行政院國家科學委員會專題研究計畫 成果報告

以功能性神經影像驗證科學認知能力的性別差異證據 ：對台灣教育政策之潛在影響

研究成果報告(精簡版)

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行政院國家科學委員會補助專題研究計畫 (成果報告)

以功能性神經影像驗證性別科學認知能力差異的證據

(原三年計畫僅獲准執行之第二年部分)

計畫類別：☑ 個別型計畫　　□ 整合型計畫

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執行期間：2008 年 08 月 01 日至 2009 年 07 月 31 日

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成果報告類型(依經費核定清單規定繳交)：☑精簡報告　□完整報告

本成果報告包括以下應繳交之附件：

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☑出席國際學術會議心得報告及發表之論文各一份

□國際合作研究計畫國外研究報告書一份

執行單位：台北榮民總醫院教學研究部

中　華　民　國　98　年　10　月　25　日

A. Proposal Background

The original proposal in tile of "Functional Neuroimaging Evidences of Sex Difference in Cognitive Abilities of Sciences: the Impact on Education Policy in Taiwan" will study the sex-difference in central activation of baseline and cognitive abilities of mathematics (or calculation), verbal and spatial domains using fMRI in gender-balanced design. The three-year project was designed to solve the multi-domain problems as proposed.

1. Meta-analyses and FMRI studies of baseline activities for Taiwanese university students (this part has been supported by NSC project of 96-2522-S-075 -001, 96/11/01～97/10/31);
2. Psycho-behavioral and FMRI studies of calculation ability for Taiwanese university students (this part was supported by this NSC project of 97-2511-S-075 -001, 97/08/01～98/07/31); and
3. Psycho-behavioral and FMRI studies of language and spatial abilities for Taiwanese university students (this part was not supported.)

A.1 Integration of the three-year project is justified by following;

Blood oxygenation level dependence (BOLD) signal derived from functional magnetic resonance imaging (fMRI) can be used to test gender effects on different tasks and various stages (e.g. follicular, menstrual, peri-ovulatory stages) in women. In this way, we can not only examine gender differences on tasks of various cognitive abilities but also provide explanations and connection to the possible underlying mechanisms. Three major points for integration were listed as follows.

1. Variation of baseline default network can be evaluated and corrected for fMRI analyses of three abilities (1^{st}-year, 2^{nd}-year and 3^{rd}-year projects). By the novel approach, revision of conventional fMRI analyses will provide new hypothesis of fMRI approaches in this gender project.
2. Three key abilities (calculation, verbal and spatial domains) will be addressed in systematic way with integrated designs of fMRI paradigms and behavioral tasks, e.g. counter-balanced, parametric or rapid mixed-trial designs (2^{nd}-year and 3^{rd}-year projects). Based on biological evidence of fMRI, weighting factors of each ability can be estimated for university students with different background. Information derived from the weighting factors will have impact in the construction of education policy in Taiwan.
3. Sex difference of the default network, which echoes the baseline metabolism, will provide biological evidence of gender variation in brain function or menstruation (1^{st}-year, 2^{nd}-year and 3^{rd}-year projects).

Content of present report was derived from the second portion of the original proposal (Psycho-behavioral and FMRI studies of calculation ability for Taiwanese university students)

B. Psycho-behavioral studies of calculation abilities

Only humans in complex cultures develop and operate on natural number concepts and use numbers and geometry to map and measure their surroundings based on the older and more primitive systems that evolved for different purposes and that humans have harnessed to solve new problems (Geary, 1996; Kimura, 1999). Research in developmental and cognitive psychology and neuroscience serves to probe the nature and development of these systems and of the processes by which different systems come together to support new concepts and operations (Dehaene, 1997; Carey, 2001; Newcombe, 2002; Spelke, 2003; Feigenson, 2004). Such research provides evidence for five different cognitive systems at the core of adults' mathematical thinking. One system serves to represent small, exact numbers of objects: the difference between one, two, and three (e.g., Trick, 1994; Butterworth, 1999). A second system serves to represent large, approximate numerical magnitudes: the difference in number (though not weight or volume) between, for example, 60 swallows and 40 seagulls (van Oeffelen, 1982; Barth, 2003). A third system consists of the quantifiers, number words, and verbal counting routine that human gain with the acquisition of a natural language in childhood (Wynn, 1992). The fourth and fifth systems serve to represent environmental geometry and landmarks, respectively, for purposes of navigation, spatial memory, and geometrical reasoning (Newcombe, 2000; Wang, 2002). When adults solve arithmetic problems, they activate areas of the brain that are involved in representing numerical magnitudes, language, and space (e.g., Dehaene, 1999). Lesion brain studies of adult patients typically show distinctive impairments in mathematical reasoning and calculation (e.g., Butterworth, 1999; Lemer, 2003). When college students are given a host of mathematical tasks, their performance shows signatures of these systems (Dehaene, 1997; Feigenson, 2004). Each of the five component systems emerges early in childhood. By six months of age, infants represent small numbers of objects, perform simple additions and subtractions on these small-number representations, and compare one small set to another on the basis of number (Feigenson, 2004). Six-month-old infants also distinguish between large, approximate numerosities when continuous variables are controlled, provided that the numbers differ by a large ratio (Xu, 2000). The detailed and contrasting limits on infants' performance with small versus large numbers provide evidence that the large- and small-number systems are distinct from one another and continuous with the systems found in older children and adults (Feigenson, 2004). Studies of these systems find no consistent sex differences at any age.

For improving the efficiency of fMRI examinations, dedicated and homogeneous test materials were needed in this fMRI study because of limited number of trial or test in one fMRI session (about 6-13 minutes). With available database of performance in ordinary mathematic operations (e.g. addition, subtraction, multiplication and division), psycho-behavioral tests with simulating the fMRI environment of background noise were conducted for screening the test materials suitable for fMRI. Gender and parametric effects of mathematic tests were demonstrated after removal of outliers of test materials. Specific fMRI paradigms of the parametric design provided evidences of central correlate of human brain.

B.1 Subjects and Methods

Forty subjects (22 male, age: 21 +/- 3, all right handed) were recruited for behavioral studies of mathematical calculation. Written consent forms were obtained after screening the history of major diseases or head injury. Stimuli were displayed on an LCD screen with the maximal visual angle (3 and 2 degrees for right-left and superior-inferior dimensions) and display brightness/contrast compatible to fMRI environment. Presentation software (version 0.71) provided high temporal precision control of stimulus delivery, experimental design and records for behavioral experiments using a PC computer. The stimuli were used for the three numerical tasks (addition, subtraction, and multiplication): every task was divided into two parts (problem and answer parts) with fixation cross at the screen center in idling. For the problem parts, digits between 2 and 99, excluding digit 5, were used to constitute the problem sets flashed for 1000 milliseconds (Dehaene, 1999). For the answer parts, stimuli of answers were continuously displayed until subject selected one using subject's dominant hand. Behavioral parameters, including the reaction time and the accuracy rate, were recorded. MRI echo planar imaging noise recorded from fMRI studies by Bruker MedSpec 300 was played during psycho-behavioral tests via ear-phone (90 dB verified by sound pressure meter, but with ear plug protection).

On each trial, two candidate answers were flashed with modulating the distance of wrong answer as 1 or 11 for minimizing the effect of answering strategy. Subjects selected the correct answer (precise answer) by depressing the corresponding hand-held button as quickly as possible. The problem was advanced when the previous problem was answered. For addition, the task included 1D+1D, 1D+1D*, 1D+2D, 1D+2D*, 2D+1D, 2D+1D*, 2D+2D, 2D+2D*, and 2D+2D** (D: digit,*: carry). For subtraction, the task included 1D-1D, 2D-1D, 2D-1D#, 2D-2D, and 2D-2D# (D: digit,#: borrow). For multiplication, the tasks included 1Dx1D, 2Dx1D, and 1Dx2D (D: digit). One hundred and twenty problem sets were used in addition, subtraction and multiplication tasks, respectively, by proportionally and randomly selecting ones from the databases of each category.

Statistical evaluation was performed by SPSS (Verison, 12.1) using twi-tail, two-sample Student t-test without correction. Significance was reached with p value <0.05.

B.2 Results of psycho-behavioral tests

Behavioral parameters, including the reaction time and the accuracy rate, were collected for operations of addition, subtraction, and multiplication in parametric design. 40 subjects was divided into groups of male (n=22) and female (n=18). Outliers (e.g. answers were multiples of tens) were summarized as Table 1, and excluded from statistics and fMRI paradigm with p<0.05 by two-sample Student t-test of each items of each operation.

Table 1: Outliers of mathematic calculation

Addition			Subtraction			Multiplication		
DOA=0	*ab + c*0	others	*a*0 - *b*	*c*0 - *df*	others	1*a* x *b*	*c* x 1*d*	others
4+76	33+50	7+9	30-5	90-80$	54-5	17x8	2x16	8x42
22+8	*dd + ff*	6+52	50-6	60-45	55-9	12x4	9x18	7x24
	22+66	7+62	40-4	50-29	14-6	12x5	3x13	46x6
	11+57	46+85	50-8	90-45	14-7	19x6		73x8
	29+22		60-3	20-17	68-64	19x2		
			20-5	43-40	44-38	11x5		
				13-10		12x3		
						19x8		

$: digit of answer (DOA)= 0, $a,b,c,d,f \in$ N

B.2.1 Addition

Two-sample t-tests revealed that the performance of males were significantly better than females in reaction time of behavioral test for 2D+1D [t(38)=−3.56, p=.001], 2D+1D* [t(38)=-2.91, p<.01], 1D+2D [t(38)=-3.11, p<.01], 2D+2D* [t(38)=−2.64, p<.05] and 2D+2D** [t(38)=−2.26, p<.05]

(Table 2). And the others showed no significant difference in group results.

B.2.2 Subtraction

Men were superior in the tasks of 2D-2D [t(38)=−2.90, p<.01] and 2D-2D#, [t(38)=−2.10 p<.05] (Table 3). Others showed no significant difference in group results.

B.2.3 Multiplication

The task of 2D x 1D [t(38)=−2.10, p<.05] favored the performance of men (Table 4). Others were not significant in group results.

