

## 科学研究費助成事業 研究成果報告書

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研究課題名(和文) Neural Correlates of Interoceptive Attention/Awareness

研究課題名(英文) Neural Correlates of Interoceptive Attention/Awareness

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研究成果の概要(和文)：本研究では、身体内部に意識を向ける課題を行っている際の神経活動を、fMRIを用いて次の3点について調べた： 熟練者は初心者と異なる脳活動を示すか、脳活動から被験者が熟練者か初心者かを予測できるか、遠心性経路を中継する脊髄でも両群で神経活動に差があるか。その結果、熟練者は下頭頂領域において初心者と逆の活動パターンを示し、脳活動から被験者が熟練者か初心者かを予測できることがわかった。また、熟練者は初心者と比べ高い脊髄神経活動を示した。研究成果の一部はOHBM 2014国際学会に発表された上で、国際学術誌2本として出版された。

研究成果の概要(英文)：We investigated the neural correlates of Interoceptive attention in two groups: a group of subjects with several years of Kokyuhō experience, where they train attending to their body, and a group of novices. Our project can be divided into two sub projects, namely spinal study and brain study. Our results showed activation in spinal cord, merely by attending to body parts, while there was no movement or stimulation of the body. However, this happened only in the experienced group. Our brain results showed activations in several parts of the brain. The interesting and overlooked information was the opposite activation pattern in novices and experienced subjects within the supramarginal area. This area was activated for novices and deactivated for experienced subjects during the task. Part of the results were presented in international conferences, OHBM 2014. We published two papers in two international journals within this fiscal year.

研究分野：Cognitive Neuroscience

キーワード：fMRI interoception brain spinal cord

### 1. 研究開始当初の背景

In many disciplines/traditions around the world such as Japanese Kokyuho, Indian Yoga, etc. a practitioner is trained to attend to and simultaneously be aware of interoceptive senses in body parts, and we consider them as Interoceptive Attention/Awareness (IAA) tasks. Previous studies investigate the effects of interoceptive attention on other processes (e.g., emotion reactivity or regulation), while our understanding of these practices and how they cause such effects are incomplete. Also, the previous neuroimaging studies only investigate the effect of IA on brain activations, while its effect on spinal activation has been totally neglected.

### 2. 研究の目的

Our goal in general is to better understand the neural correlates of IA. This goal can be divided into three objectives. 1. Clarify the effect of IA on spinal cord. 2. Clarify if the expertise level of IA can be anticipated from brain activations, using mathematical techniques (machine learning). 3. Investigate the difference of brain activations for different regions of the brain. For this part, we only focused on a generally overlooked region of the brain, supramarginal gyrus.

### 3. 研究の方法

The procedure can be divided into experiment design, data acquisition, and data analyses.

As for experiment design, subjects were supposed to perform repetitions of attention to two body parts (the knees and the lower abdominal areas) and rest.

The subjects included two groups, one group consisting of people with several years of experience with Kokyuho, a method extensively practicing IA, and a group of people with no such experience. We acquired the brain function data by scanning subjects by MRI while subjects were performing the tasks.

For data analyses we used programming languages such as Python and R and also toolboxes embedded in Matlab. Here we explain this part in more details:

- 1) For the spinal experiment, we chose a body part with a relatively high potential to be better attended to by experts compared with novices: the pubic/lower abdominal region, which is more highly emphasized in East Asian practices than are other parts of the body. Although the motivation for this emphasis is based more on tradition than established medical knowledge, experts recruited in this study have been extensively trained to concentrate on this body part. As the nerves innervating this region arise primarily from L1-2 lumbar segments, the region of interest in this study included those spinal cord segments.
- 2) Secondly, we investigated whether experts' performances could be distinguished from that of novices' by training a classifier on the fMRI data, when participants performed IA on two distinct body regions. Following cross-validation of the classification process on this dataset, the classification process was tested on

the dataset of a separate group.

- 3) For investigating IA-related supramarginal (SM) activity in two groups, we first investigated IAA induced neural activations regarding two parts of the body (the knees and the lower abdominal areas) for subjects with no experience in IAA and confirmed similar activation patterns in SM and other brain regions as previous studies, for both designated body parts. We then performed a group comparison study with a group of expert IAA practitioners and a age/gender matched group of novices using the same IAA tasks.

#### 4 . 研究成果

Spinal results showed that neural activity in the spinal segment innervating the attended-to body area increased in experts when they performed IAA and that this increase was significantly larger for experts versus novices in each of the sessions. The significant effects of IAA and expertise on spinal neural activity are consistent with and elaborate on previous reports showing similar effects on cerebral neural activity. As the spinal cord directly innervates body parts, the results might indicate that IAA has an instantaneous (possibly beneficial) effect on the physical body after extended training.

Brain results in the novices replicated that of previous studies, and we showed this is the same for IAA tasks regarding two different parts of the body. Group comparison results showed opposite

profiles of SM activation for the two groups; novices showed activation and the experts showed deactivation of the SM. The results suggest that novices recruit SM during IAA possibly due to lack of experience in those tasks but this could be alleviated for performing IAA as illustrated by activation profile in experts.

Finally, using statistical classifiers on brain data to classify two groups revealed that the classifier was able to distinguish between the amateur and professional practitioners when IA was performed regarding an area of the body which is highly emphasized in experts' trainings. Moreover, discriminating brain regions for this classifier mainly included reward-systems, and regions related to peripersonal space and sensory-motor functions. Our findings suggest that machine learning methods can be applied to fMRI data to objectively evaluate performances for such internal cognitive concentration techniques, if the task is well chosen based on their disciplines. Furthermore, our results indicate that the recruitment of pathways activated during the processing of interoceptive signals may differ between novice and expert practitioners.

#### 5 . 主な発表論文等

( 研究代表者、研究分担者及び連携研究者には下線 )

[ 雑誌論文 ] ( 計 2 件 )

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〔学会発表〕(計 2 件)

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〔図書〕(計 0 件)

〔産業財産権〕

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〔その他〕  
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