Functional MR Imaging Evaluation of Hammer Throwing Imagery: A Case Study

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INTRODUCTION

It has been detected that motor imagery of a physical activity involves the recruitment of the common neural functions in the motor system that are engaged when the movement is actually being executed (Jeannerod 1994, Decety 1996). Most of the studies have employed fine motor tasks.

Recently, a few studies of gross motor imagery using fMRI has been reported (e.g., Reiser 2002, Ross 2003). In Ross's study, for example, it was evaluated the motor imagery of the golf swing by using fMRI imaging technique. As the results, he found out that the rest versus golf paradigm showed activation in the motor cortex, parietal cortex, frontal lobe, cerebellum, vermis and action planning areas. The vermis, supplementary motor area, cerebellum, and motor regions generally showed the greatest activation during the motor imagery of the golf swing, and also revealed that a correlation existed between increased number of areas of activation and an increased handicap. However, the constancy of those neural responses during the motor imagery for the fast, complex, automatic gross movements has not yet been examined.

The main purpose of this study is to evaluate the motor imagery of the hammer throwing of an expert athlete, by using functional MR imaging (BOLD technique) to assess whether the areas of brain activation could be defined, and to assess the constancy of those neural responses in fMRI as an index of the brain function during imagery of the skill.

METHOD

1. Subject:

A right-handed expert female athlete (28-years-old) in hammer throwing.

2. Experimental apparatus:

fMRI.

A conventional 1.5T MRI scanner was used (Magnex, Shimazu).

A total of 100 scans were acquired with a gradient eco EPI sequence (TR/TE, 5000/55 ms, FA90, FOX 240 mm, matrix 64x64, 38 axial slices, 5mm slice thickness without gap).

3. Condition:

The task consisted of two imagery conditions and a rest condition.

The subject was instructed beforehand concerning the hammer throwing imagery by using internal first person viewpoint and the two special control paradigms, which were the rest and wall control. For the rest control, the subject was instructed to imagine a restful state without any physical activities, while for the wall control, the subject was instructed to imagine leaning against a wall with both hands outstretched pushing against it with about 60%maximum strength. The imaged hammer throwing was to be full with body rotations.

Each block consists of four imagery condition paradigms in order, were hammer throwing

