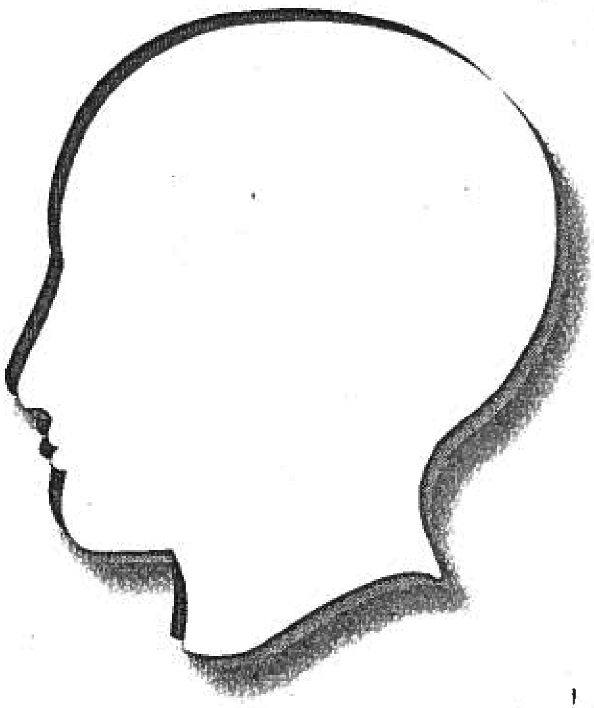
III ENCONTRO PSI

IMPLICAÇÕES E APLICAÇÕES DA PSI

LIVRO DE REGISTRO DE TRABALHOS APRESENTADOS



PROCEEDINGS OF PRESENTED PAPERS

3RD PSI MEETING: IMPLICATIONS AND APLICATIONS OF PSI

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SUMÁRIO

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BRAIN ACTIVITY WHILE GUESSING - RESEARCH BY FUNCTIONAL NEAR-INFRARED SPECTROSCOPY (FNIRS) -

A Atividade Cerebral Durante a Adivinhação
Pesquisa por Espectroscopia Próxima do Infravermelho Funcional (fNIRS)

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Abstract

There are several useful methods to examine brain functions from outside of the body. One of them is fNIRS (functional near-infrared spectroscopy) which can be used to measure only the cerebral cortex near the scalp (depth: 2-3 cm). fNIRS is non-stressful the same as EEG measurements, so it is a suitable method for sensitive subjects. The present paper deals with 3 topics using fNIRS. First, brain blood flow was measured while guessing a hidden figure in a forced-choice test. Spontaneous blood flow change often occurred at the temporal lobe, and awareness was slightly more activated at that time. Second, the cognitive process for human facial expressions was researched. It is said that Japanese are expressionless or vague compared with people of other cultures. Subjects tried to distinguish emotions of vague faces made by a Japanese actress. The task was relatively easy for Japanese while it was difficult for Chinese. Third, brain blood flow of various experts was measured while they were guessing for the invalid parts of the inside of human body or for a small thing hidden in a dark box. Brain activities of star psychics during clairvoyance were not similar to activities of other subjects. The characteristic activated area of star psychics was the prefrontal area although the guessing task required formulating visual images and many subjects showed activation of the right temporal lobe.

Keywords: brain, functional,near-infrared spectroscopy (fNIRS), spontaneous blood flow change, instantaneous highly activated state of awareness, temporal lobe, prefrontal, guess, clairvoyance, facial recognition, expression, Japanese face

