Chapter 15
Functional Neuroimaging of Acupuncture: A Systematic Review

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ABSTRACT

Acupuncture, an ancient Chinese healing methodology, is becoming increasingly popular throughout the world. However, the mechanism by which acupuncture exerts its effects is not yet fully understood. Functional magnetic resonance imaging (fMRI) is a widely used technique to observe brain activity noninvasively. In this chapter, the authors first review the existing literature on the effects of acupuncture on brain activity and connectivity. The authors next discuss some basic issues in the study of acupuncture with fMRI, including deqi, baseline and control measures, acupuncture modalities, and experimental paradigms. At the end of the chapter, future research directions in the study of acupuncture with fMRI are suggested.

INTRODUCTION

Acupuncture, an ancient therapeutic technique, has been used for more than 25 centuries (Medicine, 1980; Eisenberg et al., 1993; Ernst, 2009). It originated in ancient China, and is an important part of Traditional Chinese Medicine (TCM). According to TCM theory, acupuncture at specific acupoints is able to treat certain types of diseases and modulate the neuroendocrine and circulatory systems. In 1997, a National Institutes of Health (NIH) consensus statement on acupuncture affirmed the efficacy of acupuncture for the treatment of specific conditions such as menstrual cramps,

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tennis elbow, and fibromyalgia (NIH, 1998). Acupuncture is becoming increasingly popular in the United States, Europe and throughout the world, emerging as an important treatment alternative and complementary intervention (Kessler et al., 2001; Li & Su, 2011). However, the mechanism by which acupuncture exerts its effects remains poorly understood. With the aim of making acupuncture widely adopted, researchers need powerful and reliable tools to study the effects of acupuncture.

In recent years, the functional magnetic resonance imaging (fMRI) technique has become a well-suited tool to explore the complex mechanisms and assess the effects of acupuncture on brain activity (Bai et al., 2009; S. Y. Cho et al., 2010; Z. H. Cho et al., 1998; K. K. S. Hui, Liu, Makris, Gollub & Chen, 2000; K. K. S. Hui et al., 2005; Kong, Gollub, Webb et al., 2007; Kong et al., 2002; Yan et al., 2005). fMRI, together with other neuroimaging techniques, offers a mechanism for studying the brain noninvasively and revolutionizes the analysis of acupuncture methods.

In this chapter, we will systematically review the literature on the effects of acupuncture on brain activation, and will discuss some basic issues associated with the study of acupuncture using fMRI techniques.

MAIN FOCUS IN ACUPUNCTURE STUDIES USING FMRI

fMRI Research on Acupuncture in Humans

To understand the mechanisms behind acupuncture effects using fMRI or another neuroimaging technique, investigators have developed many theories to interpret the neural activities and connectivity patterns associated with acupuncture stimuli. We should first note that the fMRI investigation of acupuncture and its effects is in its infancy. Therefore, it is not unusual that some controversial results exist in the literature. Among many possible explanations are the methodologies used in imaging preprocessing and statistical analyses in these reports. For example, negative findings for activations based on univariate approaches do not necessarily preclude the existence of connectivity observed using multivariate approaches. Hui and Cho were the first to show activations in the brain during acupuncture stimulation (Z. H. Cho et al., 1998; K. Hui, Liu, & Kwong, 1997). Cho and other researchers (Z. H. Cho, et al., 1998) compared the time-course between a conventional checkerboard 8-Hz light-flash stimulation of the eye and stimulation of a vision-related acupoint (VA1). Close correlations between the two conditions were observed, and similar activation was not observed when a non-acupoint (NAP) was stimulated. Based on further research in 2006, authors of the 1998 publication (Z. H. Cho et al., 1998) claimed that the observed acupoint specificity was not generalizable for pain and analgesic effects (Z. Cho, Chung, Lee, Wong, & Min, 2006). Kong et al. (2009) used a multiple-session experiment to test whether electroacupuncture stimulation at two TCM vision-related acupoints, UB 60 and GB 37, could produce fMRI signal changes in the occipital regions of the brain, and to assess the speciðcity of this effect when compared with stimulation at an adjacent NAP. Their results did not support the view that acupuncture stimulation at vision-related acupoints induces speciðc fMRI blood-oxygen-level dependent (BOLD) signal changes in the occipital cortex. In recent years, many additional studies have tried to elucidate the underlying mechanisms of acupuncture by means of fMRI (Beissner & Henke, 2011). Yan et al. (2005) analyzed fMRI images from 37 healthy volunteers in response to acupuncture at Liv3 and LI4 versus sham points using a random effects analysis method. They found that acupuncture at Liv3 evoked specific activation in the postcentral gyrus, posterior cingulate, parahippocampal gyrus, BA 7, 19 and 41, but deactivation in the inferior frontal gyrus, anterior cingulate, and BA