Table 2: psycho-behavioral results of addition

	Male				Female			
	Reaction Time(ms)		Accuracy Rate		Reaction Time(ms)		Accuracy Rate	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
1D+1D	518.2	94.6	1.00	0.00	600.9	168.1	1.00	0.00
1D+1D*	532.3	83.5	0.99	0.04	598.1	131.7	0.99	0.03
1D+2D	604.9	97.8	0.96	0.03	728.0	150.9	0.95	0.05
1D+2D*	884.6	277.0	0.94	0.05	1065.9	315.5	0.89	0.08
2D+1D	565.3	91.8	0.98	0.04	702.3	149.5	0.96	0.06
2D+1D*	602.4	127.5	0.98	0.05	756.6	204.6	0.98	0.06
2D+2D	974.0	296.3	0.94	0.06	1171.4	383.3	0.87	0.11
2D+2D*	1231.4	428.8	0.89	0.13	1718.4	726.6	0.84	0.19
2D+2D**	1550.2	513.2	0.80	0.14	1990.5	716.2	0.70	0.19

* = carry a number, S.D. = standard deviations, RT= reaction time, AR= accuracy rate

Table 3: psycho-behavioral results of subtraction

	Male				Female			
	Reaction Time(ms)		Accuracy Rate		Reaction Time(ms)		Accuracy Rate	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
1D-1D	487.5	78.1	1.00	0.02	531.4	140.2	1.00	0.01
2D-1D	634.8	209.9	0.97	0.04	691.4	205.1	0.98	0.04
2D-1D#	1164.6	440.3	0.97	0.04	1451.9	485.9	0.93	0.07
2D-2D	1015.9	388.5	0.95	0.06	1414.8	483.7	0.93	0.07

2D-2D#	1860.2	798.7	0.91	0.09	2541.8	1243.8	0.82	0.15

#= carry a number, S.D. = standard deviations, RT= reaction time, AR= accuracy rate

Table 4: psycho-behavioral results of multiplication

	Male				Female			
	Reaction Time(ms)		Accuracy Rate		Reaction Time(ms)		Accuracy rate	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
1Dx1D	567.0	128.6	1.00	0.00	599.8	147.7	1.00	0.00
1Dx2D	1252.7	433.6	0.96	0.05	1515.3	493.8	0.94	0.06
2Dx1D	1198.8	381.8	0.96	0.04	1481.4	471.1	0.93	0.06

S.D. = standard deviations, RT= reaction time, AR= accuracy rate

C. FMRI studies of calculation abilities

C.1 Subjects and Methods

Twenty-three healthy volunteers (12 male, age: 22+/- 3 with age balanced for gender groups, all right handers) participated in this fMRI study under the regulation of Taipei Veterans General Hospital. Written informed consent was obtained from each subject prior to the experiment. Each subject had normal or corrected-to-normal vision. By Edinburgh Handness Inventory, all subjects showed strong right-hand preferences. For female participants, menstrural history and timing of menstruation on the test date was recorded.

C.1.1 Experimental Protocol of Resting Study

Subjects were instructed to “empty their mind” and “prohibit imagery tasks” during the studies. After 5-minute sensory deprivation by auditory protection and dimmed room light, imaging studies of resting state were obtained with eye fixation on a dimmed red cross which was viewed through a mirror projection. The eye fixation simulated the control state of conventional fMRI studies with similar resting brain activity as resting state with eye closed by PET study (Raichle *et al.*, 2001). Subjects were free to blink during eye fixation for the resting study of about seven minutes with the head fixation using a vacuum pillow. For verifying the state of consciousness, subjects responded to the end of each imaging session by pushing bottom using right hand.

C.1.2 FMRI Protocol of Mathematical Studies

FMRI studies of subjects were conducted using a 3T Medspec S300 system (Bruker GmbH, Ettlingen, Germany) equipped with an actively shielded gradient coil, a quadrature transceiver of head and physiological recording of electro-cardiography, respiratory rates and electro-myography of larynx with three electrodes placed bilaterally to thyroid cartilage (AD Instrument, CO, USA) with sampling rate of 10 Hz. Single-shot echo planar images (64x64 matrix, matrix size = 3.6x3.6x6 mm, 20 slices) covering whole brain were acquired with a flip angle = 90 degree, echo time (TE) = 50 ms, repetition time (TR) = 2000 ms, dummy scan (DS) = 5 for reaching stable magnetization and repetition number (NR) = 181 and 405 for block-designed and event-related paradigms. Block-designed fMRI paradigm included intervals of fixation for control and 120 trails for three parametric conditions with counter-balanced arrangement of blocks and averaged inter-stimuli interval (ISI) of 2000 milliseconds as identified by psycho-behavioral tests.

An on-line real-time analysis, modified from AFNI (Analysis of Functional NeuroImages, NIMH, Bethesda, USA), of the head motion ensured the quality of fMRI study with head translation < 1 mm and head rotation < 0.5 degree within each session (Yeh, *et al.*, 2001). Processing time of the on-line AFNI processing using the workstation platform (Octane R10000, RAM= 256 MB) was less than 40 seconds after finishing each session. Studies of head motion exceeding the motion criteria mentioned above were rejected from data analysis, and subjects were required to repeat the study with reordering the trials.

Anatomical MRI was acquired using a T1-weighted 3D-gradient echo pulse sequence (matrix = 128x128x128, TR/TE/inversion time=88/4/650 milliseconds).

C.1.3 Data Preprocessing and fMRI analysis

The obtained images were first subjected to a slice time-alignment process to minimize image intensity inhomogeneity arising from differences in slice image acquisition timing of 2000 ms in multi-slice studies. Realignment and normalization of fMRI images were processed with Statistical Parametric Mapping (SPM2, Wellcome Department of Cognitive Neurology, London, UK) implemented in MATLAB (Mathworks, Sherborn, MA, USA). Scans of each subject are realigned with each other to correct for interscan movement artifacts. The functional images were coregistered on the anatomical data sets after manually defining the anterior commissure reference point and then smoothed with a Gaussian spatial kernel of 8-mm FWHM (full-width half-volume). Statistical analysis was tested with a t-value (SPM {t}) at each voxel using a box-car reference waveform or hemo-dynamic event modeling for block-designed paradigms. Regressors of head motion, motor response of button pressing and EMG recordings of larynx were applied for modeling confounding effects. Each SPM {t} was transformed to a unit normal distribution to give the SPM {Z} statistic. Regional activations significant at $p < 0.001$, uncorrected for multiple comparisons and cluster size > 0 voxels, were considered with adaptation for artifacts and noise levels. And random effect analysis was applied for grouped studies of gender comparison. And regression analysis was applied for examining the effect of co-variant, e.g. gender or menstrual effects.

Parametric modeling of reaction time derived from correct trials in each blocks provided confident statistical evaluation of the functional correlates, both before and after removal of DMN effect from the original fMRI data.

C.1.4 Independent Component Analysis

Independent component analysis was applied to BOLD-signal time series of within-brain voxels to separate the data into spatially independent brain maps and find the associated BOLD-signal time courses. Data were analyzed using spatial informax ICA, developed by Computational Neurobiology Laboratory, The Salk Institute for Biological Studies, La Jolla, USA, for identifying components with specific temporal/spatial distributions as previously described (McKeown *et al.*, 1998a, 1998b; McKeown and Sejnowski, 1998; Duann *et al.*, 2002,). For fMRI data with time points much smaller than the number of spatial voxels, spatial independence was assumed (McKeown *et al.*, 1998a). Principal component analysis (PCA) preprocessing was applied to reduce the dimension of training data set from 200 (the number of time points) to 50. Sources of the constituent activities include task-related or task-unrelated hemodynamic changes, blood flow, central spinal fluid (CSF) flow, subject movements and machine artifacts.

For ICA training, initial values of learning rate and data points chosen in each iteration were 0.0001 and 100, respectively. After the spatial ICA training converged, the spatially independent components were ranked by z values by subtracting voxel mean from each voxel and dividing by the standard deviation of the map weights. Maps of region of activity (ROA) were demonstrated by $|z| > 2$ (McKeown *et al.*, 1998a). To illustrate the relationship between the component time courses derived by spatial ICA and the time courses of correlated voxels in the raw data, the mean back-projected time course of the ROA voxels was compared to the mean ROA time course in the raw data. To determine the salience of a selected component in the raw data, its mean back-projected time course over the positive ROA voxels in the original data space was compared to the mean positive ROA time course in the raw data by computing the percent variance

(P.V.) as described previously (Duann *et al.*, 2002).

Thus, fifty spatial independent components account for the fMRI BOLD time courses were derived with spatially-fixed three-dimensional "component maps" and associated activity time courses. Component selection of default-mode network (DMN) depended on statistical evaluation of spatial correlation coefficient (C.C.) > 0.4 using the DMN template previously constructed using the database created by Bruker 3T MRI (N=55) as the DMN or tripod component involved bilateral occipital, precuneus, posterior cingulate, inferior parietal lobule, and prefrontal regions as demonstrated in Figure 1.

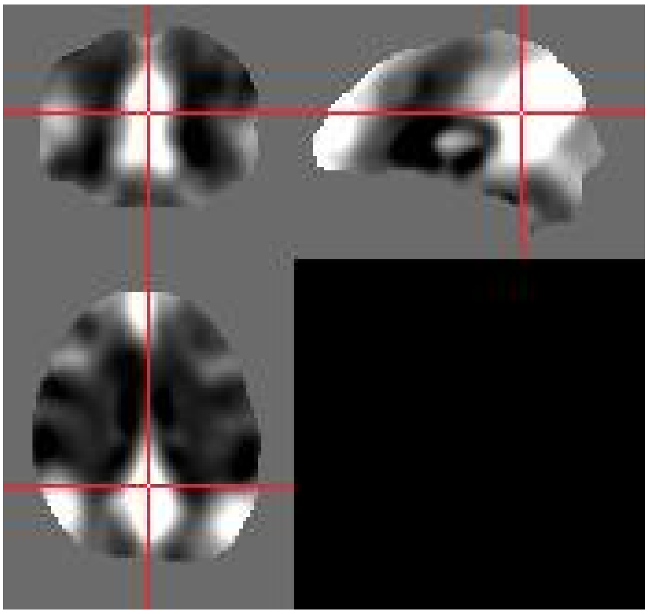

Figure 1 : Template of default-mode network or tripod resting rhythm (tripod component) of 55 subjects (25 male) was presented as the t-score maps in the normalized brain template. Statistical criteria were corrected $p<0.001$ and voxel extension > 25.

By correcting the mixing matrix of ICA, removal of DMN was obtained for examining the effect of DMN on the functional correlates of mathematical operation.