Resumo

Há vários métodos úteis para exáminar as funções cerebrais de fora do corpo. Um deles é o fNIRS (espectroscopia funcional próxima ao infravermelho) que pode ser usado para medir só o córtex cerebral perto do escalpe (profundidade: 2-3 cm). fNIRS é não-estressante tanto quanto as medidas de EEG, então é um método conveniente para pessoas sensíveis. O presente artigo lida com 3 temas usando fNIRS. Primeiro, fluxo de sangue cerebral foi medido enquanto se adivinhava uma figura escondida em testes de escolha-forçada. Primeiro, o fluxo de sangue de cérebro foi medido enquanto se adivinhava uma figura escondida num teste de escolha forçada. Freqüentemente ocorreram mudanças espontâneas de fluxo de sangue no lóbulo temporal, e a consciência ficou levemente mais ativa nessa ocasião. Segundo, o processo cognitivo para expressões faciais humanas foi pesquisado. É dito que os japoneses não têm expressão facial ou a têm de forma vaga se comparados com as pessoas de outras culturas. Os sujeitos tentaram distinguir as emoções das expressões faciais feitas por uma atriz japonesa. A tarefa era relativamente fácil para os japoneses enquanto era difícil para os chineses. Terceiro, o fluxo de sangue cerebral de vários peritos foi medido enquanto adivinhavam partes inválidas do interior do corpo humano ou alguma coisa pequena escondida numa caixa escura. As atividades cerebrais de psíquicos reconhecidos na mídia durante a clarividência não eram semelhantes às atividades de outros indivíduos. A área característica ativada de psíquicos da mídia foi a área pré-frontal embora o que tarefa de adivinhação requerisse fosse a formulação de imagens visuais e muitos sujeitos mostraram ativação do lóbulo temporal direito.

Palavras-chave : cérebro, espectroscopia funcional próxima ao infravermelho (fNIRS), mudança espontânea de fluxo de sangue, instantâneo estado altamente ativado de consciência, lóbulo temporal, pré-frontal, adivinhação, clarividência, reconhecimento facial, expressão, rosto japonês.

1. INTRODUCTION

Guessing......the authors have long had an interest in guessing especially among various mental activities. Guessing is considered an important activity which has a close connection with psi, especially, clairvoyance. The details of the physiological mechanism relating to psi need to be elucidated if researchers are to know which areas of the human brain are activated during guessing. For example, it has been reported that the prefrontal area of the human brain is activated during guessing (Elliott, et al, 1999). This finding is very interesting because the prefrontal area is located at the position of the so-called "third eye". This report was done by fMRI (functional magnetic resonance imaging). The authors with Morihiro Sugishita (University of Tokyo) have also measured brain activities by fMRI during clairvoyance by a star psychic (W004, female, 32 y) in 1999, and obtained a similar result (unpublished). However, unfortunately, the authors had to abandon additional work because the subject declined to participate in further fMRI studies.

There are several useful methods to examine brain functions from outside of the body, not only fMRI; for example, EEGs (electroencephalograms), MEGs (magneto-encephalograms), PET (positron emission tomography) and fNIRS (functional near-infrared spectroscopy) can all be used. fNIRS is the newest non-invasive imaging method which has been developed in Japan. fNIRS can be used to measure the cerebral cortex near the scalp (depth: 2-3 cm) and its spatial resolution is 2-3 cm, although its time resolution is 100ms. fNIRS is quiet and subjects find it to be non-stressful the same as EEG measurements. Therefore fNIRS is a suitable method for sensitive subjects such as in the present study.

2. MEASUREMENT OF BRAIN ACTIVITY BY FNIRS

fNIRS shows brain activities as the flow-changes of oxygenated hemoglobin (oxy-Hb) and deoxygenated hemoglobin (deoxy-Hb) in blood.

