Final Progress Report for Research Projects Funded by Health Research Grants

Instructions: Please complete all of the items as instructed. Do not delete instructions. Do not leave any items blank; responses must be provided for all items. If your response to an item is "None", please specify "None" as your response. "Not applicable" is not an acceptable response for any of the items. There is no limit to the length of your response to any question. Responses should be single-spaced, no smaller than 12-point type. The report **must be completed using MS Word**. Submitted reports must be Word documents; they should not be converted to pdf format. Questions? Contact Health Research Program staff at 717-783-2548.

1. **Grantee Institution: Albert Einstein Healthcare Network**

2. **Reporting Period (start and end date of grant award period): 1/1/2009 – 6/30/2011**

3. **Grant Contact Person (First Name, M.I., Last Name, Degrees): Mary Klein, PhD**

4. **Grant Contact Person's Telephone Number: 215-456-7216**

5. **Grant SAP Number: 4100047622**

6. **Project Number and Title of Research Project: 03 – Evaluation of Spatial Normalization Protocols for Brains with Focal Lesions**

7. **Start and End Date of Research Project: 1/1/2009 – 6/30/2011**

8. **Name of Principal Investigator for the Research Project: Junghoon Kim, PhD**

9. **Research Project Expenses**.

   9(A) Please provide the amount of health research grant funds spent on this project for the entire duration of the grant, including any interest earned that was spent:

   $45,296.80

   9(B) Provide the last names (include first initial if multiple individuals with the same last name are listed) of **all** persons who worked on this research project and were supported with health research funds. Include position titles (Principal Investigator, Graduate Assistant, Post-doctoral Fellow, etc.), percent of effort on project and total health research funds expended for the position. For multiple year projects, if percent of effort varied from year to year, report in the % of Effort column the effort by year 1, 2, 3, etc. of the project (x% Yr 1; z% Yr 2-3).

Last Name	Position Title	% of Effort on Project	Cost

Kim	Principal Investigator	10%	$19,616
Avants	Co-Investigator	5%	$7,325

9(C) Provide the names of **all** persons who worked on this research project, but who *were not* supported with health research funds. Include position titles (Research Assistant, Administrative Assistant, etc.) and percent of effort on project. For multiple year projects, if percent of effort varied from year to year, report in the % of Effort column the effort by year 1, 2, 3, etc. of the project (x% Yr 1; z% Yr 2-3).

Last Name	Position Title	% of Effort on Project
Whyte	Co-Investigator	1%
Coslett	Co-Investigator	1%
Schwartz	Co-Investigator	1%
Pluta	Research Assistant	5%
Europa	Research Assistant	3%
Rajan	Research Assistant	3%

9(D) Provide a list of **all** scientific equipment purchased as part of this research grant, a short description of the value (benefit) derived by the institution from this equipment, and the cost of the equipment.

Type of Scientific Equipment	Value Derived	Cost
A laptop	Data analysis became possible on a laptop which was carried between the two institutes, greatly facilitating the efficiency of data analysis.	$1,742

10. Co-funding of Research Project during Health Research Grant Award Period. Did this research project receive funding from any other source during the project period when it was supported by the health research grant?

Yes_____ No____X_____

If yes, please indicate the source and amount of other funds:

11. Leveraging of Additional Funds

11(A) As a result of the health research funds provided for this research project, were you able to apply for and/or obtain funding from other sources to continue or expand the research?

Yes____X_____ No_____

If yes, please list the applications submitted (column A), the funding agency (National Institutes of Health—NIH, or other source in column B), the month and year when the application was submitted (column C), and the amount of funds requested (column D). If you have received a notice that the grant will be funded, please indicate the amount of funds to be awarded (column E). If the grant was not funded, insert "not funded" in column E.

Do not include funding from your own institution or from CURE (tobacco settlement funds). Do not include grants submitted prior to the start date of the grant as shown in Question 2. If you list grants submitted within 1-6 months of the start date of this grant, add a statement below the table indicating how the data/results from this project were used to secure that grant.

A. Title of research project on grant application	B. Funding agency (check those that apply)	C. Month and Year Submitted	D. Amount of funds requested:	E. Amount of funds to be awarded:
A Longitudinal Multi-modal Neuroimaging Investigation of Functional Recovery after Diffuse Traumatic Brain Injury	☒ NIH ☐ Other federal (specify:_____ _____) ☐ Nonfederal source (specify: _____)	07/2009 (1st revision)	$ 1,625,949	$ 1,422,705
	☐NIH ☐ Other federal (specify:_____ _____) ☐ Nonfederal source (specify: _____)		$	$
	☐NIH ☐ Other federal (specify:_____ _____) ☐ Nonfederal source (specify: _____)		$	$

The results from this project were not provided at the time of 1st revision of the NIH R01 grant application. However, we mentioned this project in the introduction of the grant revision because we wanted to emphasize our expertise in neuroimaging methodology, especially in spatial registration. In particular, our proposal was a longitudinal neuroimaging study, the success of which depends on an optimal spatial registration method. The mere fact that we were conducting an evaluation study using state-of-the-art registration protocols must have worked favorably for our application.