C.2 Result of fMRI studies

C.2.1 Parametric additional fMRI

With the block-designed additional paradigm, RT-based parametrical modeling demonstrated the neural correlates of bilateral visual, bilateral medial parietal, bilateral lateral parietal, bilateral anterior cingulate and bilateral dorsal lateral prefrontal areas. After removal of DMN from the raw fMRI data by ICA, increment of BOLD-based activity by applying statistical contrast of after vs. before DMN removal located in the bilateral BA 7, 30 and 31 regions which did not engage the calculation matrix as illustrated by Figure 2 and Table 5 with statistical criteria of uncorrected p<0.05. Left BA39 and right BA40 of calculation matrix showed increased activity after removal of DMN (* in Table5). With statistical contrast of before vs. after DMN removal (statistical criteria of uncorrected p<0.05), the calculation matrix of addition (e.g. bilateral BA10, left BA24, right BA40 and right BA9, Figure 3 and Table 5) increased activity after DMN removal.

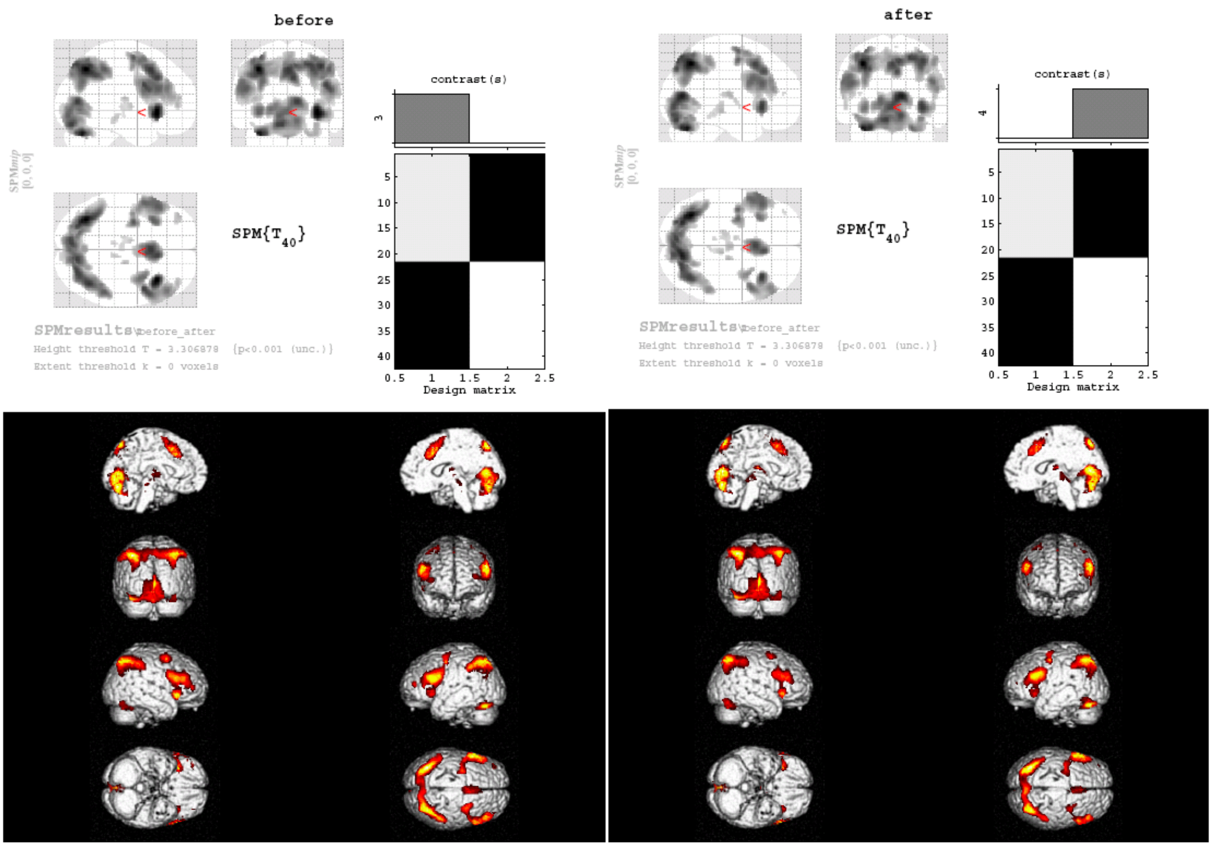

Figure 2: Effect of DMN on the parametric modeling of block-designed adition (statistical criteria: uncorrected p<0.001, voxel cluster>0 for before DMN removal or after DMN removal);

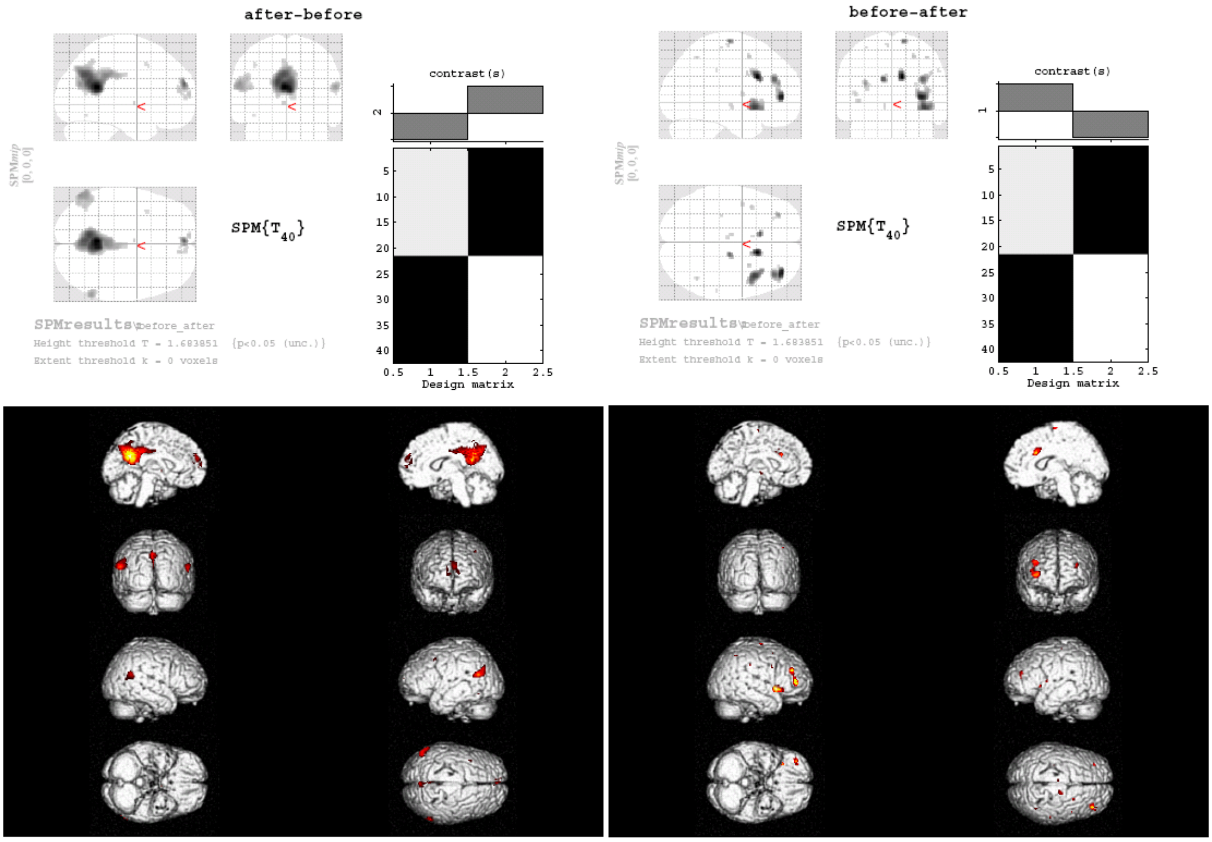

Figure 3: Effect of DMN on the parametric modeling of block-designed addition (statistical criteria: uncorrected p<0.05, voxel cluster>0);

Table 5 : Effect of DMN on the parametric fMRI results of addition

ROI	X	Y	Z	Area	A-B	B-A
1	-1.9	-45.5	20.7	L BA 30	+	
2	-9.9	-53.0	26.6	L BA 31	+	
3	-1.9	-58.4	36.0	L BA 7	+	
4	-1.9	57.2	19.2	L BA 10	+	
5*	-55.4	-64.7	25.3	L BA 39	+	
8*	59.4	-51.3	20.9	R BA 40	+	
10	9.9	51.1	12.1	R BA 10	+	
12	-1.9	-1.8	1.9	L Thalamus	+	
13	-37.6	13.7	41.6	L BA 6	+	
14	-39.6	-58.6	-7.1	L BA 37	+	
1	11.8	18.8	26.6	R BA 32		+
2*	37.6	38.1	23.8	R BA 10		+
3	39.6	15.2	-5.8	R BA 47		+
4*	-9.9	22.6	24.6	L BA 24		+
5	13.8	-10.2	66.8	R BA 6		+
6*	-31.6	43.6	18.0	L BA 10		+
8	-39.6	11.6	-0.5	L BA 13		+
9*	41.5	-49.9	50.3	R BA 40		+

10	-7.9	-11.7	-2.7	L Subthalamus		+
12*	47.5	7.3	30.9	R BA 9		+
13	-3.9	-12.4	61.4	L BA 6		+
14	-29.7	-20.3	59.9	L BA 4		+
17	55.4	-27.3	36.3	R BA 2		+

ROI (region of interest) showed higher BOLD activation after removal of DMN. R/L:right/left; BA: Broadmann area; +: presence of the ROI at the statistical criteria.; *: spatial extension of additional matrix as involved by group result of parametric fMRI modeling by recorded reaction time during fMRI sessions.

C.2.2 Association of psycho-behavioral and fMRI studies in parametric addition

By regression of reaction time of correct trials within each fMRI blocks with the parametric analysis of fMRI, covariance map showed right inferior frontal (BA47), left cuneus/lingual (BA17) and right parahippocampal (BA30) (Figure 4 and Table 6) within the calculation matrix of parametric addition (statistical criteria of uncorrected p<0.05 and cluster size >0).