Fig. 1 fNIRS

When near-infrared light (wavelength: 700-3000nm) is irradiated onto body parts such as the skin and skull, the Lambert-Beer Law describes the relation between the amount of reduction of the light before and after a permeation and the material concentration in the light path (Fig. 1).

$$\log(I_{in} / I_{out}) = \varepsilon c l \qquad \text{(Eq. 1)}$$

Iin: intensity of incident light　Iout: intensity of permeated light
log (Iin/Iout): absorbance　ε: molar absorbance coefficient
c: material concentration　l: path length of light

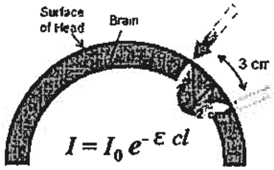

Fig. 1 fNIRS

Since oxygenated hemoglobin (oxy-Hb) and deoxygenated hemoglobin (deoxy-Hb) have a characteristic absorption in the near-infrared field, the light incident to the cerebral cortex at about a 20mm depth from the scalp will be absorbed/dispersed by hemoglobin and transferred/attenuated. If permeated light is detected in another position farther away than 30mm, the hemoglobin concentration of the cerebral cortex can be measured.

Then, the reflection and dispersion of the body part (tissue) are considered, and the relationship between the oxy-Hb/deoxy-Hb concentration change and permeated light intensity is approximated from Eq. 1 as Eq. 2 by using the wavelength λ.

$$\log(I_{in}(\lambda) / I_{out}(\lambda)) = \varepsilon oxy(\lambda)\, c oxy\, l + \varepsilon deoxy(\lambda)\, c deoxy\, l + a(\lambda) + s(\lambda) \qquad \text{(Eq. 2)}$$

From this formula, if a(λ) is ignored, and two or more wavelengths of light are used by assuming that the dispersion s(λ) does not change with wavelength, oxy-Hb and deoxy-Hb can be obtained by solving two or more simultaneous equations. The total hemoglobin (total-Hb) concentration change is considered to correspond to blood volume which is changed by brain activity.

In usual measurements, brain blood flow always fluctuates and has a trend. Fluctuation is smoothed by averaging, and the trend is corrected by a mathematical model.

The topography of brain blood flow is obtained by multiple channel NIRS (fNIRS). Several companies have developed multiple channel NIRS in Japan; for example Hitachi Medical and Shimadzu. The authors used a Hitachi system in their early studies. But recently the authors' group has used OMM-3000 (Shimadzu) which uses 3 near-infrared lasers (wavelengths: 780, 805 and 830nm) (Chen, et al, 2003). There are a maximum of 16 emitting and receiving probes and probe combinations are variable. Moreover, it has the advantage that the subject's burden during experiments is less since the diameter of the optical fiber is large.

3. INSTANTANEOUS HIGHLY ACTIVATED STATE OF AWARENESS

-- Spontaneous Blood Flow Change at Temporal Lobes in Forced-Choice Guessing Test --

At first, the authors' interest was focused on the temporal lobes in the study for brain activities while guessing under a clairvoyant condition. The aim was to research brain blood flow change in clairvoyant experiments when the temporal lobe was stimulated by very weak magnetic fields. This idea was based on work by Persinger & Makarec (1987) that the ability of precognition was improved remarkably while the temporal lobe was stimulated by very weak magnetic fields. The first experiment was preliminary, but the authors obtained interesting results. Fig.2 (all the color figures are in the special sheets) shows an example of measured brain blood flow at the right temporal lobe in a guessing test with a clairvoyant condition (Yoichi, et al, 2002). The target was Zenar cards.

In the 3rd guessing trial in Fig. 2, oxy-Hb increased to 0.82 [m mol x mm] 25s after the start of the trial, then it decreased to 0.00 [m mol x mm] 66s after the start. The minimum deoxy-Hb was 19s later than the maximum oxy-Hb peak. This phenomenon was also observed simultaneously at the left temporal lobe. The subject said that he got a clear visual image of the figure of the hidden target in the 3rd trial. In the 1st and 2nd trials, there were no specific changes of oxy-Hb and deoxy-Hb. Moreover, the subject said that he could not concentrate his mind during the 1st and 2nd trials.

Although this was a preliminary study by a few subjects and only small numbers of data were collected, the results suggested that the phenomenon was related to the degree of impression formulation of figures during guessing and also to correct responses.

