

Split modeling of face and object recognition

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Abstract:

Because of the partial decussation of optic nerves, our visual field is initially split and the two halves are contralaterally projected to the two hemispheres. A fundamental question in cognitive science is thus why such a split exists. Such an initial split has been shown to have functional significance. For example, in face recognition, it has been shown that there is a left side bias effect, especially for familiar faces (e.g., Brady et al., 2005). This phenomenon has been argued to be an indicator of right hemisphere involvement in the perception of faces. Ivry and Robertson (1998) proposed a double frequency filtering theory to account for various hemispheric difference phenomena. They proposed that visual information coming into the brain goes through two frequency filtering stages: the first stage is to keep task relevant frequency and filter out irrelevant frequency information, and the second stage is to bias the information to low and high frequency in the left and right hemisphere respectively.

In the current study, we apply the split model (Shillcock & Monaghan, 2001), initially applied to modeling visual word recognition, to face and greeble recognition (See Fig. 1). In the split model, we first put Gabor filters on sampling points on the input image, and then bias information in the left visual field and right visual field to low and high spatial frequency respectively. We then apply principle component analysis to the two halves of the input separately, and feed the resulting input representation to the split model (Fig. 1).

We also compare the split model's performance with two other architectures: a split model with a nonsplit hidden layer, and a completely nonsplit model (Fig. 2). We show that with different frequency bias in the two halves of the model, the split models are able to account for the left side bias effect in behavioral studies. We also show that when the task is to recognize individual faces or greebles under different lighting conditions, the split model with a nonsplit hidden layer outperforms the other two models (Fig. 3), suggesting an advantage for initial splitting and early convergence after the split. This result suggests that the split architecture is able to develop better representations when part of the input is not reliable, such as shadows cast on faces and Greebles. Since we constantly encounter lighting changes in the real world, a split visual system may have helped us develop better representations of objects in the real world.

Fig. 1.

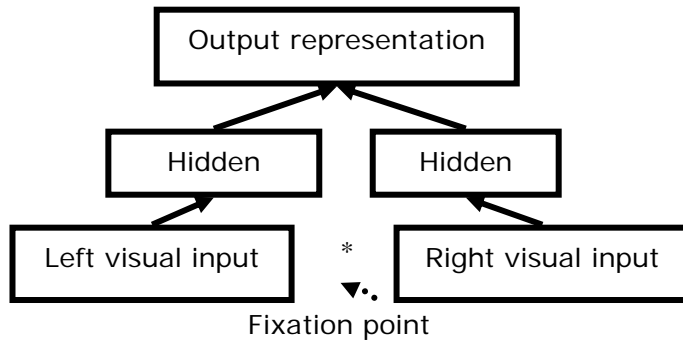


Fig 2.

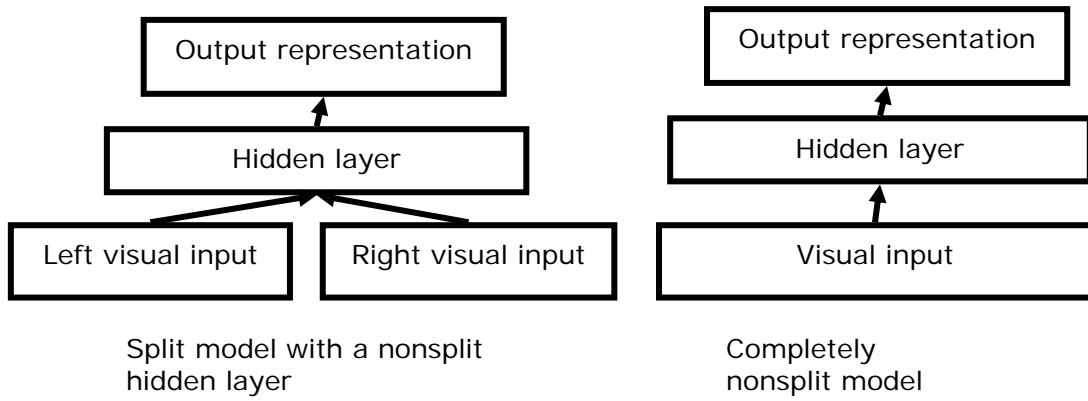


Fig. 3.