11(B) Are you planning to apply for additional funding in the future to continue or expand the research?

Yes____X_____ No_____

If yes, please describe your plans:

We have outlined a subsequent project that is to be submitted to the NIH as an R21 application. Using the results from this project as preliminary data, we expect to submit the application for Cycle III (October 16th). See the next item (12. Future of Research Project) for more details.

12. Future of Research Project. What are the future plans for this research project?

Our long term goal is to continue our research to identify the optimal methods to process brains with focal and diffuse lesions. In our subsequent research, we will conduct evaluation studies using different parameters and techniques that determine the quality of spatial normalization. For example, the specific aims of our next evaluation study (to be submitted as an NIH R21 proposal) will include the following:

1) to use 'optimal' (rather than default) normalization parameters by asking the developers of each normalization algorithm to choose the parameters. We will first send out five randomly selected brains with focal lesions to the developers of each algorithm so that they can adjust their normalization parameters using these sample brains. Then we will use these parameters for our next phase of evaluation, to compare the algorithms 'at their best.'
2) to investigate the relationship between registration error and the distance from the focal lesion in different normalization protocols. We hypothesize that the closer a landmark is to the lesion center, the lower the normalization accuracy is. This proximity-to-the-lesion effect may vary across different normalization protocols. To test the location by normalization algorithm interaction, we need more landmark locations. We propose to employ additional twenty anatomical landmarks to collect more data points.
3) to use a 'symmetric template' instead of the Colin brain. A symmetric template averages the left and right hemisphere as a final stage. First we create a custom template as normal, flip the template and make a new unbiased template out of those two. By using a symmetric template, we can compare the normalization results from the left and right hemisphere with more confidence.

4) to add another popular large deformation normalization algorithm, DARTEL (The Diffeomorphic Anatomical Registration Through Exponentiated Lie Algebra), implemented in the SPM8 package.
5) to examine the effect of skull stripping before registration for each normalization protocol.

13. **New Investigator Training and Development**. Did students participate in project supported internships or graduate or post-graduate training for at least one semester or one summer?

Yes_____ No___X_____

If yes, how many students? Please specify in the tables below:

	Undergraduate	Masters	Pre-doc	Post-doc
Male				
Female				
Unknown				
Total				

	Undergraduate	Masters	Pre-doc	Post-doc
Hispanic				
Non-Hispanic				
Unknown				
Total				

	Undergraduate	Masters	Pre-doc	Post-doc
White				
Black				
Asian				
Other				
Unknown				
Total				

14. **Recruitment of Out-of–State Researchers**. Did you bring researchers into Pennsylvania to carry out this research project?

Yes_____ No____X_____

If yes, please list the name and degree of each researcher and his/her previous affiliation:

15. **Impact on Research Capacity and Quality**. Did the health research project enhance the quality and/or capacity of research at your institution?

Yes___X_____ No_____

If yes, describe how improvements in infrastructure, the addition of new investigators, and other resources have led to more and better research.

There are several researchers at our institute who investigate the brain-behavior relationship in patients with brain injury. The results from this project have provided and will continue to provide guidance to the researchers at our institution about what type of spatial normalization protocol is optimal for the brains with focal and diffuse lesions. This will improve the quality of their data, ultimately leading to better research results.

16. Collaboration, business and community involvement.

16(A) Did the health research funds lead to collaboration with research partners outside of your institution (e.g., entire university, entire hospital system)?

Yes___X_____ No_____

If yes, please describe the collaborations:

This fund enabled the PI to collaborate with co-investigators both inside and outside of Albert Einstein Healthcare Network. First, within the Network, the PI was able to collaborate with Dr. Myrna Schwartz because he was using Dr. Schwartz's stroke patients. Second, the PI was able to continue his collaboration with researchers at the University of Pennsylvania: Dr. Coslett for lesion delineation, Dr. Avants for registration consultation, and Mr. Pluta for landmark planting and data analysis.

16(B) Did the research project result in commercial development of any research products?

Yes_____ No____X_____

If yes, please describe commercial development activities that resulted from the research project:

16(C) Did the research lead to new involvement with the community?

Yes_____ No____X_____

If yes, please describe involvement with community groups that resulted from the research project:

17. Progress in Achieving Research Goals, Objectives and Aims.

List the project goals, objectives and specific aims (as contained in the grant application's strategic plan). Summarize the progress made in achieving these goals, objectives and aims <u>for the entire grant award period.</u> Indicate whether or not each goal/objective/aim was achieved; if something was not achieved, note the reasons why. Describe the methods used. If changes were made to the research goals/objectives/aims, methods, design or timeline since the original grant application was submitted, please describe the changes. <u>Provide</u>

detailed results of the project. Include evidence of the data that was generated and analyzed, and provide tables, graphs, and figures of the data. List published abstracts, poster presentations and scientific meeting presentations at the end of the summary of progress; peer-reviewed publications should be listed under item 20.

This response should be a DETAILED report of the methods and findings. It is not sufficient to state that the work was completed. Insufficient information may result in an unfavorable performance review, which may jeopardize future funding. If research findings are pending publication you must still include enough detail for the expert peer reviewers to evaluate the progress during the course of the project.