The authors attempted to study the details of this phenomenon, collaborating with Tsuneo Watanabe (Toho University) (Kokubo, et al, 2005b) and Kimiko Kawano (Nippon Medical School) (Kokubo, et al, 2005c). Subjects were 14 healthy adult volunteers (8 males, 6 females): average age was 44.8 years. The experiment was a 5-forced-choice experiment and the targets were geometric figures (Zenar symbols) and photos of fruits. One trial consisted of a 3-minute guessing task period and a 3-minute rest period, and 1 run consisted of 3 trials. After the task, subjects chose one from five figures, and evaluated the degree of their image formulation. The degree of impression formulation was evaluated as 1; "not obvious", 2; "partial" or 3; "obvious" by subjects. During the guessing task, each subject concentrated on merely guessing what the hidden figure was that was displayed on the covered CRT. Data from 69 trials (23 runs) could be analyzed in most cases. Spontaneous blood flow changes of the temporal lobe were observed in 10 out of 65 trials; 4 trials were excluded because it was not easy to recognize the change due to the subjects' heads moving too much during the task. Fig. 3 shows an example of spontaneous blood flow change during the guessing task. Although the amount of change had large variation depending on the measurement sites and the subjects, oxy-Hb reached a peak in 20-30s. The height of a peak was an average of 0.6 [m mol x mm], but 1.7 [m mol x mm] might be reached at the maximum. Change of deoxy-Hb was 10s behind that for oxy-Hb. The average minimum value was -0.19 [m mol x mm], but the largest value of the change reached -0.6 [m mol x mm]. This phenomenon disappeared after 60s-80s.

There was a significant tendency that the degree of impression formulation was high when the change occurred ($p<0.001$, one-tail) (Table 1). However, correct hits were 10 trials among 69 trials and this was not significant. Also there was no significant relation between the spontaneous blood flow change and the correct hits.

Table 1 Evaluation of Impression Formulation and Spontaneous Blood Flow Change during Task

Evaluation	Change		Sum
	Yes	No	
3	7	2	9
1 or 2	3	53	56
Sum	10	55	65

(Kokubo, et al, 2005b)

In the present study (Kokubo et al, 2005b, 2005c), the authors confirmed that there are two states, at least, of brain blood flow of the temporal lobe during the guessing task for hidden figures. In one of the states, the blood flow is relatively stable, and in the other, the blood flow changes spontaneously at the temporal lobe. The latter has a momentary decrease of deoxy-Hb. This decrease is caused by deoxy-hemoglobin in capillaries running out due to the rapid increase of blood flow in the large veins (Yamamoto & Kato, 2002). The frequency of the spontaneous blood flow changes was approximately once in 7 to 8 times, and the change was related to clearness of image formulation of the target figures. The change was not caused by subjects' mental work during rest; the subjects gave as the names of figures and they intentionally visualized as figure images (Yoichi, et al, 2002).

Spontaneous blood flow change is not considered as a rare phenomenon. For example, spontaneous blood flow changes were observed approximately once in 5 to 6 times when subjects made their responses using a switch box. It is supposed that the subjects saw sample figures clearly on the box at that time. Fig. 4 (U002, male, 40 y) shows an example of spontaneous blood flow change at the frontal area during a Kraepelin test on the condition that 1 trial was 60s. The Kraepelin test is a kind of performance test in which subjects do continuous addition of single numbers. In this example, the subject said that he could concentrate very much on the task at that time.

The change of subjects' awareness (consciousness) is very slight during spontaneous blood flow change at the temporal lobe and frontal area. However, the subjects can recognize the change of awareness easily if they make a little effort. The authors call such activated state of awareness as *the instantaneous highly activated state of awareness* (**Fig. 5**).

4. FACIAL RECOGNITION OF EXPRESSION

The authors have studied cultural differences of cognition for human facial expressions, collaborating with Miyako Tazaki (Tokyo University of Science). It is often said that Japanese are expressionless or vague compared with people of other cultures. Japanese have a tendency to be moderate in their expressions (one of the reasons may be that they are scolded as "That's bad manners!" or "Be serious!" if they overdo expressions of their emotions in public). Therefore it is difficult for people of other cultures to recognize Japanese emotions through their faces.

