RESEARCH STATEMENT

Research Experience

My current research concerns hemispheric processing in reading, face recognition, and object recognition, along with the development of the expertise in these domains. Over 50 years of research has provided abundant evidence for the existence of hemispheric asymmetry in cognitive processes, such as the right visual field / left hemisphere advantage in English word recognition, and the left side bias effect in face recognition. Nevertheless, the understanding of how the hemispheric asymmetry emerges remains very limited. I have addressed this issue through computational modeling, which allows perfect control over the asymmetry in the input, the processor (i.e. the two hemispheres), and the connections between the input and the processor.

First, by using the split fovea model (Shillcock & Monaghan, 2000), results from modeling Chinese character pronunciation show that given a symmetric processor, hemispheric asymmetry emerges purely due to asymmetric information structure of the input stimuli, suggesting the influence of perceptual learning. Corresponding behavioral data confirm the modeling prediction. (Hsiao & Shillcock, 2006). Second, the modeling data also show qualitative differences when the asymmetric input is processed in just one or both hemispheres (i.e., different levels of laterality), and are able to account for sex differences in Chinese character naming in the behavioral data (Hsiao & Shillcock, 2005). The corresponding ERP study shows that this sex difference is reflected in N350, and the foveal splitting effect can be observed in N170 (Hsiao, Shillcock, & Lee, 2007).

Finally, modeling the recognition of faces, which have a symmetric information structure, allows an examination of the intrinsic asymmetry in the hemispheres. By implementing "Double Filtering by Frequency" (DFF) theory (Ivry & Robertson, 1998), which argues differential frequency bias in the hemispheres, the modeling data suggest that, to show the left side bias effect, the convergence of the visual field split must take place at a late stage, at least after information has been encoded separately in the hemispheres, a fact that is often overlooked in computational modeling of cognitive processes (Hsiao, Shieh, & Cottrell, *in press*). I have also proposed a new theory of hemispheric differences that provides an entirely different explanation: hemispheric differences in perception take place at an encoding stage beyond the sensory level, resulting from differential connectivity configurations in the two hemispheres. The corresponding modeling data show that the model based on the new theory fits the human data better than the model based on DFF.

In addition, I used both TMS and cueing paradigms to examine the interaction between the hemispheres and the information structure of lexical stimuli (Hsiao, Shillcock, & Lavidor, 2006; 2007). The results show that each hemisphere responds optimally to the information in the contralateral visual hemifield to which it has direct access, and are consistent with the split fovea claim, which suggests that functional foveal splitting is a universal processing constraint in reading.

I have adopted eye tracking as a methodology to address issues of where subjects obtain information from stimuli. I show that two fixations suffice in face recognition, and propose that eye fixations are directed to the "center of the information", instead of individual features, after the expertise is acquired (Hsiao & Cottrell, *in press*). This argument is supported by the data from a Bayesian model of fixation-based memory (Barrington, Marks, Hsiao, & Cottrell, *submitted*). In addition, I have examined how familiarity and different learning experiences influence our eye movement behavior in face and object recognition (Hsiao, Tanaka, & Cottrell, *in preparation*). The data show that individual-level recognition training significantly shortened fixation duration, suggesting the ability to retrieve visual information more efficiently; in contrast, categorical-level recognition training increased saccade lengths, suggesting an increase of perceptual span.

I have also examined whether face-specific effects, such as holistic processing and the left side bias effect in face perception, can also be observed in expertise-level visual word recognition. Concerning Chinese characters, I show that novices (non-Chinese readers) have stronger holistic processing than experts (Chinese readers), in contrast to the belief that holistic processing is an expertise marker from the face recognition literature. I also show that experts have a left side bias effect in Chinese character perception, whereas novices do not; this suggests that the left side (right hemisphere) bias effect may be the real expertise marker (Hsiao & Cottrell, *in preparation*; this study has been accepted as an oral presentation at the Vision Sciences Society meeting this year).

Research Interests

My research interests can be put into two related research directions:

1. Hemispheric asymmetry in cognitive processes: I aim to expand and apply my theories and models of hemispheric processing to account for hemispheric asymmetry and interaction in perception and cognition, not only on healthy subjects, but also on persons with recognition difficulties such as prosopagnosia, autism, and dyslexia. I am interested in examining hemispheric asymmetry in neuroanatomy and incorporate the neuroanatomical findings into the model to account for behavioral data. I am also interested in investigating why the hemispheric difference exists and whether this is an optimal design for performing different cognitive tasks that require different types of information given that the brain has limited resources.

2. The development of perceptual expertise: I aim to investigate what is specific to a type of visual stimuli (e.g., words and texts in different languages, faces, and objects) and whether there exists a visual-expertise-universal. I am interested in examining changes in behavior and neural mechanism in the acquisition of different types of visual expertise and the role of the two hemispheres in its development, along with how visual expertise interacts with other cognitive functions, such as memory and language acquisition. I am also interested in transferring these research findings into instructions to teach people to acquire different types of visual expertise more efficiently and effectively, especially for expertise that has social importance such as reading and face recognition.