Health research grants funded under the Tobacco Settlement Act will be evaluated via a performance review by an expert panel of researchers and clinicians who will assess project work using this Final Progress Report, all project Annual Reports and the project's strategic plan. After the final performance review of each project is complete, approximately 12-16 months after the end of the grant, this Final Progress Report, as well as the Final Performance Review Report containing the comments of the expert review panel, and the grantee's written response to the Final Performance Review Report, will be posted on the CURE Web site.

There is no limit to the length of your response. Responses must be single-spaced below, no smaller than 12-point type. If you cut and paste text from a publication, be sure symbols print properly, e.g., the Greek symbol for alpha (α) and beta (ß) should not print as boxes (□) and include the appropriate citation(s). DO NOT DELETE THESE INSTRUCTIONS.

Original Aim

The purpose of the current project is two-fold. First is to quantitatively evaluate several different protocols that involve spatially transforming images of focally lesioned brains. The second purpose of the project is to build a small database of images of brains with focal lesions where anatomical landmarks are planted. These brain images with landmarks can be used for future studies that aim to evaluate more spatial transformation protocols.

Aims Achieved

We have achieved both goals stated above. First, we have built a database of unilaterally lesioned brains with anatomical landmarks. This database will be used as a valuable resource for the future studies that aim to evaluate spatial normalization protocols for brains with focal lesions. Second, we conducted an evaluation study on the following three normalization protocols: SPM5 Unified Segmentation approach with and without cost function masking, FNIRT (FMRIB's Non-linear Image Registration Tool, with and without cost function masking), and SyN (Symmetric Normalization, with and without lesion masking). The affine-only transformation was served as a baseline. Initial results indicated that the three nonlinear registration algorithms performed better than affine-only registration in most brain regions and were particularly beneficial in the presence of focal lesions (i.e., in the lesioned hemisphere). SPM5 Unified Segmentation and SyN seemed to produce less normalization error than FNIRT. See the Results section for more details.

Change from the Original Plan

We originally planned to use both stroke and TBI brains for evaluation study. However, we realized the fact that our stroke patients have unilateral lesion (i.e., left hemisphere), which provides a unique opportunity to examine normalization errors at each hemisphere separately. Thus, we included only stroke patients in our final analysis and also the manuscript in progress. The normalized TBI brains were included in another paper, which was published in Journal of Neurotrauma.

We also decided not to include the results from cost function masking in the final report (we reported it in the last year's progress report) because using cost function masking did not change normalization error measure. Due to the relatively small sample size, the interpretation of this null finding is difficult to make.

Method and Results

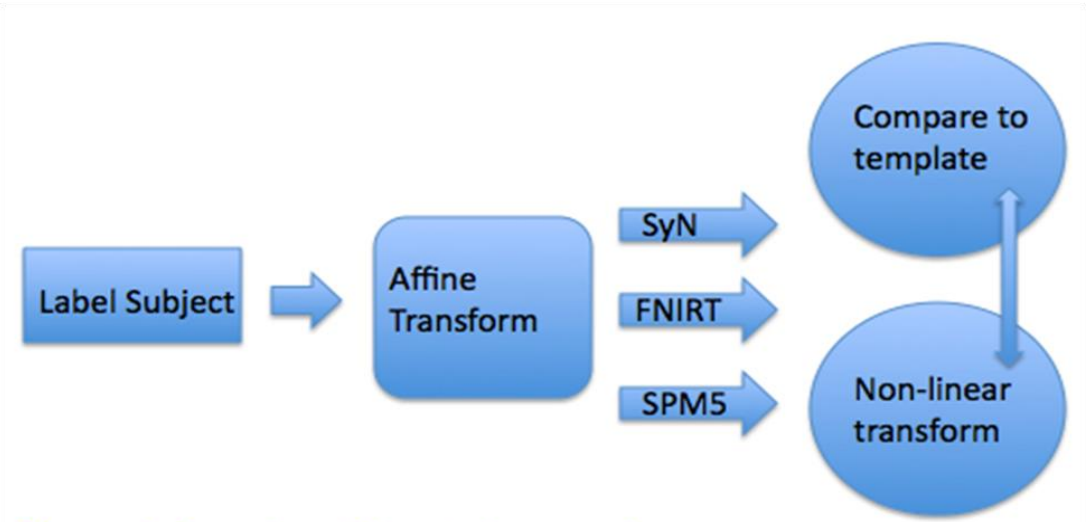


Figure 1: Overview of the study procedure.

Labeling. Twenty subjects with left hemisphere lesions due to stroke had spherical labels placed bilaterally in 10 predefined regions of interest, identified by particular anatomical landmarks. Raters were trained by labeling test subjects and having the labels reviewed by an expert (Dr. Coslett). The same labels were placed on the MNI template. Labels were divided among three research assistants and placed independently on each subject.