Stimuli of this study were photos of a young Japanese woman's face; the woman had been trained as an actress. Six emotions were decided as basic emotions in this study; laughter, surprise, fear, anger, dislike and scorn. The set of stimuli had many vague faces, therefore it was difficult for people of other cultures to distinguish the emotions (it was difficult to distinguish them completely even for Japanese subjects).

Fig. 6 shows a topograph of brain blood flow of a Japanese subject (Y002, male, 60 y) during the tasks, and **Fig. 7** shows a topograph of a Chinese subject (T005, female). These figures show only difference from blood flow at the start of the task. In **Fig. 6**, the degrees of the change of blood flow were small relatively. It was considered that the tasks of this study were easy for Y002. While in **Fig. 7**, blood flow increased at the right temporal gyri. This area relates to mental actions to recognize human faces. It was considered that the tasks to distinguish emotions from Japanese faces was very difficult for T005 (a Chinese), therefore her brain blood flow increased there.

Although the study is on going, various interesting phenomena have already been seen. For example, **Fig. 8** shows a topograph of brain blood flow of a Chinese (A003, female) when she did not answer because of misunderstanding the experimental instructions (which were given to her in the Japanese language). The authors do not know what she did in her mind at that time. But the distribution of her brain blood flow suggests that she formulated visual images of the displayed faces. Even under similar conditions, the area related to distinguishing faces was not activated possibly if the subject did not make answers intentionally. The authors recognized the importance of instructions again.

Fig. 9 is an example showing that the frontal area, especially the prefrontal area, was activated during the tasks (O001, Chinese, male). The human brain is very flexible. If an area of the brain is damaged and function is stopped, other areas often work as alternative circuits of the function. **Fig.9** is considered as such a case. Here, the alternative circuit was located at the prefrontal area which has important functions of guessing. It seemed that he *guessed* emotions. If someone is instructed as "Please *guess* emotions from photos of faces", will that person's brain show a similar pattern?

Moreover, the spontaneous blood flow change was observed during this task. The authors also want to know relationship between this change and the photos.

5. EXPERTS AND STAR PSYCHIC - FREE-RESPONSE GUESSING TEST

The experiments of guessing in the previous sections were done by a forced-choice test. In this section, the authors deal with their most recent study of free-response by various experts (Kokubo, et al, 2006).

Subjects were 11 healthy volunteers (5 males, 6 females): average age was 39.7 (SD=12.1) years. They were an ordinary person, an expert of abacus and mental arithmetic (who had ability of the 10th rank which is the highest rank), a pro-boxer, a remote viewer, 5 healers (including 1 qigong healer) and 2 star psychics. In the forced-choice test, 1 trial was 3 minutes and the targets were geometric figures (Zenar symbols). In the free-response test, 1 trial was from 3 to 30 minutes and the target was the invalid parts of the inside of human body or a small thing hidden in a dark box. The target in the dark box was monitored by a magneto-meter and 3 video cameras including a weak photon camera which had an image intensifier.

In this study, subjects were instructed that they should try to simulate clairvoyance in the same way that psychics are considered to do it. However, if subjects had their own methods such as systematic remote viewing, they were permitted to use their own methods.

Figs. 10-12 show topographs of a master of qigong healing, the expert of mental arithmetic and pro boxer during the clairvoyant task for human body. In each case, formulation of visual images was active because the right temporal lobe was activated.