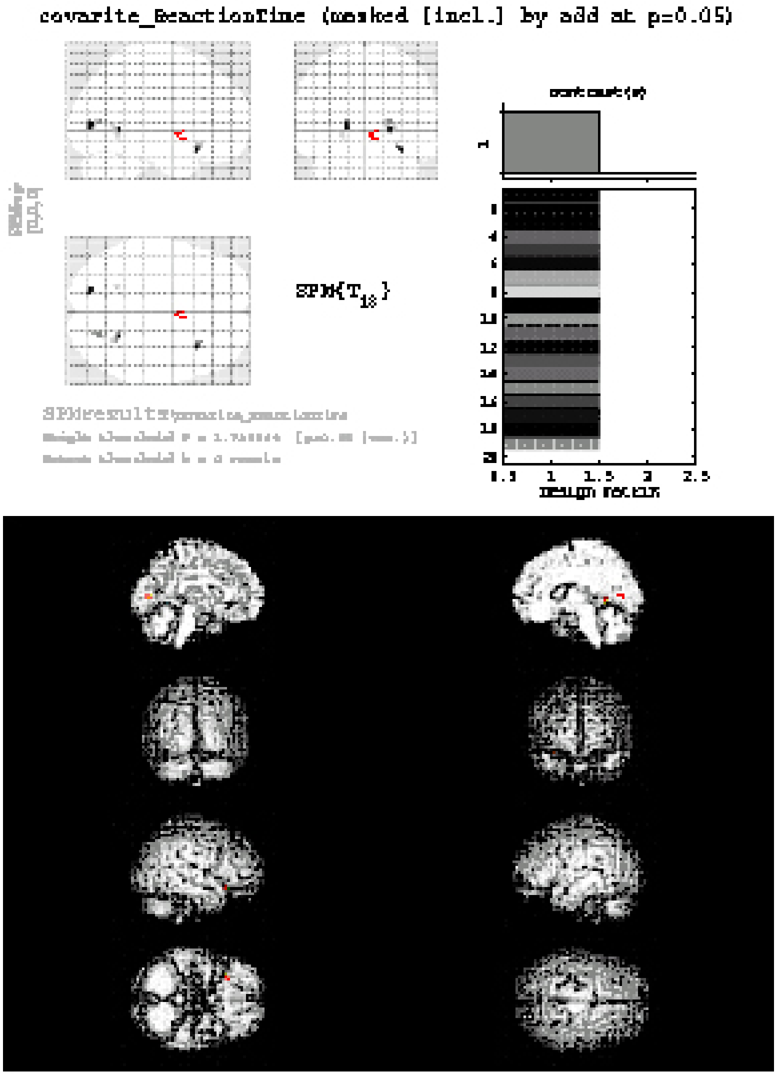

Figure 4: Covariance of parametric addition and reaction time during fMRI

Table 6: Neural correlates with covariance of parametric addition and reaction time during fMRI

Region	Side	BA	Coordinate			Cluster	t score	z value
			x	y	z			
Inferior Frontal Gyrus	Right	47	34	22	-16	7	2.54	2.32
Cuneus	Left	17	-18	-78	8	15	3.13	2.76
Lingual Gyrus	Left		-22	-52	-2	3	1.82	1.73
Parahippocampal Gyrus	Right	30	22	-50	2	9	2.35	2.17
Posterior Cingulate	Right	30	22	-70	8	8	2.28	2.11

C.2.3 Association of menstruation and fMRI studies in parametric addition

By regression of menstrual cycling period modeled by estradiol with the parametric analysis of fMRI, covariance map showed bilateral inferior frontal (BA13 or 44), right superior parietal (BA46) and right middle frontal gyri (BA7) (Figure 5 and Table 7) within the calculation matrix of parametric addition (statistical criteria of uncorrected p<0.05 and cluster size >0).

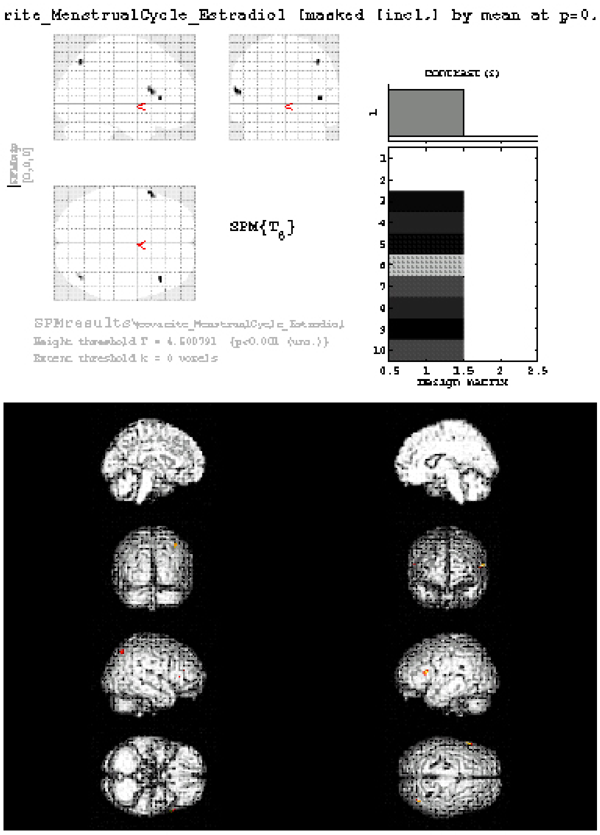

Figure 5: Covariance of parametric addition in fMRI and menstrual cycling

Table 7: Neural correlates with covariance of parametric addition and

menstrual cycling modeled by estradiol

Region	Side	BA	Coordinate			Cluster	t value	z value
			x	y	z			
Inf. Frontal Gyrus	Right	13	44	30	8	3	5.95	3.58
	Left	44	-58	18	16	19	5.94	3.58
Sup. Parietal Lobule	Right	46	56	36	18	1	4.72	3.17
Middle Frontal Gyrus	Right	7	40	-68	50	12	5.61	3.48

C.2.4 Gender difference of parametric addition during fMRI

By two-sample Student t test of gender effect (N=10 for each gender group, statistical criteria of uncorrected p<0.05 and cluster size >0), right inferior frontal gyrus (BA47) showed higher BOLD-based neuronal activity for women by parametric addition fMRI. Men showed higher activity in right superior temporal (BA38) and right cingulate (BA24) (Figure 6 and Table 8) within the calculation matrix of parametric addition. After removal of DMN, the gender effect was more evident in men vs. women contrast (Figure 7 and Table 9) with involvement of right parahippocampus (BA34) and right posterior cingulate (BA31).

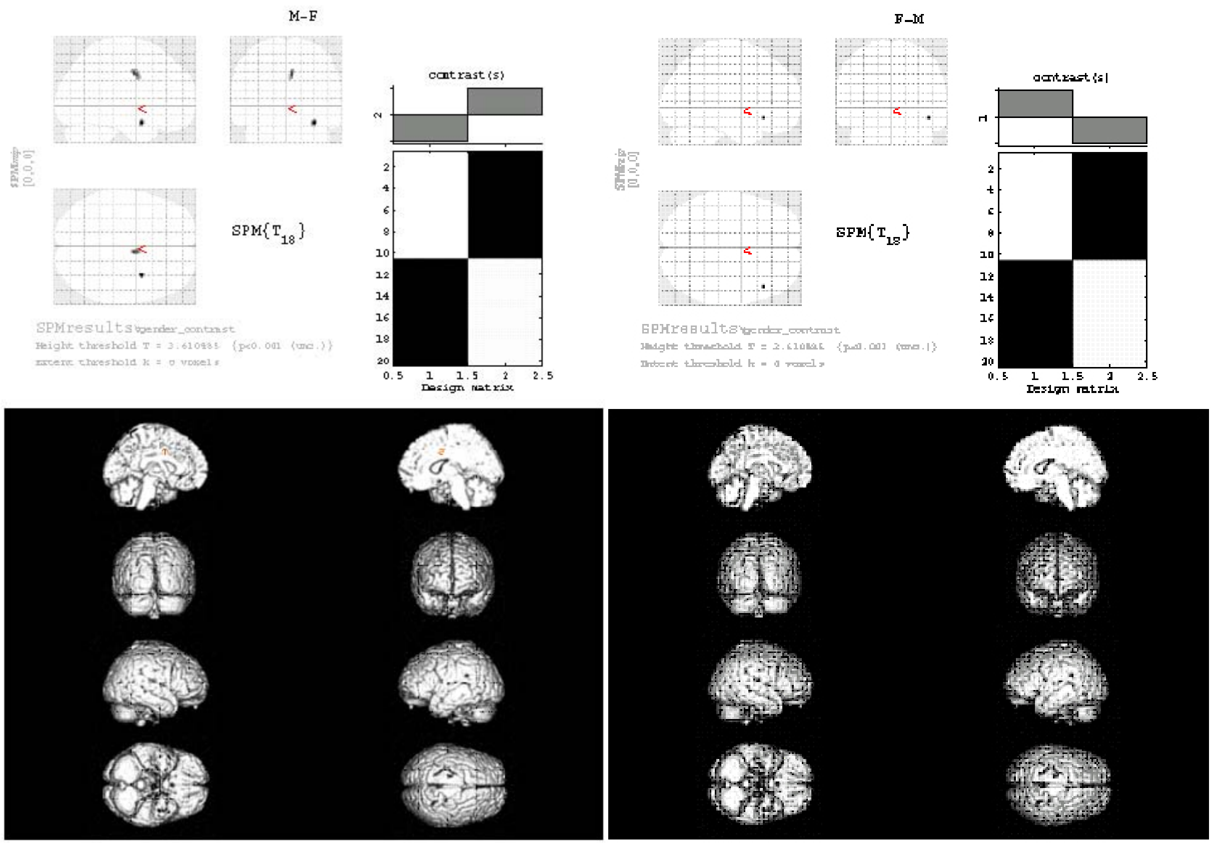

Figure 6: Gender effect of parametric addition in fMRI (uncorrected p<0.05 and cluster size >0)

Table 8: Neural correlates with gender difference in parametric addition (uncorrected p<0.05 and cluster size >0)

Region	Side	BA	Coordinate			Cluster	t value	z value
F>M			x	y	z			
Inferior Frontal Gyrus	Right	47	46	26	-10	4	3.88	3.26
M>F								
Superior Temporal Gyrus	Right	38	34	6	-18	18	4.87	3.84
Cingulate Gyrus	Right	24	6	-2	38	26	4.45	3.61