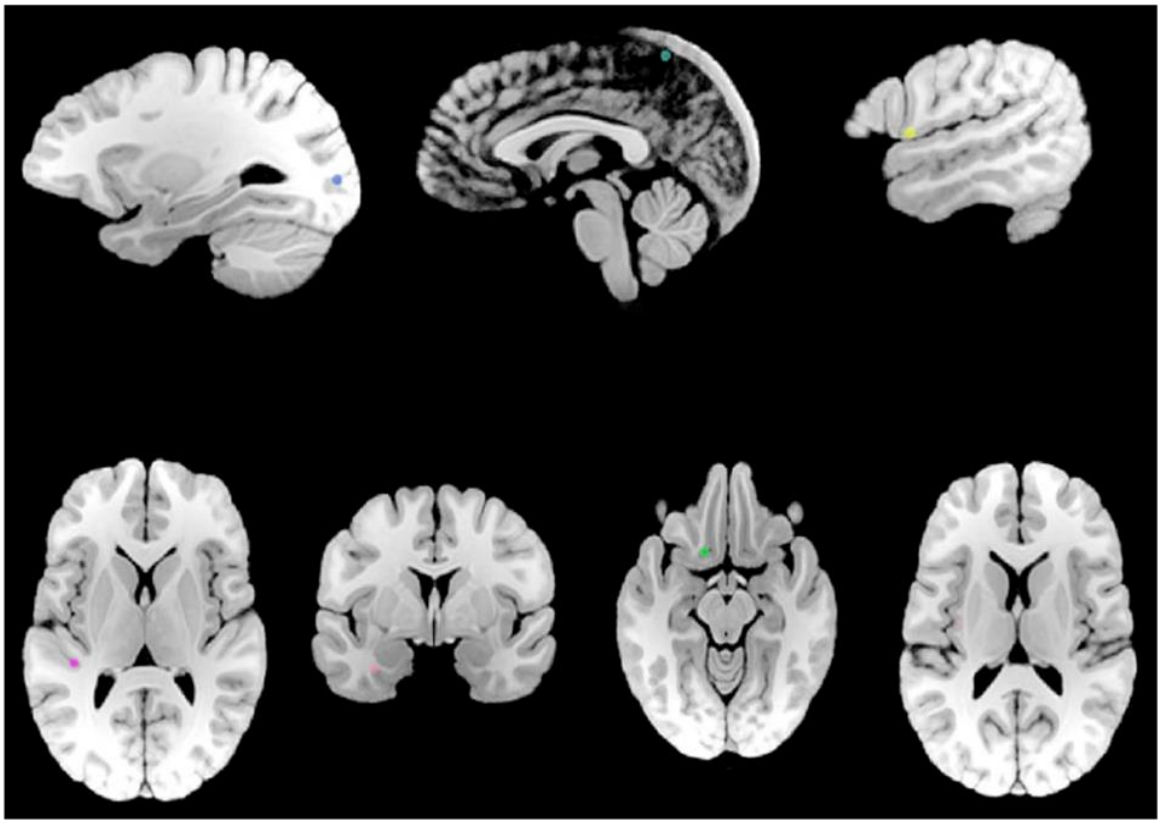


Figure 2: Sample cortical labels placed on a template brain. Labeled regions were (clockwise from top left): interior occipital sulcus, pars opercularis, transverse temporal sulcus, collateral sulcus, olfactory sulcus. Regions were labeled as 5mm spheres, and error was defined as the distance between any two labels (such as a label on a subject and the homologous label on the template).

Intra-rater reliability. To assess reliability, labels were drawn a second time by the same raters, after a period of 6 months. Labels with mean error greater than 3mm were eliminated. Figure 1 shows the overview of the study procedure and Figure 2 shows the average error for each label. Normalization error was measured as the distance between the centre of each label at Time 1 and Time 2. A label with average error of greater than 3mm was considered unreliable. Interior occipital sulcus (IOS), central insular sulcus (CIS), and occipital horn of the lateral ventricle (OHLV) were eliminated as unreliable.

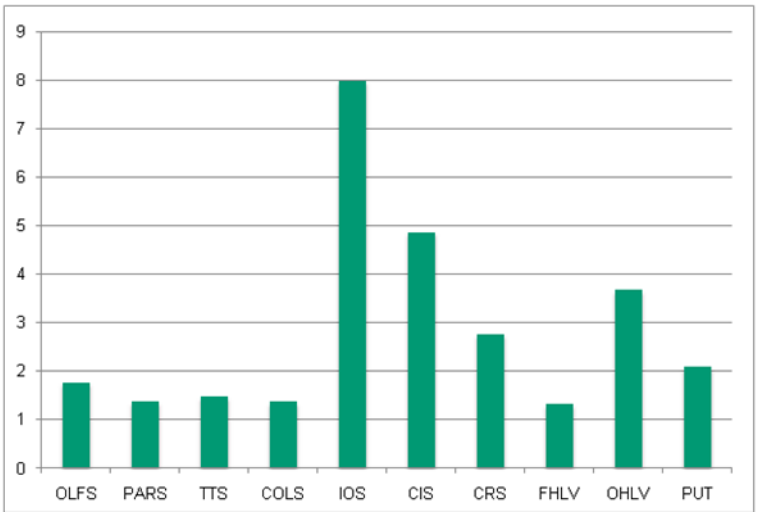


Figure 3: Average error for each label. Error is measured as the distance (mm) between the centre of each label at rating 1 and rating 2

Normalization. To restrict the analysis to only the effect of non-linear registration on normalization accuracy, an affine mapping was first computed for each subject in SPM5. Labels and structural images were transformed with affine-only registration first and subsequently had a non-linear registration computed by each method. All parameters were listed as the published defaults for each method.

