A Neurocomputational Model for the Hemispheric Asymmetry Development of Face Processing

Panqu Wang¹, Garrison Cottrell²

¹Department of Electrical and Computer Engineering, University of California, San Diego
²Department of Computer Science and Engineering, University of California, San Diego

Extensive research effort has been put onto building neurocomputational models for face and object recognition. However, the relationship between the object recognition model and the development of human brain is still rarely considered. Research on the development of contrast sensitivity shows that human infants can only perceive low spatial frequency information from visual stimuli, but their acuity improves gradually with age. Also, the right hemisphere (RH) develops earlier than the left hemisphere (LH), and is dominant in infants. Here we show that these two temporal constraints, coupled with a desire on the part of the infant to individuate its caretakers and family, lead naturally to the strong right hemisphere bias for face processing. We propose a developmental model for face and object recognition using a modular neural network (See Figure 1) based on Dailey and Cottrell (1999). In this model, each visual stimuli is preprocessed through Gabor filter banks followed by PCA at each spatial frequency. The neural network has two modules to represent the two hemispheres and one hidden layer for each module. The output of the neural network is modulated by a gating network, which learns to gate the contribution of each module to the output, based on their contribution to performance. To model changes in infant acuity, we low-pass filter the data set, and gradually increase fidelity over training. To model the asymmetric developmental pattern, we give the two modules different learning rate over time. The strong RH and low spatial frequency bias for face recognition emerges naturally in the model from the interaction of the slow development of acuity and the early dominance of the right hemisphere. Remarkably, this strong asymmetry does not appear to hold for the other object categories that we tried.

Figure 1: Architecture of Dailey and Cottrell’s (1999) modular neural network model