Chapter 18
Neuronal Function in the Cortical Face Perception Network

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ABSTRACT

Face perception is considered the most developed visual perceptual skill in humans. Functional magnetic resonance imaging (fMRI) studies have graphically illustrated that multiple regions exhibit a stronger neural response to faces than to other visual object categories, which were specialized for face processing. These regions are in the lateral side of the fusiform gyrus, the "fusiform face area" or FFA, in the inferior occipital gyri, the "occipital face area" or OFA, and in the superior temporal sulcus (pSTS). These regions are supposed to perform the visual analysis of faces and appear to participate differentially in different types of face perception. An important question is how faces are represented within these areas. In this chapter, the authors review the function, interaction, and topography of these regions relevant to face perception. They also discuss the human neural systems that mediate face perception and attempt to show some research dictions for face perception and neural representations.

INTRODUCTION

Faces have long been of interest to scientists in a wide range of aspects. In recent years, this has allowed us to understand many different aspects of how we perceive and process faces. Face perception performs as the most developed visual perceptual skill in humans. People prefer to look at faces at a very early age and, across their lifespan, most people spend more time looking at faces than at any other type of object (Haxby et al., 2000). People seem to have the capacity to perceive the unique identity of a virtually unlimited number of

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different faces and much cognitive and neuroscience research has focused on face perception. Face perception is based on the perception of aspects of facial structure that are invariant and changes in expression and other movements.

Much of the cognitive and neuroscience research on face perception has focused on the neuronal mechanization of face processing. Functional magnetic resonance imaging (fMRI) studies have identified multiple regions distributed across cortices that exhibit a stronger neural response to faces than to other visual object categories (Gauthier et al., 2000; Kanwisher et al., 1997; Puce et al., 1996), so we can now approach this cortical network hierarchically and physiologically to ask questions about face processing at a level of detail that was previously unimaginable. These regions have been linked together to form the components of a distributed cortical network specialized for face perception (Ganel et al., 2005; Haxby et al., 2000; Iaria et al., 2008). Each of the regions has been shown to exhibit different functional properties. However, the cognitive operations performed in these regions are not yet fully understood (Iaria et al., 2008; Kanwisher and Yovel, 2006). In this review, we will discuss the human neural systems that mediate face perception and attempt to show how cognitively distinct aspects of face perception are mediated by distinct neural representations.

THE ANANATOMICAL LOCALIZATION OF FACE PERCEPTION

Face perception is mediated by a distributed neural system in the human brain, comprised of multiple bilateral regions. Early fMRI studies defined the face-selective regions using a contrast of faces greater than scrambled images and letter strings (Gauthier et al., 2000; Puce et al., 1996), but they are now more commonly defined using a contrast of faces greater than a diverse range of non-face category images such as objects(Grill-Spector et al., 2004; Levy et al., 2001), or both objects and scenes(Large et al., 2008). The core of the human neural system for face perception consists of three bilateral regions in the occipitotemporal visual extrastriate cortex. The results from a conventional functional localizer in one participant using a contrast of faces greater than houses, common objects and phase scramble objects are shown in (Figure 1). These regions are in the lateral side of the mid-fusiform gyrus, the "fusiform face area" or FFA (Kanwisher et al., 1997), in the inferior occipital gyri, the "occipital face area", OFA (Kadosh et al., 2011), and in the superior temporal sulcus (pSTS) (Turk-Browne et al., 2010). These regions are presumed to perform the visual analysis of faces and appear to participate differentially in different types of face perception.

THE ROLE OF THE FACE AREA IN FACE PERCEPTION

Three regions in the visual extrastriate cortex have been found as the core of the human neural system for face perception. These regions participate in different aspects of face perception (Haxby et al., 2001). In this part, we will review the neuronal function of each face-selective area.

The Neuronal Function of the Fusiform Face Area

PET studies initially showed the activation of the fusiform gyrus in a variety of face perception tasks (Haxby et al., 1991), and subsequently fMRI has revealed more of the specificity of these cortical regions for faces, with demonstrations of fusiform regions that responded more strongly to faces than to letter strings and textures (Puce et al., 1996), flowers(Grill-Spector et al., 2004), everyday objects, houses, and hands (Grill-Spector et al., 2004; Kanwisher et al., 1997). A number of studies support the idea that the FFA is activated specifically by faces, and not by the low-level