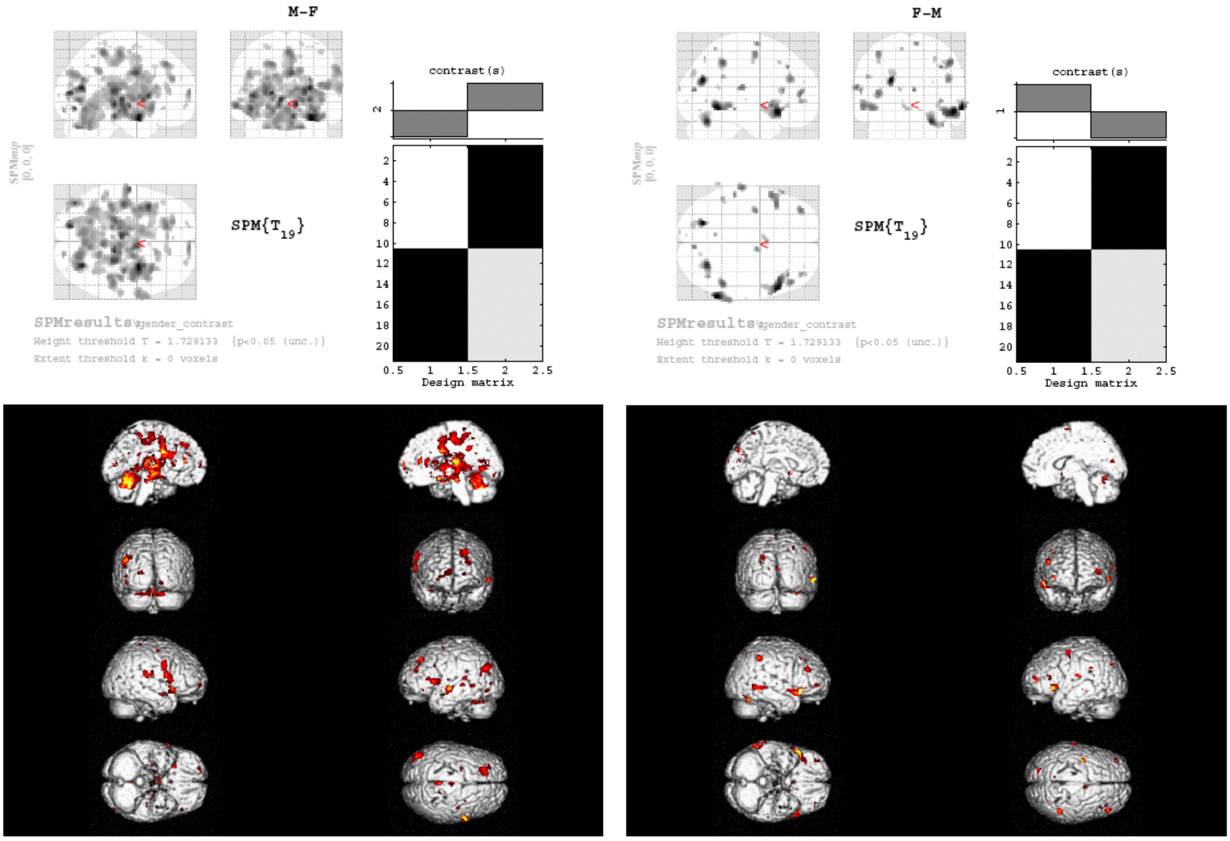

Figure 7: Gender effect of parametric addition in fMRI after DMN removal (uncorrected p<0.05 and cluster size >0); Total cluster size of M-F result showed spatial extension of 11733 voxels.

Table 9: Neural correlates with gender difference in parametric addition after DMN removal (uncorrected p<0.001 and cluster size >3)

Region	Side	BA	Coordinate			Cluster	t value	z value
M>F			x	y	z			
Parahippocampal Gyrus	Right	34	30	1	-15	26	4.4	3.6
Posterior Cingulate	Right	31	28	-63	18	5	4.0	3.4

D. Discussion and Conclusion

Three parietal circuits for numbering processing has been proposed by Dehaene et al (Dehaene, 2003). Bilateral horizontal segmenta of intraparietal sulci, left angular gyrus and bilateral posterior superior parietal lobules were proposed to engage the number quantity processing, numbering in verbal form and attentional orientation on mental number line, respectively. With the present results of twelve neuroimaging references, meta-analysis using ALE echoed the bilateral superior and inferior parietal lobules involved in mental calculation. Previous report (the 1st year portion, 96-2522-S-075-001) provided evidence for the overlapped superior parietal lobule by the conjunctional analysis of (1) ALE meta-analysis of mental calculation, (2) spatial template of default-mode network or tripod component (from 55 normal young subjects) and (3) parametric fMRI of digit naming vs. one-digit vs. two-digit addition.

By applying stringent modeling of parametric design based on recorded reaction time during fMRI session, specific functional correlates of addition showed involvement of working memory as proposed by Baddeley (1996). Bilateral prefrontal execution systems involved the parametric functioning content with two salve systems as verbal and spatial sub-systems. But parametric BOLD-based activities of visual cortices were also demonstrated by the grouped results (Figure 2) with similar topography of calculation matrix for conditions before or after DMN removal. Visual stimuli of parametric addition design may induce the visual loading with parametric modulation (e.g. visual angle or visual complexity) as task difficulty (e.g. 1D+1D, 1D+2D, 2D+2D, etc.). BOLD-based fMRI results of parametric modeling were coherent with the psycho-behavioral results (Table 2). Increased parametric BOLD-based activity in the DMN spatial extension was demonstrated after DMN removal. The signal-to-noise effect of DMN removal was impressed with involvement of overlapped calculation matrix (e.g. left BA39 and right BA40, Figure 3 and Table 5). The major effect of DMN removal was demonstrated in before DMN removal vs. after DMN removal (Figure 3 and Table 5) as diminishing BOLD-based activity within calculation matrix (e.g. bilateral BA10, left BA24, right BA40 and right BA9) after removal of DMN activity from original fMRI data. By parametric modeling, removal of DMN activity may provide restrained spatial extension of calculation matrix ($p<0.05$, voxel cluster>0) if the correlate did not overlap with DMN extension. But the observation needs verification using stringent statistical criteria.

Weak association with reaction time and menstrual cycling was demonstrated using the parametric modeling of addition ($p<0.05$ and cluster>0). In conclusion, no individual variation via reaction time (N=21) and menstrual cycling (N=10) was observed by present results (Figures 4 and 5; Tables 6 and 7).

Statistical significance of gender difference was enhanced by removal of DMN (Figures 6 and 7; Tables 8 and 9). Men showed much higher BOLD-based activity during parametric addition with main correlates involving limbic system (Table 9). As compared to psycho-behavioral results (**B.2.1**), the increased BOLD-based activity and spatial extension may provide biological evidence of gender difference in addition operation.

Our 1st-year results suggested the hypotheses as following;
The co-existence of default-mode network during the fMRI studies engaging special tasks (e.g. mental calculation) may interfere the statistical analyses of fMRI. Change of default-mode network has been proposed during functional task with different mental loading or difficulties. Dynamics of default-mode network may cause subtraction errors by statistical mode which did not model the default-mode network. Results of our conjunctional analyses suggested the candidate regions of “false positive” in (1) superior parietal lobules, (2) bilateral precuneus, (3) bilateral anterior cingulate and (4) left middle frontal gyrus. The 2nd-year results supported different modulation of parametric fMRI results, depending on the function overlapping to DMN. By applying stringent parametric modeling, the task-relevant activation within DMN showed attenuation after DMN removal when task-relevant activation outside DMN increased. The effect of signal-to-noise on statistical modeling needs further verification by DMN removal.

In conclusion, results of the 2nd-year portion provided stringent neuro-imaging evidences supporting the following;

(1) The psycho-behavioral results of parametric addition were echoed by the parametric modeling of BOLD-based activity by recorded reaction time. Correlates of working memory, including verbal and visual spatial slave systems, were engaged during parametric addition.

(2) Gender difference of additional operation with male preference was demonstrated by both psycho-behavioral and fMRI approaches in these studies. Correlates of gender difference mainly located at limbic system (right parahippocampus and posterior cingulated) by parametric modeling.

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出國報告（出國類別：出國參加國際會議）

題目：
參加國際磁振醫學會 2009 年年會 及實驗性會後研討會

服務機關：台北榮民總醫院 教學研究部
姓名職稱：葉子成 醫師
派赴國家：美國夏威夷
出國期間：2009 年 4 月 17-25 日
報告日期：2009 年 9 月 3 日

一、 摘要

國際磁振醫學會(International Society of Magnetic Resonance in Medicine)的年會，是以磁振影像進行腦功能相關研究及臨床應用的相關領域中，最具規模的國際會議，對於職務專業及所執行的臨床或基礎研究計畫而言，均甚爲重要。廣義的腦部功能性磁振造影(Functional Magnetic Resonance Imaging of Brain)是使用磁振造影的各種技術來偵測(1)分子影像(如鈣離子動態、基因表現、細胞訊息傳遞、受體、神經傳遞物質)、(2)電生理影像(如神經膜電位、生物電流)、(3)細胞影像(如追蹤幹細胞或其他特定細胞、細胞體積變化)、(4)細胞連接或突觸影像(如擴散磁振影像或功能性連接)及(5)新陳代謝血液動力學影像(如神經傳遞物質之新陳代謝、腦血流、腦血量及腦部血管內的血液含氧量)。每一種功能性磁振影像都有其各別的理論及特殊的磁振造影(Magnetic Resonance Imaging、MRI)方法獲得時間及空間的「4D 定量」訊息，但同時需要考量時間及空間解析度的要求及限制。參加該年會的重要及主要原因，是(1)發表研究心得、(2)與相關領域專家交換經驗、及(3)將會議中的重要突破及關鍵技術以『學習經驗會後研討會』型式進一步引入台北榮民總醫院的腦功能研究團隊。

關鍵字: 磁振影像、功能、結構、人腦

二、　目次

三、本文

（1）會議目的

參加 2009 國際磁振醫學會(International Society of Magnetic Resonance in Medicine)年會的重要及主要原因，除了發表論文兩篇:(1)以數學計算及默認網路之群統計分析檢驗血氧相關功能性磁振之結果(Meta-analyses of Mathematical Calculation and Default-Mode Networks: impact on BOLD-based fMRI)，及(2)以機率擴散密度偵測運動視丘:藉運動功能性磁振之驗證(Detection of Motor Thalamus by Probabilistic Diffusion Density : verification by motor BOLD-based fMRI)以外。是將會議中的重要突破及關鍵技術進一步引入台北榮民總醫院的腦功能研究團隊，故而在會後於 2009 年 6 月至 2009 年 8 月安排 60 多次的研討會，在約 150 個研討專題中，選擇 6 個相關主題由研究團隊的同仁負責導讀，以影音重現的方式回顧該領域在 2009 的進展或應用，由職指導研討會的進行，而導讀同仁亦收集相關參考資料以供研究團隊參考或應用於研究。