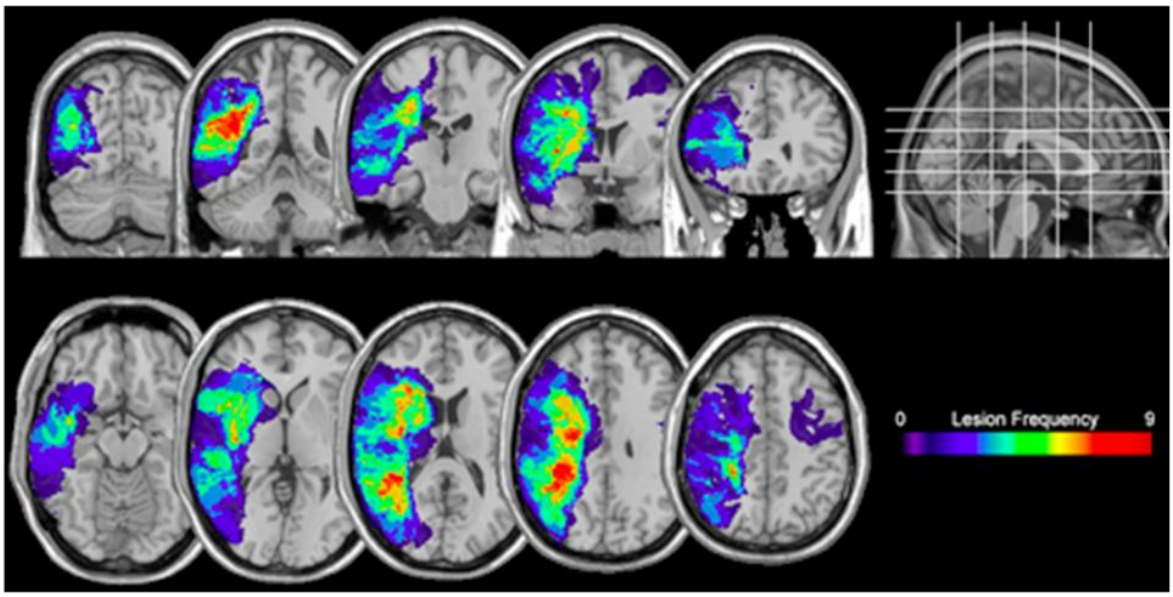


Figure 4: Lesion frequency map displays the distribution of lesions from each subject, displayed on a common template. All subjects had left-hemisphere lesions induced by stroke. Landmarks in the lesioned hemisphere may yield more normalization error relative to the ones in the intact hemisphere.