Figs. 13 and **14** show topographs of star psychics. **Fig. 13** is during a clairvoyant task for human body by a Russian psychic (T004, female, 14 y). **Fig. 14** is during a clairvoyant task for a thing hidden in a dark box by a Chinese psychic (W003, female, 37 y). The common activated area was the prefrontal area, and it was also the same with another star psychic (Chinese, W004, female, 32 y) who was measured by fMRI (forced-choice, Zenar cards, 1 trial was 15s). T004 claimed that she guessed abnormal points through comparing visual images

of internal organs of the target person with pictures of normal internal organs in her memory (she had already learned them from medical books). Her mental work of comparing was considered to activate non-prefrontal areas. Subject W003 showed her brain was activated in the left hemisphere. The reason was considered that she sometimes did the task by talking about her impression.

The tasks of this study require subjects to formulate visual images. The brain of many subjects was much activated at the right temporal lobe, not the prefrontal area. But in the case of star psychics, their characteristic activation point was the frontal area, especially the prefrontal area. Formulation of visual images may not be important for "guessing" by star psychics. From fNIRS data, which are only from the cerebral cortex near the scalp, the mental action of "clairvoyance" by star psychics is similar to "thinking" even if the task is formulation of visual images.

The authors prepared the instructions based on talking to psychics and training techniques which were developed in China in the 1980's (Kokubo & Yamamoto, 1999; Kokubo, et al, 2005a). The important point of the instructions is "Be devoted only to guessing a target during execution." The instructions need further consideration.

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COLOR FIGURES SHEET

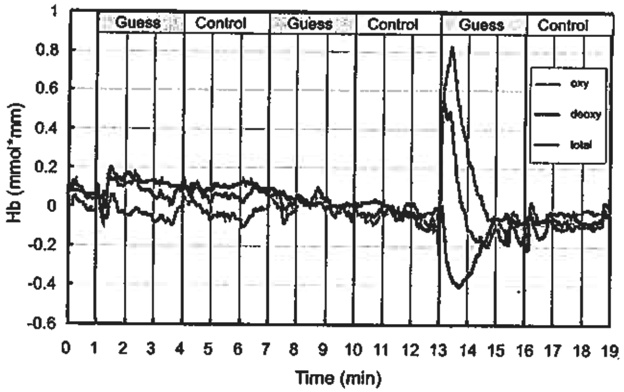

Fig. 2 Time change of hemoglobin of the right temporal lobe during one run.
Subject: K005, male, 43 y (Yoichi, et al, 2002)

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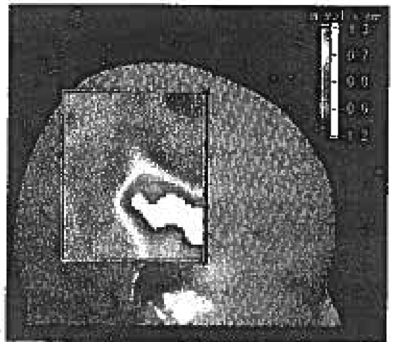

Fig. 3 Spontaneous Blood Flow Change
oxy-Hb, right temporal lobe, S004, male, 24y
(Kokubo, et al, 2005c)

Fig. 4 Spontaneous Blood Flow Change
U002, male, 40y, Kraepelin test

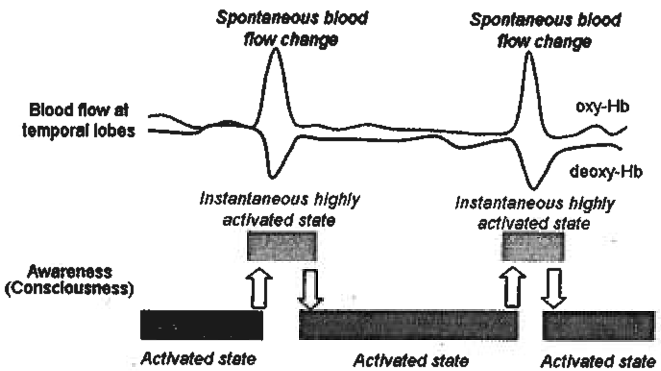

Fig. 5 Spontaneous Blood Flow Change Correspondence to Instantaneous Highly Activated State of Awareness