（2）會議過程

國際磁振醫學會之議程包括教育課程 2 日(10 項全日的平行議程)及會議 4.5 日(10 項全日的平行議程)，共計約 150 個研討專題。

（3）會後之研究會

在 2009 年 6 月至 2009 年 8 月間，利用晨間及午間時間進行研討會，以減少對於同仁常規工作的影響。所選擇的相關主題包括(1) Crossing Fibers in Diffusion MRI、(2) Diffusion Tensor MRI for the Clinician & the Neuroscientist : From Experimental Design to Data Analysis、(3) Advanced Neuroimaging 、(4) fMRI Advanced Issues & Processing Software、(5) Imaging Strategies、(6) The Rise and Fall of the Brain Part II: The Aging Brain、 及(7) Tools & Tips for Mouse Imaging & Spectroscopy

每項研究主題所含蓋的詳細內容及主講者爲：

(1) Crossing Fibers in Diffusion MRI (共 6 次)

White Matter – Microstructure, Macrostructure, Pathways and Networks	Patric Hagmann, M.D., Ph.D.
Diffusion as a Probe of Tissue Microstructure and Complexity	Jacques-Donald Tournier, Ph.D.
Crossing Fibres- The Methods (How to Tell How Much is Going Where)	Daniel Alexander, Ph.D.
How to Do It In Practice – Optimal Approaches to Resolving Fiber Crossings	Adam W. Anderson, Ph.D.
Validation of Crossing Fibers	Tim B. Dyrby, Ph.D.
Applications / Limitations	Jennifer Campbell, Ph.D.

(2) Diffusion Tensor MRI for the Clinician & the Neuroscientist : From Experimental Design to Data Analysis (共5次)

How to Acquire Your Diffusion Images on a Clinical Scanner	Chunlei Liu, Ph.D.
How to Design Your Experiment and Process Your Data	Derek K. Jones, Ph.D.
Strategies for Data Analysis	Andrew L. Alexander, Ph.D.
Clinical Interpretation of DT-MRI Data	Robert C. McKinstry, M.D.,Ph.D.
Comparative Review of Available Software Packages	Lindsay Walker, M.Sc., and M. Okan Irfanoglu

(3) Advanced Neuroimaging (共14次)

Perfusion	
Perfusion in Tumor Diagnosis and Treatment Monitoring	Alan Jackson, Ph.D.
DSC vs ASL	Lawrence Latour, Ph.D.
Clinical Applications of ASL	Joseph A. Maldjian, M.D.
Diffusion	
Diffusion imaging in MS and other White Matter Diseases	Alex Rovira, M.D.
Diffusion Imaging in Traumatic Brain Injury	Aaron S. Field, M.D., Ph.D.
Diffusion in Developmental Brain Disorders	Elysa Widjaja, M.D.
Diffusion Imaging of the Spine - Does It Have a Clinical Role?	Madja Thurnher, M.D.
Combining Advanced Techniques in Clinical Management	
Advanced Imaging in the Management of Brain Tumors	Thomas L. Chenevert, Ph.D.
Advanced Imaging in Management of Epilepsy	Mark R. Symms, Ph.D.
Advanced Imaging in Functional Neurosurgery	Alberto Bizzi, M.D.
Cutting Edge and Future Advances	
MEG and MRI: Current and Future Clinical Applications	Steven Stufflebeam, M.D.
Structural Imaging at 7T: Relevance to Future Clinical Practice	Josef H. Duyn, Ph.D.
MRS in the Multicoil High Field Environment: Clinical Potential	Peter B. Barker, D.Phil.
PET and MRI: What Do We Gain?	Heinz-Peter W. Schlemmer, M.D., Ph.D.

(4) fMRI Advanced Issues & Processing Software (共16次)

Regression and Group Analysis Pipeline

fMRIB Software Library (FSL)	Mark Jenkinson, Ph.D.
Analysis of Functional Neuro Images (AFNI)	Robert W. Cox, Ph.D.
Statistical Parametric Mapping (SPM)	John Ashburner, Ph.D.
Connectivity	
Dynamic Causal Modeling (DCM)	Andre Marreiros, Ph.D.
SEM, Granger Causality	Alard Roebroeck, Ph.D.
Resting state:	
Independent Component Analysis (ICA) / Group ICA	Stephen M. Smith, D.Phil.
Brainscape	Avi Snyder, Ph.D.
Classification:	
Multi Voxel Pattern Analysis (MVPA / PyMVPA)	Michael Hanke, Dipl. Psych
Classification in Real Time	Stephen M. LaConte, Ph.D.
Formats, Visualization, Automation:	
Data Formats, Visualization, Automation	Ziad S. Saad, Ph.D.
Cutting Edge fMRI	
fMRI Pattern Effect Imaging	John-Dylan Haynes, Ph.D.
Real Time fMRI	Stefan Posse, Ph.D.
Resting State Fluctuations	Mark J. Lowe, Ph.D.
Temporal Resolution Limits	Jurgen K. Hennig, Ph.D.
Spatial Resolution Limits	Noam Harel, Ph.D.
Interpretation Limits	Robert Turner, Ph.D.

(5) Imaging Strategies (共12次)

General Pulse Sequences Strategies

Echo-Train Sequences: EPI, RARE, GRASE	John P. Mugler III, Ph.D.
Steady-State Sequences: From Spoiled to Balanced	Klaus Scheffler, Ph.D.
Image Contrast Strategies	Jeffrey L. Duerk, Ph.D.
Pulse Sequence Tools	
RF Pulse Design	Charles H. Cunningham, Ph.D.
Motion-Sensitizing Gradients: ASL, Diffusion and Phase Contrast	Eric C. Wong, M.D., Ph.D.

Motion Compensation Strategies	Anja C. Brau, Ph.D.
Tools for Rapid Imaging - 1	
Acceleration Possibilities with Alternative Trajectories	Dwight G. Nishimura, Ph.D.
Temporal Undersampling Strategies	Jeffrey Tsao, Ph.D.
Spectroscopic Imaging: Implementation and Acceleration	Ulrike Dydak, Ph.D.
Tools for Rapid Imaging - 2	
Parallel Imaging: Principles and Implementation	Philip J. Beatty, Ph.D.
Constrained Reconstruction Methods	Zhi-Pei Liang, Ph.D.
Parallel Transmit: Methods & Applications	V. Andrew Stenger, Ph.D.

(6) The Rise and Fall of the Brain Part II: The Aging Brain (共 4 次)

Normal Aging of the Brain	Marco Essig, M.D., Ph.D.
Pathological Aging of the Brain	Clifford R. Jack, Jr., M.D.
Small Vessel Disease	Mark A. Van Buchem, M.D., Ph.D.
Psychiatric Diseases	Anand Kumar, M.D.

(7) Tools & Tips for Mouse Imaging & Spectroscopy (共 7 次)

Introduction	Klaas Nicolay, Ph.D.
The Strength and Limitations of the Use of Transgenic and Knock-Out Animal Models	Frederick H. Epstein, Ph.D.
High-Field Imaging of Small-Animal Brain	Stephen J. Blackband, Ph.D.
Ultra Small Voxel Spectroscopy	Rolf Gruetter, Ph.D.
Diffusion Imaging of Mouse Skeletal and Cardiac Muscle	Gustav Strijkers, Ph.D.
The Use of Whole Body Scanners for Mouse MRI Studies	Brian K. Rutt, Ph.D.
The Design of Dedicated RF Coils for Mouse MR	Dennis W.J. Klomp, Ph.D.

會議紀錄已列於『**附錄**』中，以茲參考。

（3）會議心得

以影音重現的方式呈現 2009 國際磁振醫學會的會議內容，可以協助負責相關領域的同仁收集相關參考資料以及了解國際上其他進行同質性研究的研究團隊，以達到知己知彼的目標。同時可以彌補同仁未能參與國際會議的遺憾，也因為同仁需要導讀可以增進同仁英文能力，可謂同時達到多項功能目標。亦感謝國際磁振醫學會能提供影音資料以餉同好。

（4）**建議事項**

(一)國際學術會議是『學習經驗』及『展示成果』的最好機會，鑑於有限之經費，若

可獲得及保留會議影音資料，可考慮於會後重現重要的會議內容，以增進國內及同事的相關知識及研究能力。

(二)感謝國科會的經費支持本人參與該次國際學術會議，亦需在國科會計畫結案報告繳交參加會議之報告，與本次報告是完全一樣的內容，建議可以考慮簡化相關的公務人員報告。

(三)會後報告之繳交期限，宜依其呈現效果方式而異，本次會後的研討會型式與以往要求公開報告有所不同，故延後於完成研討會後方提出報告，該實驗性的研討會方式可以大大增加國家公費資助國際學術會議的效益。

四、附錄

2009ISMRM 會後 follow-up 研討會之 66 次會議紀錄

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Lab Meeting Minutes

Integrated Brain Research Unit

ISMRM 2009.
Follow-up Study Group.

Date/Time:	2009/6/5	Adjourned	
Place:			
Convener:	鄭州閔	Recorder:	
Attendance			

	Subject : Imaging Strategies Topic : EPI, RARE and GRASE 洪慈憶 周志彬 [stamp: 醫學研究部 醫師 葉子成] 林志銘 許宗凱 鄭吏仁
Discussion:	摘要如附件

Address: Laboratory of Integrated Brain Research, Department of Medical Research and Education,
Taipei Veterans General Hospital, No. 201, Sec. 2, Shih-Pai Road, Taipei 112, Taiwan

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Lab Meeting Minutes

Integrated Brain Research Unit

ISMRM 2009.
Follow-up Study Group.

Date/Time:	2009 / 6/22	**Adjourned**	
Place:			
Convener:	鄭州閔	**Recorder:**	
Attendance			

Discussion:	Subject : Image ~~Stra~~ Strategies Topic : Steady - State Sequences 摘要如附件 [illegible] 鄭州閔 [illegible] [illegible] 6/15 葉子成

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Lab Meeting Minutes

Integrated Brain Research Unit

ISMRM 2009.
Follow-up Study Group.

Date/Time:	2009. 6. 25	**Adjourned**	
Place:			
Convener:	郭世閣	**Recorder:**	
Attendance			

Discussion:	Subject : Imaging strategies Topic : Strategies for Control of contrast and Enhanced Resolution 摘要如附件 鄭崇凱 洪慈憶 林志穎 許宗凱 周

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Lab Meeting Minutes

Integrated Brain Research Unit

ISMRM 2009.
Follow-up Study Group.