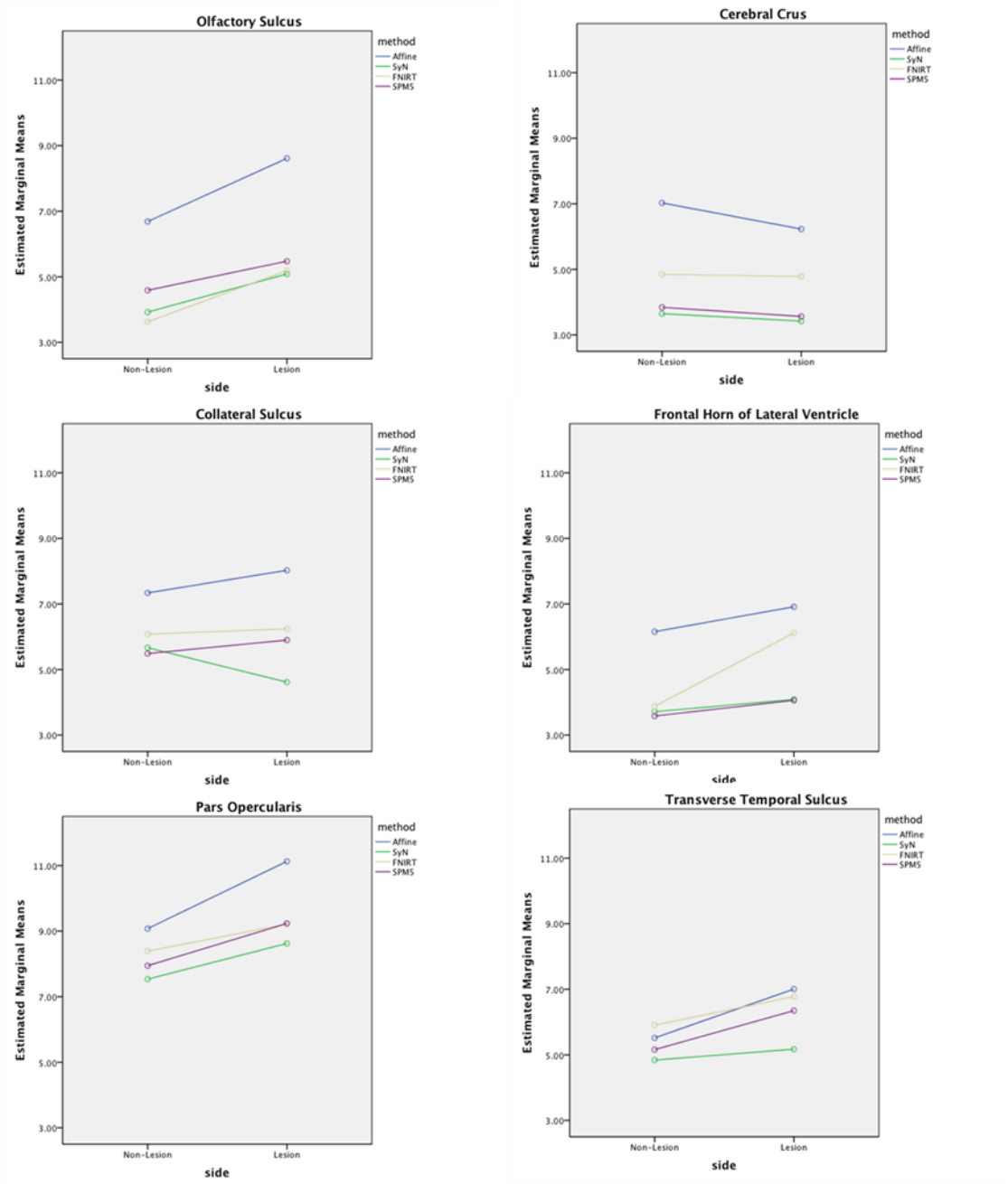
Evaluation. Figure 5 shows the results of repeated measures ANOVA test for each landmark. A complex interactions between side and method for different areas of the brain were found. Post hoc paired t-tests revealed that SyN and Unified Segmentation (SPM5) yielded less error than affine registration in 3 regions in the non-lesioned hemisphere, and 5 regions in the lesioned hemisphere, while FNIRT improved registration in 1 region in non-lesioned hemisphere and 2 in the lesioned side.

Conclusions

We have successfully built a database of unilaterally lesioned brains with anatomical landmarks. Preliminary results indicated that the three nonlinear registration algorithms performed better than affine-only registration in most brain regions and were particularly beneficial in the presence of focal lesions (i.e., in the lesioned hemisphere). SPM5 Unified Segmentation and SyN seemed to produce less normalization error than FNIRT.

Poster presentation

We presented our results from this project as a poster in the Research Recognition Day at Albert Einstein Healthcare Network (May 2011). The poster title was "Assessment of nonlinear spatial normalization algorithms in the presence of focal lesions: A preliminary study."



LM:	OFS	CCRS	CSUL	FHLV	PARSOP	TTS
side	<0.001	0.514	0.929	0.007	0.136	0.433
method	<0.001	<0.001	<0.001	<0.001	0.002	0.019
Side*method	0.004	0.672	0.005	<0.001	0.681	0.451

Figure 5: Results of repeated measures ANOVA

18. Extent of Clinical Activities Initiated and Completed. Items 18(A) and 18(B) should be completed for all research projects. If the project was restricted to secondary analysis of clinical data or data analysis of clinical research, then responses to 18(A) and 18(B) should be "No."

18(A) Did you initiate a study that involved the testing of treatment, prevention or diagnostic procedures on human subjects?

_____Yes
__X____No

18(B) Did you complete a study that involved the testing of treatment, prevention or diagnostic procedures on human subjects?

_____Yes
__X____No

If "Yes" to either 18(A) or 18(B), items 18(C) – (F) must also be completed. (Do NOT complete 18(C-F) if 18(A) and 18(B) are both "No.")

18(C) How many hospital and health care professionals were involved in the research project?

_____Number of hospital and health care professionals involved in the research project

18(D) How many subjects were included in the study compared to targeted goals?

_____Number of subjects originally targeted to be included in the study
_____Number of subjects enrolled in the study

Note: Studies that fall dramatically short on recruitment are encouraged to provide the details of their recruitment efforts in Item 17, Progress in Achieving Research Goals, Objectives and Aims. For example, the number of eligible subjects approached, the number that refused to participate and the reasons for refusal. Without this information it is difficult to discern whether eligibility criteria were too restrictive or the study simply did not appeal to subjects.

18(E) How many subjects were enrolled in the study by gender, ethnicity and race?

Gender:
_____Males
_____Females
_____Unknown

Ethnicity:
_____Latinos or Hispanics
_____Not Latinos or Hispanics

_____Unknown

Race:
_____American Indian or Alaska Native
_____Asian
_____Blacks or African American
_____Native Hawaiian or Other Pacific Islander
_____White
_____Other, specify:_____
_____Unknown

18(F) Where was the research study conducted? (List the county where the research study was conducted. If the treatment, prevention and diagnostic tests were offered in more than one county, list all of the counties where the research study was conducted.)