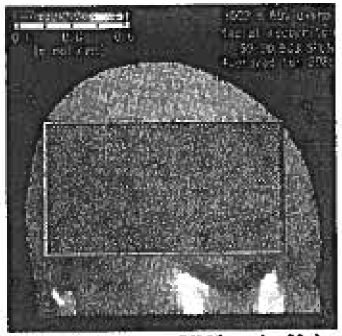

Fig. 6 Japanese (Y002, male, 60y)
Averaged for 308s

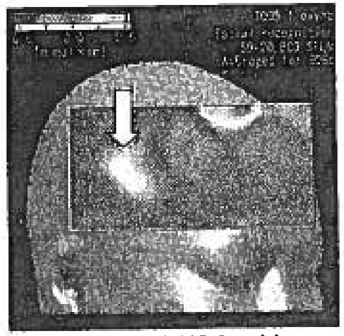

Fig. 7 Chinese (T005, female)
Averaged for 308s

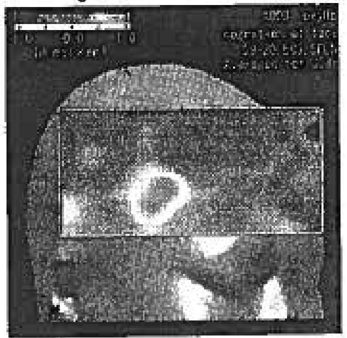

Fig. 8 Misunderstanding of the Task
A003, female, Averaged for 308s

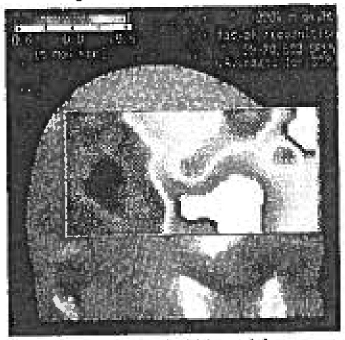

Fig. 9 Chinese (O001, male)
Averaged for 308s

Fig. 10 Master of Qigong Healing
Z001, m, 75y, Averaged for 360s
(Kokubo, et al, 2006)

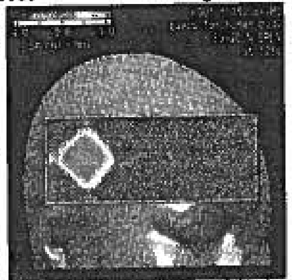

Fig. 11 Expert of Mental Arithmetic
H001, f, 15y, Typical pattern
(Kokubo, et al, 2006)

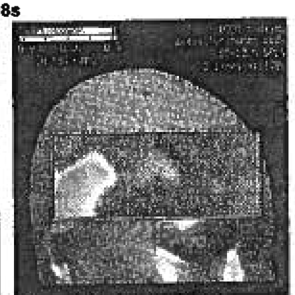

Fig. 12 Pro-boxer
U001, m, Averaged 3 times
(Kokubo, et al, 2006)

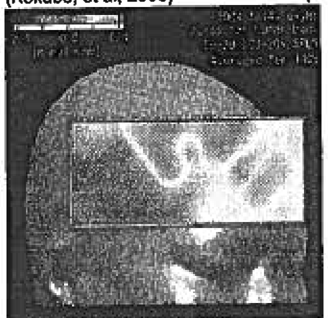

Fig. 13 Russian Psychic
T004, female, 14y, Averaged for 140s
(Kokubo, et al, 2006)

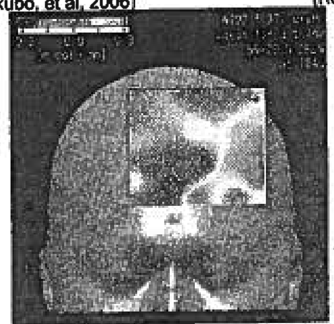

Fig. 14 Chinese Psychic
W003, female, 37y, Characteristic pattern
(Kokubo, et al, 2006)