and Localizing Multiple Objects Using Artificial Ventral and Dorsal Visual Cortical Pathways *

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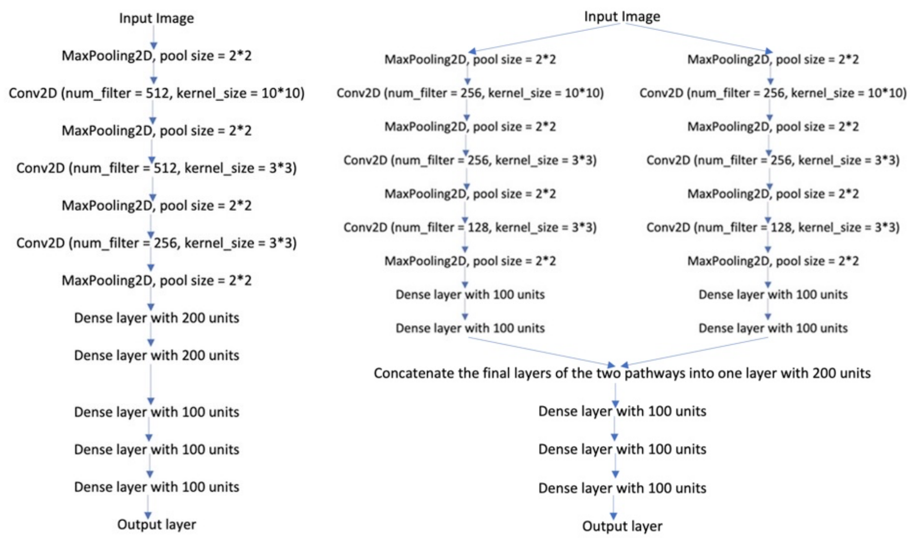
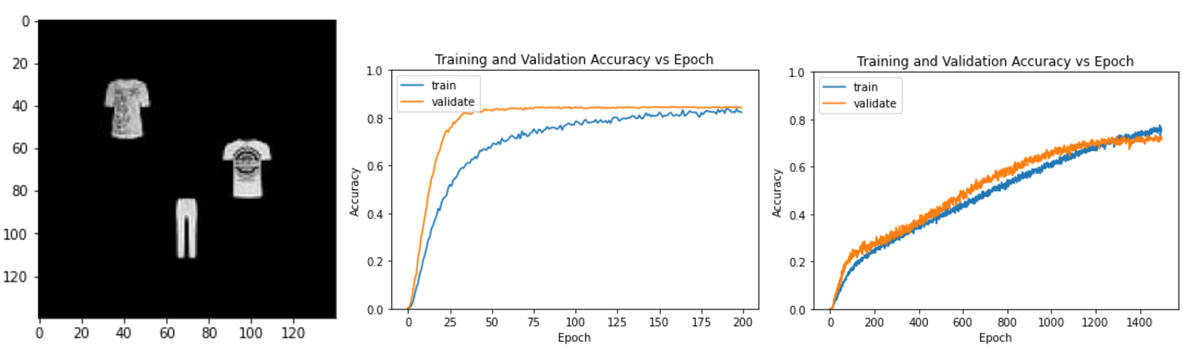
Our simulation results reported in Han and Sereno (2022) suggested that when modeling two separate cortical visual pathways for identity and space, these model pathways: (1) actively retained information about both identity and space (2) retained information about identity and space differently and (3) this differently retained information about identity and space in the two model pathways was necessary to accurately and optimally recognize and localize objects. We concluded that model cortical visual pathways actively retained information differently according to the different goals of the training tasks. One limitation of our study was that there was only one object in each input image whereas in reality there may be multiple objects in a scene.

In our current study, we try to find a brain-like algorithm that can recognize and localize multiple objects. We trained an artificial identity network to simulate the ventral pathway and an artificial location network to simulate the dorsal pathway. We trained the identity network by asking it to report the identities of the objects in order. The order was determined according to the relative locations between the objects. We trained a location network by asking it to report the locations of all the objects regardless of their identities. Then we combined the two networks and trained the combined network ($network_{two\_pathways}$) to recognize and localize multiple objects. For comparison, we also designed another network ($network_{one\_pathway}$) with the same size as the combined network and directly trained it to recognize and localize multiple objects. Our preliminary results with a three-object recognition and localization task suggest that $network_{two\_pathways}$ could achieve a significantly higher average testing accuracy ($p < 0.001$) with smaller variance and be trained in fewer epochs.



a *



b c d

Figure 1. (a) The structure of $network_{one\_pathway}$ and $network_{two\_pathways}$. (b) An input image that was used in the current study. (c) The training and validation accuracy curves for $network_{two\_pathways}$ in an example/a single trial. The testing accuracy was (85.4±0.1) % for 5 trials. (d) The training and validation accuracy curves for $network_{one\_pathway}$ in an example/a single trial. The testing accuracy was (63.7±9.4) % for 5 trials.

References

Han, Z., & Sereno, A. (2022). Modeling the ventral and dorsal cortical visual pathways using artificial neural networks. *Neural Computation, 34(1),* 138 – 171. https://doi.org/10.1162/neco_a_01456