Date/Time:		Adjourned	
Place:			
Convener:	鄭州閔	Recorder:	
Attendance			

Discussion:	Subject : Imaging Strategies Topic : RF Pulse Design 周 [illegible] 蕭 [illegible] 洪慈[illegible] 林志[illegible] [illegible] 許宇凱

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Lab Meeting Minutes

ISMRM 2009.
Follow-up Study Group.

Integrated Brain Research Unit

Date/Time:		Adjourned	
Place:			
Convener:	[illegible]	Recorder:	
Attendance			

Discussion:	Subject: Imaging Strategies Topic: Motion-sensitive Gradients [illegible] 洪慈憶 [illegible] [illegible] [illegible]

Address: Laboratory of Integrated Brain Research, Department of Medical Research and Education, Taipei Veterans General Hospital, No. 201, Sec. 2, Shih-Pai Road, Taipei 112, Taiwan

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ISMRM 2009.
Follow-up Study Group.

Date/Time:		Adjourned	
Place:			
Convener:	[illegible]	Recorder:	
Attendance			

Discussion:	Subject: Imaging Stragetics Topic: Motion Compensation Strategies 摘要如附件 [illegible] 葉子成 [illegible] [illegible]

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Date/Time:		**Adjourned**	
Place:			
Convener:	[illegible]	**Recorder:**	
Attendance			

Discussion:	Subject : Imaging Strategies Topic : Acceleration Possibilities Using Alternative Trajectories 醫學研究部 醫師 葉子成 鄭東凱 [illegible] 林志航 [illegible]

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Date/Time:	2009.7.28.	Adjourned	
Place:			
Convener:	[illegible]	Recorder:	
Attendance			

Discussion:	Subject = Imaging Strategies Topic = Temporal Undersampling [illegible] [illegible] 醫學研究部 醫師 葉子成 [illegible]

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Date/Time:		Adjourned	
Place:			
Convener:	[illegible]	Recorder:	
Attendance			

Discussion:	Subject: Imaging Strategies Topic: Spectroscopic Imaging: Implentation and Acceleration [illegible] [illegible] [illegible] [illegible] [illegible]

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Date/Time:	2009.	Adjourned	
Place:			
Convener:	[illegible]	Recorder:	
Attendance			

Discussion:	Subject: Imaging Strategies Topic: Parallel Imaging 林志翰 [illegible] [illegible] 張慈憶 許宗凱 [illegible]

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Date/Time:	8/12	Adjourned	
Place:			
Convener:	鄭州閔	Recorder:	
Attendance			

	Subject: Constrained Reconstruction. Topic: Imaging Strategies
Discussion:	林[illegible] 洪慈憶 許宗凱 [illegible] 周[illegible] 鄭[illegible]

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Date/Time:	8/5	Adjourned	
Place:	DA room		
Convener:	許宗凱	Recorder:	
Attendance			

Discussion:	Subject = Diffusion Tensor MRI for the Clinician & the Neuroscientist ~~from~~ from experimental Design to Data Analysis Topic = Comparative Review of Available Software Packages 醫學研究部 醫師 葉子成 許宗凱 周志陽 林志軒 鄭東凱 洪[illegible]

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Date/Time:	2009 / 6 / 3	Adjourned	
Place:			
Convener:	許宗凱	Recorder:	
Attendance	[illegible]		

Discussion:	Subject : Crossing fibers in diffusion MRI Topic : White Matter - Microstructure, Macrostructure, Pathways & Networks [illegible] 洪[illegible] 鄭[illegible] 許宗凱 林[illegible] [illegible]

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Date/Time:	2009.7.23	Adjourned	
Place:			
Convener:	許宗凱	Recorder:	
Attendance	[redacted]		

Discussion:	Subject: Diffusion Tensor MRI for the clinician & Neuroscientist Topic: from Experimental Design to Data Analysis Strategies for Data Analysis (3/5) [illegible] [illegible] [illegible] [illegible] 許宗凱 [illegible]

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Date/Time:	2009.6.30	Adjourned	
Place:			
Convener:	許宗凱	Recorder:	
Attendance			

Discussion:	Subject: Crossing fiber. Topic: Validation of Crossing fibers. 許宗凱 洪慈憶 [illegible] 教學研究部 醫師 葉子成 [illegible] 林志[illegible]

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Date/Time:	2009/6/24	Adjourned	
Place:			
Convener:	許宇凱	Recorder:	
Attendance			

Discussion:	Subject: Crossing fibers. Topic: Optimal approach to resolving fiber crossing [illegible] 許宇凱 [illegible] [illegible] [illegible] 醫學研究部 醫師 葉子成 [illegible]

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Date/Time:	2009/6/17	**Adjourned**	
Place:			
Convener:	許宗凱	**Recorder:**	
Attendance			

Discussion:	Subject: Crossing fiber Topic: Crossing fiber ~the method~ 林志軒 洪慈憶 蔡明閔 許宗凱 鄭吏弘 周右璿 醫學研究部 醫師 葉子成

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Date/Time:	2009/6/10	**Adjourned**	
Place:			
Convener:	許宗凱	**Recorder:**	
Attendance			

Discussion:	Subject: Crossing fiber in diffusion MRI Topic: Diffusion as a probe of Tissue Microstructure & complexity 許宗凱 洪[illegible] [illegible] [illegible] 周[illegible] 林[illegible]

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Date/Time:	7/15	Adjourned	
Place:			
Convener:	鄭東凱	Recorder:	
Attendance			

Discussion:	Subject: The Aging Brain Topic: Normal Aging of the Brain [stamp] [illegible] 葉子成 [illegible] 鄭東凱 [illegible] [illegible]

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Date/Time:		Adjourned	
Place:			
Convener:	鄭[illegible]	Recorder:	
Attendance			

Discussion:	Subject: The Aging Brain Topic: Psychiatric Disease [illegible] [illegible] 林[illegible] [illegible] 教學研究部 醫師 葉子成

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Date/Time:	2009.7.1	**Adjourned**	
Place:	--		
Convener:	[illegible]	**Recorder:**	
Attendance			

Discussion:	Subject: Tools and Tips for Mouse Imaging and Spectroscopy Topic: The Use of Whole Body Scanners for Mouse MRI Studies [illegible] 教學研究部 督 師 葉子成 [illegible] [illegible] [illegible] [illegible] [illegible]

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Date/Time:		**Adjourned**	
Place:			
Convener:	鄭志弘	**Recorder:**	
Attendance			

Discussion:	Subject : Tools and Tips for Mouse Imaging and Spectroscopy Topic : Diffusion Imaging of Mouse Skeletal and Cardiac Muscle 醫學研究部 醫師 葉子成 許宗凱 張慈慧 周[illegible] 林[illegible] 蔡[illegible]閔 鄭志弘

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Date/Time:	2009/6/18	Adjourned	
Place:			
Convener:	鄭建弘	Recorder:	
Attendance			

Discussion:	Subject: Tools and Tips for Mouse Imaging and Spectroscopy Topic: Ultra-Small Voxel Spectroscopy 教學研究部 醫師 葉子成 鄭建弘 林之頴 教學研究部 醫事放射士 周志哲 張慈憶

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Date/Time:	Jun 11th	Adjourned	
Place:			
Convener:	鄭生凱	Recorder:	
Attendance			

Discussion:	Subject : Tools and Tips for Mouse Imaging and Spectroscopy Topic : High-Field Imaging of Small-Animal Brain 鄭生凱 [illegible] 洪慈憶 許宗凱 林志穎 周志殷 蔡州閔

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Date/Time:	June 4th, 2009	Adjourned	
Place:	12:30 ~ 13:30		
Convener:	鄭[illegible]	Recorder:	
Attendance			

Discussion:	Subject: Tools and Tips for mouse imaging & spectroscopy Topic: The Strength and Limitations of the Use of Transgenic and Knock-Out Animal Models 醫學研究部 醫師 葉子成 林志毅 許宗凱 [illegible] [illegible] 洪慈憶

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Date/Time:		Adjourned	
Place:			
Convener:		Recorder:	
Attendance			

Discussion:	Subject : Tools and Tips for Mouse Imaging & Spectroscopy Topic : The Design of Dedicated RF coils for mouse MR [illegible] 許宗凱 翁珊閔 周立[illegible] 林志穎 洪慈憶 葉子成

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Date/Time:		Adjourned	
Place:			
Convener:	[illegible]	Recorder:	
Attendance			

Discussion:	Subject: Data format, visualization, automation Topic: fMRI advanced [illegible signatures] [stamp] 葉子成

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Date/Time:		Adjourned	
Place:			
Convener:	洪慈憶	Recorder:	
Attendance			

Discussion:	Subject: fMRI advanced software Topic: fMRI pattern effect image 林心敏 鄭吏菁 高林闕 [illegible] 許宗凱

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Date/Time:		Adjourned	
Place:			
Convener:	[illegible]	Recorder:	
Attendance			

Discussion:	Subject = real-time fMRI Topic = fMRI advanced software 林[illegible] 葉[illegible] 周[illegible] 鄭[illegible] [illegible] 許宗凱

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Date/Time:		Adjourned	
Place:			
Convener:	[illegible]	Recorder:	
Attendance			

Discussion:	Subject: fMRI advanced Topic: ICA (resting state) [illegible] [illegible] [illegible] [illegible] [illegible] 教學研究部 醫師 葉子成

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Date/Time:	June 4th. 2009	**Adjourned**	
Place:	9:00 – 10:00 AM.		
Convener:	洪慈憶	**Recorder:**	
Attendance			

Discussion:	Subject: fMRI Advanced Issues & Processing Software Topic: FSL. 教學研究部 醫師 葉子成 林志毅 [illegible] [illegible] 洪慈憶 [illegible]

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Date/Time:	2009/6/10	**Adjourned**	
Place:			
Convener:	洪慈憶	**Recorder:**	
Attendance			

Discussion:	Subject : FMRI software Topic : AFNI 洪慈憶 許宗凱 范剛閔 鄭史訓 林志凱

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Date/Time:	2009/6/18 22	**Adjourned**	
Place:			
Convener:	洪慈憶	**Recorder:**	
Attendance			

Discussion:	Subject: fMRI advanced software. Topic: SPM. [illegible signatures] 洪慈憶 醫學研究部 醫師 葉子成

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Date/Time:	2009/6/24	**Adjourned**	
Place:			
Convener:	洪慈憶	**Recorder:**	
Attendance			