19. Human Embryonic Stem Cell Research. Item 19(A) should be completed for all research projects. If the research project involved human embryonic stem cells, items 19(B) and 19(C) must also be completed.

19(A) Did this project involve, in any capacity, human embryonic stem cells?
_____Yes
__X____ No

19(B) Were these stem cell lines NIH-approved lines that were derived outside of Pennsylvania?
_____Yes
_____ No

19(C) Please describe how this project involved human embryonic stem cells:

20. Articles Submitted to Peer-Reviewed Publications.

20(A) Identify all publications that resulted from the research performed during the funding period and that have been submitted to peer-reviewed publications. Do not list journal abstracts or presentations at professional meetings; abstract and meeting presentations should be listed at the end of item 17. **Include only those publications that acknowledge the Pennsylvania Department of Health as a funding source** (as required in the grant agreement). List the title of the journal article, the authors, the name of the peer-reviewed publication, the month and year when it was submitted, and the status of publication (submitted for publication, accepted for publication or published.). Submit an electronic copy of each publication, listed in the table, in a PDF version 5.0.5 format, 1,200 dpi. Filenames for each publication should include the number of the research project, the last name of the PI, the number of the publication and an abbreviated research project title. For example, if you submit two publications for PI Smith for the "Cognition and MRI in Older

Adults" research project (Project 1), and two publications for PI Zhang for the "Lung Cancer" research project (Project 3), the filenames should be:

Project 1 – Smith – Publication 1 – Cognition and MRI
Project 1 – Smith – Publication 2 – Cognition and MRI
Project 3 – Zhang – Publication 1 – Lung Cancer
Project 3 – Zhang – Publication 2 – Lung Cancer

If the publication is not available electronically, provide 5 paper copies of the publication.

Note: The grant agreement requires that recipients acknowledge the Pennsylvania Department of Health funding in all publications. Please ensure that all publications listed acknowledge the Department of Health funding. If a publication does not acknowledge the funding from the Commonwealth, do not list the publication.

Title of Journal Article:	Authors:	Name of Peer-reviewed Publication:	Month and Year Submitted:	Publication Status (check appropriate box below):
1. Resting CBF alterations in chronic traumatic brain injury: An arterial spin labeling perfusion fMRI study	Kim, J., Whyte, J., Patel, S., Avants, B., Europa, E., Wang, J., Slattery, J., Gee, J. C., Coslett, H. B., & Detre, J. A.	Journal of Neurotrauma [cover article]	11/2009	☐Submitted ☐Accepted ☒Published
2.				☐Submitted ☐Accepted ☐Published
3.				☐Submitted ☐Accepted ☐Published

The above article, although the main finding is about resting perfusion, includes data from 15 patients who had focal lesions in their brains. These brains were spatially normalized with the Symmetric Normalization algorithm as part of the current project.

20(B) Based on this project, are you planning to submit articles to peer-reviewed publications in the future?

Yes___X_____ No_____

If yes, please describe your plans:

John Pluta, a senior research specialist at the University of Pennsylvania is writing a manuscript under the supervision of the PI. It is expected that he will submit the manuscript by the end of the summer. The title of the manuscript will be "Assessment of nonlinear spatial normalization algorithms in the presence of focal lesions: A preliminary study." This

manuscript is based on the twenty stroke patients' brains. Only stroke patients were used for this manuscript. The brains with traumatic brain injury were spatially normalized for the published article (see the above table).

21. Changes in Outcome, Impact and Effectiveness Attributable to the Research Project. Describe the outcome, impact, and effectiveness of the research project by summarizing its impact on the incidence of disease, death from disease, stage of disease at time of diagnosis, or other relevant measures of outcome, impact or effectiveness of the research project. If there were no changes, insert "None"; do not use "Not applicable." Responses must be single-spaced below, and no smaller than 12-point type. DO NOT DELETE THESE INSTRUCTIONS. There is no limit to the length of your response.

This project does not directly contribute to improving the quality of health in patients with stroke or traumatic brain injury (TBI). However, the results from this type of research are expected to greatly improve the quality of the research that is needed for improving the status of their health. Specifically, this project found that certain type of spatial normalization algorithms outperform others in providing robust results for brains with focal lesions. This information regarding which protocol yields the most robust results for brains with focal lesions will be useful for future neuroimaging studies in these populations.

22. Major Discoveries, New Drugs, and New Approaches for Prevention Diagnosis and Treatment. Describe major discoveries, new drugs, and new approaches for prevention, diagnosis and treatment that are attributable to the completed research project. If there were no major discoveries, drugs or approaches, insert "None"; do not use "Not applicable." Responses must be single-spaced below, and no smaller than 12-point type. DO NOT DELETE THESE INSTRUCTIONS. There is no limit to the length of your response.

We discovered that 1) large deformation diffeomorphic algorithms outperform in normalizing brains with focal lesions and 2) there is no advantage in using a cost function masking in combination with the algorithms we evaluated.

