A model of the ventral visual system based on temporal stability and local memory

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The cerebral cortex is a remarkably homogeneous structure suggesting a rather generic computational machinery. Indeed, under a variety of conditions, functions attributed to specialized areas can be supported by other regions. However, a host of studies have laid out an ever more detailed map of functional cortical areas. This leaves us with the puzzle of whether different cortical areas are intrinsically specialized, or whether they differ mostly by their position in the processing hierarchy and their inputs but apply the same computational principles. Here we show that the computational principle of optimal stability of sensory representations combined with local memory gives rise to a hierarchy of processing stages resembling the ventral visual pathway when it is exposed to continuous natural stimuli. Early processing stages show receptive fields similar to those observed in the primary visual cortex. Subsequent stages are selective for increasingly complex configurations of local features, as observed in higher visual areas. The last stage of the model displays place fields as observed in entorhinal cortex and hippocampus. The results suggest that functionally heterogeneous cortical areas can be generated by only a few computational principles and highlight the importance of the variability of the input signals in forming functional specialization.