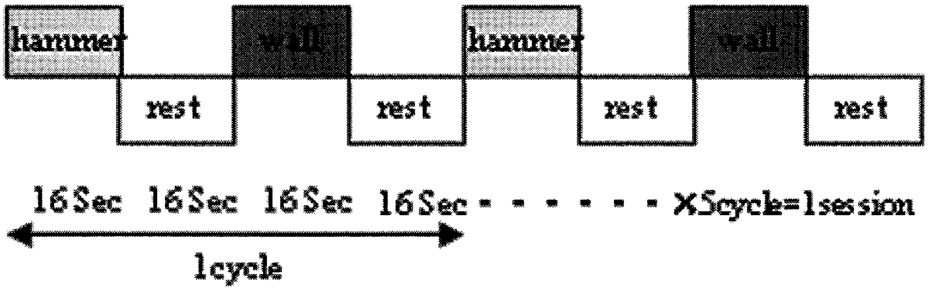

Figure 1 Experimental protocol

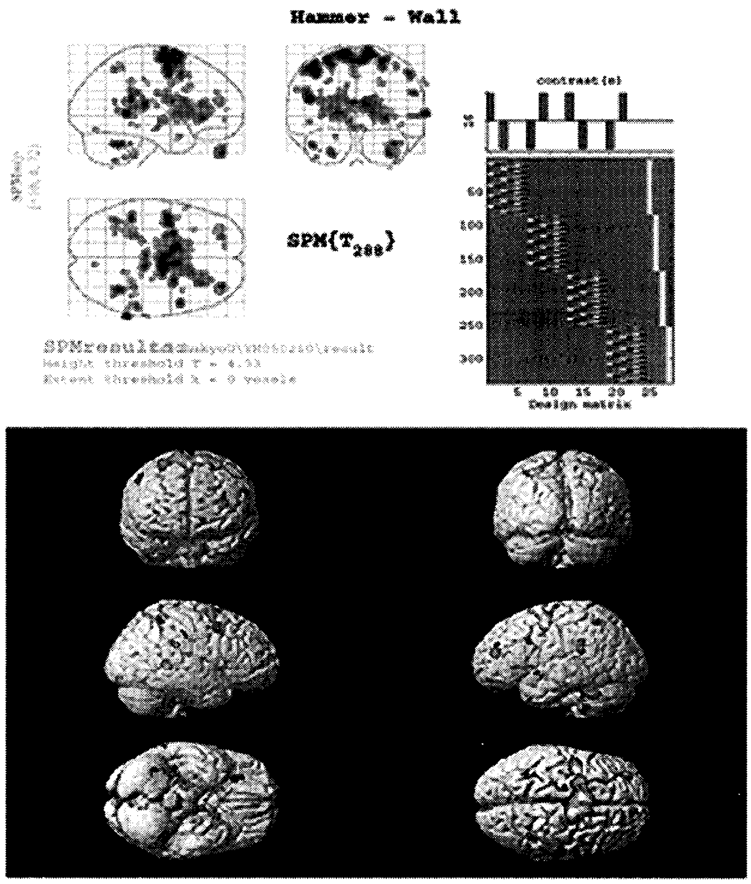

Figure 2 Area of brain activation (hammer–rest 1st)

(16 sec.), rest control (16 sec.), wall control (16 sec.), rest control (16 sec.), Five blocks were set in a session, and four sessions were given in total.

After 50 days, the same experiment was repeated to assess the constancy of responses in fMRI. The experimental protocol is shown Figure 1. ATR Review of Board approved the present study. The subject was given written informed consent.

RESULTS and DISCUSSION

Statistical evaluation of the fMRI data was conducted by automatic calculation with SPM. As a result, the brain functional map of the wall-versus-hammer throwing paradigm provide evidence that :

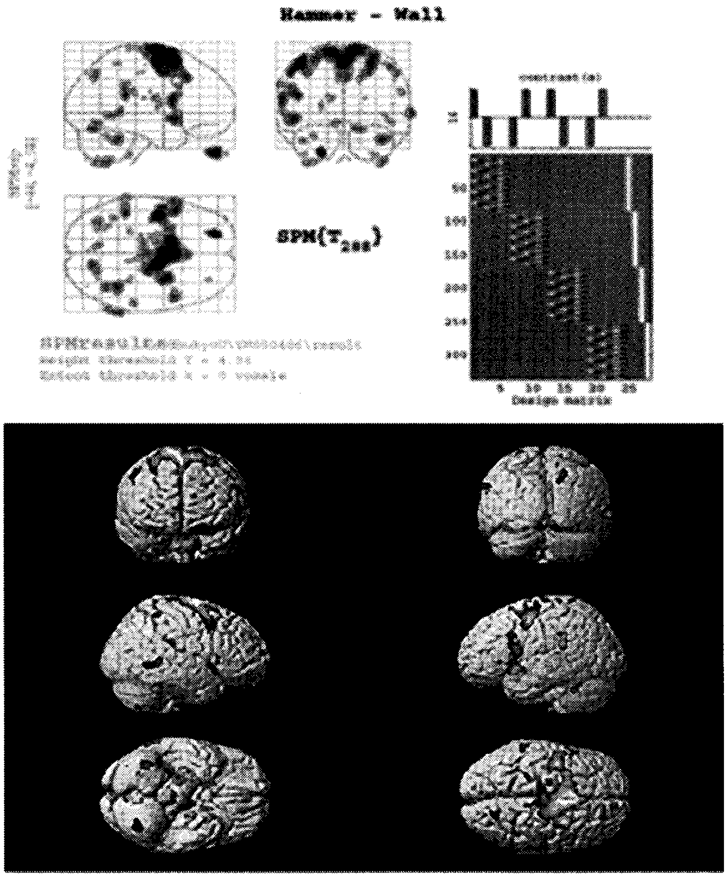

Figure 3 **Area of brain activation (hammer–rest 2nd)**

1) Stronger activations of the motor cortex area (BA 4 and BA 6) and auditory association area (BA 22) are involved during hammer throwing imagery. On the other hand, the visual sensory area (e.g. BA 17,18) was not involved (Figure 2).

2) These neural functions during motor imagery at an expert level remain relatively stable for a few months (Figure 2 and 3).

In conclusion, these results support that expert athletes have relatively stable motor imagery over the long term, and that their motor imagery might be specific to characteristics of sport skills and also skill levels.

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