Discussion:	Subject: fMRI advanced Topic: DCM 許宗凱 鄭翔閔 [illegible] 林志穎 [illegible] 教學研究部 醫師 葉子成

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Date/Time:		Adjourned	
Place:			
Convener:	[illegible]	Recorder:	
Attendance			

Discussion:	Subject : PyMVPA Topic : Advanced fMRI sofaware [illegible] [illegible] [illegible] [illegible] [illegible]

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Date/Time:	2009. 8. 13	Adjourned	
Place:			
Convener:	洪慈憶	Recorder:	
Attendance			

Discussion:	Subject : resting state Topic : fMRI advanced software 林之筱 鄭竹閔 周志昭 許宗凱 洪慈憶

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Date/Time:	2009/12/2	Adjourned	
Place:			
Convener:	張德明	Recorder:	
Attendance			

Discussion:	Subject: fMRI advanced Topic: SEM, Granger Casuality 周志郎 林志新 鄭桐熙 黃弘文 黃陳仁

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Date/Time:	2009. 07. 29	**Adjourned**	
Place:			
Convener:	林志凱	**Recorder:**	
Attendance			

Discussion:	Subject : Advanced Neuroimaging Topic : Advanced Imaging in Functional Neurosurgery 蔡世閔 周志協 教學研究部 醫師 葉子成 蘭夫凱

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Date/Time:	2009.7.22	Adjourned	
Place:			
Convener:	[illegible]	Recorder:	
Attendance	[illegible]		

Discussion:	Subject: Advanced Neuroimaging Topic: Advanced MRI in the Management of Epilepsy [illegible] [illegible] [illegible] 教學研究部 醫師 葉子成 林志凱 [illegible]

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Date/Time:	8/7.6	**Adjourned**	
Place:			
Convener:	林志凱	**Recorder:**	
Attendance			

Discussion:	Subject: Advance Neuroimaging Topic: Structural Imaging at 7.0T [illegible] [illegible] 林志凱 [illegible] 周志堅 洪蕙憶

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Date/Time:	2009, 07, 08	Adjourned	
Place:			
Convener:	[illegible]	Recorder:	
Attendance			

Discussion:	Subject : Advanced Neuroimaging Topic : ~~Diffusion in Developmental Brain Disorders~~ Diffusion imaging of the spine - Does it have a clinical role? [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] 教學研究部 醫師 葉子成

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Date/Time:	2009.7.16	Adjourned	
Place:			
Convener:	[illegible]	Recorder:	
Attendance			

Discussion:	Subject = Advanced Neuroimaging Topic = Advanced Imaging in the Management of Brain Tumor. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

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Date/Time:	2009.6.29	Adjourned	
Place:			
Convener:	林志穎	Recorder:	
Attendance			

Discussion:	Subject: Advanced Neuroimaging Topic: Diffusion in Developmental Brain Disorder 鄭楚紅 教學研究部 醫事放射士 周志哲 洪慈憶 林志軒 教學研究部 醫師 葉子成 許宗凱

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Date/Time:	2009/6/23	Adjourned	
Place:			
Convener:	林志龍	Recorder:	
Attendance			

Discussion:	Subject: Advanced Neuroimaging Topic: Diffusion imaging in Multiple Sclerosis and other White Matter Diseases 林志龍 鄭吏弘 [illegible] 洪慈憶 許宗凱 敎學研究部 醫師 葉子成 翁[illegible]

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Date/Time:	2009/6/17	Adjourned	
Place:			
Convener:	林志勳	Recorder:	
Attendance			

Discussion:	Subject : Advanced Neuroimaging Topic : Clinical Applications of Arterial Spin-labeling (ASL) MR Perfusion Imaging 林志勳 洪慈憶 許宗凱 [illegible] 教學研究部 醫師 葉子成 [illegible] [illegible]

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Date/Time:	8.12	**Adjourned**	
Place:			
Convener:	林志毅	**Recorder:**	
Attendance			

Discussion:	Subject : Advanced Neuroimaging Topic : MRS in the Multi-Coil High Field Environment : Clinical Potential. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

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Date/Time:	2009/6/1	**Adjourned**	
Place:			
Convener:	林志穎	**Recorder:**	
Attendance	[illegible]		

Discussion:	Subject = Advanced Neuroimaging Topic = Perfusion in Tumor Diagnosis and Treating Monitoring 鄭州閔 許宇凱 洪慈憶 [illegible] 鄭吏弘 林志穎

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Date/Time:	2009/6/8	**Adjourned**	
Place:			
Convener:	林志毅	**Recorder:**	
Attendance			

Discussion:	Subject : Advanced Neuroimaging Topic : DSC v.s. ASL 林志毅 周志偉 許宗凱 [illegible] [illegible] 教學研究部 醫師 葉子成 洪慈憶

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Date/Time:		Adjourned	
Place:			
Convener:	[illegible]	Recorder:	
Attendance			

Discussion:	Subject = Advanced Neuroimaging Topic = MEG and MRI: Current and Future Clinical Application. 鄭吉心 許宇凱 洪慈憶 教學研究部 醫事放射士 鄭州閔 教學研究部 醫師 葉子成 教學研究部 醫事放射士 周志哲

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Date/Time:		Adjourned	
Place:			
Convener:	洪慈憶	Recorder:	
Attendance			

Discussion:	Subject: fMRI advanced software Topic: SEM, Granger Causality 洪慈憶 教學研究部 醫師 葉子成 [illegible] [illegible] [illegible] [illegible] 教學研究部 醫事放射士 周志哲

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Date/Time:		Adjourned	
Place:			
Convener:	洪慈憶	Recorder:	
Attendance			

Discussion:	Subject: fMRI advanced software Topic: Interpretation Limits 洪慈憶 林志凱 許宗凱 醫學研究部 醫師 葉子成 醫學研究部 醫事放射士 周志哲

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Date/Time:		Adjourned	
Place:			
Convener:	[illegible]	Recorder:	
Attendance			

Discussion:	Subject: fMRI advanced software Topic: Spatial Resolution Limits [illegible] [illegible] [illegible] [illegible] 教學研究部 醫師 葉子成 [illegible] 教學研究部 醫事放射士 周志哲

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Convener:	洪慈憶	Recorder:	
Attendance			

Discussion:	Subject: fMRI advanced software Topic: Temporal Resolution Limits 洪慈憶 教學研究部 醫師 葉子成 林志[illegible] [illegible] 許宇[illegible] [illegible] 教學研究部 醫事放射士 周志[illegible]

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Convener:		Recorder:	
Attendance			

Discussion:	Subject: fMRI Advaned Sftware Topic: Brainscape 教學研究部 醫師 葉子成 教學研究部 醫事放射士 周志哲

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Date/Time:		Adjourned	
Place:			
Convener:	[illegible]	Recorder:	
Attendance			

Discussion:	Subject: fMRI advanced software Topic: Classification in Real Time [illegible] [illegible] [illegible] [illegible] 教學研究部 醫 師 葉子成 教學研究部 醫事放射士 鄭州閔 教學研究部 醫事放射士 周志哲

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Convener:	許宗凱	Recorder:	
Attendance			

Discussion:	Subject: Crossing fibers in diffusion MRI Topic: Application / limitations (6/6) [illegible] [illegible] 許宗凱 [illegible] 教學研究部 醫師 葉子成 教學研究部 醫事放射士 鄭州閔 教學研究部 醫事放射士 周志哲

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Attendance			

Discussion:	Subject : DTI for The Clinician & the Neuroscientist from Experimental design to data Analysis Topic : Clinical Interpretation of DTI-MRI Data (4/5) 林志[illegible] [illegible] 許宗凱 洪慈憶 教學研究部 醫事放射士 鄭州閔 教學研究部 醫師 葉子成 教學研究部 醫事放射士 周志哲

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Discussion:	Subject: DTI for the clinician & Neuroscientist: from Experimental Design to Data Analysis Topic: How to Design your experiment & process your data (3/5) 鄭州閔 許宗凱 林志銘 張蕊蕊 教學研究部 醫事放射士 鄭州閔 教學研究部 醫師 葉子成 教學研究部 醫事放射士 周志哲

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Attendance			

Discussion:	Subject : DTI for the Clinician & the Neuroscientist from Experimental Design to Data Analysis Topic : How To Acquire Your Diffusion Image on Clinical Scanner (1/5) 林志行 [illegible] 許宗凱 張慈憶 教學研究部 醫事技術士 鄭州閔 教學研究部 醫師 葉子成 教學研究部 醫事技術士 周志哲

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Convener:	鄭東凱	Recorder:	
Attendance			

Discussion:	Subject : The Aging Brain Topic : Small Vessel Disease 鄭東凱 許宇凱 林志銘 洪慧憶 教學研究部 醫師 葉子成 教學研究部 醫事放射士 鄭州閔 教學研究部 醫事放射士 周志哲

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Convener:	鄭[illegible]	Recorder:	
Attendance			

Discussion:	Subject : The Aging Brain Topic : Pathological Aging of the Brain 鄭[illegible] 許宇凱 林志紅 洪慈憶 教學研究部 醫師 葉子成 教學研究部 醫事技術士 鄭州閔 教學研究部 醫事技術士 周志哲

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Convener:	鄭州閔	Recorder:	
Attendance			

Discussion:	Subject: Imaging Strategies Topic: Parallel Transmit: Methods and Applications [illegible] 許宇凱 林志邦 [illegible] 張慈憶 教學研究部 醫師 葉子成 教學研究部 醫事放射士 鄭州閔 教學研究部 醫事放射士 周志哲

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Convener:	鄭州閔	Recorder:	
Attendance			

Discussion:	Subject : Advanced fMRI Topic : Cutting Edge fMRI : Spatial resolution limits [signatures] 林志彬 許宗凱 洪慈憶 教學研究部 醫事放射士 鄭州閔 教學研究部 醫師 葉子成 教學研究部 醫事放射士 周志哲

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Place:			
Convener:		Recorder:	
Attendance			

Discussion:	Subject = Advanced Neuroimaging Topic = PET and MRI : What Do We Gain ? 教學研究部 醫事放射士 鄭州閔 教學研究部 醫 師 葉子成 教學研究部 醫事放射士 周志哲

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Place:			
Convener:	[illegible]	Recorder:	
Attendance			

TBI

Discussion:	Subject: Advanced Neuroimaging. Topic: Advanced Imaging in Traumatic Brain Injury. [illegible] [illegible] [illegible] 教學研究部 醫事放射士 鄭洲閔 教學研究部 醫 師 葉子成 教學研究部 醫事放射士 周志哲

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