23. Inventions, Patents and Commercial Development Opportunities.

23(A) Were any inventions, which may be patentable or otherwise protectable under Title 35 of the United States Code, conceived or first actually reduced to practice in the performance of work under this health research grant? Yes_____ No___X_____

If "Yes" to 23(A), complete items a – g below for each invention. (Do NOT complete items a - g if 23(A) is "No.")

a. Title of Invention:

b. Name of Inventor(s):

c. Technical Description of Invention (describe nature, purpose, operation and physical, chemical, biological or electrical characteristics of the invention):

d. Was a patent filed for the invention conceived or first actually reduced to practice in the performance of work under this health research grant?
Yes_____ No___

If yes, indicate date patent was filed:

e. Was a patent issued for the invention conceived or first actually reduced to practice in the performance of work under this health research grant?
Yes_____ No___
If yes, indicate number of patent, title and date issued:
Patent number:
Title of patent:
Date issued:

f. Were any licenses granted for the patent obtained as a result of work performed under this health research grant? Yes_____ No___

If yes, how many licenses were granted?_____

g. Were any commercial development activities taken to develop the invention into a commercial product or service for manufacture or sale? Yes__ No___

If yes, describe the commercial development activities:

23(B) Based on the results of this project, are you planning to file for any licenses or patents, or undertake any commercial development opportunities in the future?

Yes_____ No____X_____

If yes, please describe your plans:

24. Key Investigator Qualifications. Briefly describe the education, research interests and experience and professional commitments of the Principal Investigator and all other key investigators. In place of narrative you may insert the NIH biosketch form here; however, please limit each biosketch to 1-2 pages. *For Nonformula grants only – include information for only those key investigators whose biosketches were not included in the original grant application.*

See the biosketch forms below.

BIOGRAPHICAL SKETCH

NAME	POSITION TITLE
Junghoon Kim, PhD	Institute Scientist

EDUCATION/TRAINING

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
Seoul National University, Seoul, Korea	BA, *Cum Laude*	1991	Psychology
Seoul National University, Seoul, Korea	MA	1995	Psychobiology
The University of Pennsylvania, Philadelphia, PA	PhD	2001	Experimental Psychology
UCLA, Los Angeles, CA	Post-doc	2001-2002	Clinical Neuroscience
Moss Rehabilitation Research Institute and the University of Pennsylvania, Philadelphia, PA	Post-doc	2002-2005	Clinical Neuroscience

A. Personal Statement

Conducting neuroimaging research in stroke population poses substantial methodological challenges due to the complex nature of neuropathology and recovery. Thus, it is desirable that the investigators have expertise in both methodological and clinical aspects of the proposed research. During my training at the University of Pennsylvania and UCLA, I obtained first-hand experience in multiple neuroimaging modalities, including tensor-based morphometry, diffusion tensor imaging, functional connectivity analysis, and perfusion functional MRI. I have also built my clinical/behavioral expertise regarding various neurological populations under the mentorship of senior scientists at the Moss Rehabilitation Research Institute during my post-doctoral years. I am currently interested in various neurorehabilitation issues in traumatic brain injury including the nature of injury-related cognitive deficit, the predictors of functional recovery, and the mechanisms of treatment efficacy. My lab uses state-of-the-art neuropsychological and neuroimaging tools to study these topics. The current research of our lab focuses on 1) understanding the nature and extent of cognitive deficits resulting from TBI, 2) identifying predictors of natural recovery from TBI, and 3) revealing the mechanisms of pharmacological and cognitive interventions for survivors of TBI.

B. Positions and Honors

Positions and Employment

2001-2002 Post-doctoral Fellow, Clinical Neuroscience Lab, Department of Psychology, UCLA, CA

2002-2005 Post-Doctoral Fellow, Moss Rehabilitation Research Institute, Philadelphia, PA and Center for Functional Neuroimaging, University of Pennsylvania, Philadelphia, PA

2005 - Institute Scientist and Director of Rehabilitation Neuroscience Laboratory, Moss Rehabilitation Research Institute, Philadelphia, PA

2007 - Research Assistant Professor, Department of Rehabilitation Medicine, Thomas Jefferson University, Philadelphia, PA

Other Experience

2005 - Ad-hoc reviewer, Archives of Physical Medicine & Rehabilitation, Brain & Cognition, Journal of Rehabilitation, Neuroimage, Neuropsychologia, Psychiatry and Clinical Neurosciences

Honors

1989-1991 Fellowship for Prominent Collegians, Korea Foundation for Advanced Studies, Seoul, Korea

1991 Walden II Fellowship, Department of Psychology, Seoul National University, Seoul, Korea

1995-1997 Fellowship for Study Abroad, Korea Foundation for Advanced Studies, Seoul, Korea
2006 Third place poster in the People's Choice Award at the 18th Annual Research Recognition Day, Albert Einstein Healthcare Network, Philadelphia, PA

C. Selected Peer-reviewed Publications

Kim, J., Glahn, D., Nuechterlein, K., & Cannon, T. (2004). Maintenance and manipulation of information in schizophrenia: Further evidence for impairment in the central executive component of working memory. Schizophrenia Research, 68: 173-187.

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