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):** 1/1/2010 – 12/31/2012

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

4. **Grant Contact Person's Telephone Number:** 215-456-7864

5. **Grant SAP Number:** 4100050886

6. **Project Number and Title of Research Project:** 3 - Longitudinal Multi-modal Neuroimaging of Natural Recovery after Traumatic Brain Injury: A Pilot Study

7. **Start and End Date of Research Project:** 1/1/2010 – 12/31/2012

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

9. **Research Project Expenses**.

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

   $ 40,826.25

   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	PI	10%	9,691
Bognar	Research Asst	5%	2,872
Philip	Research Asst	5%	1,289
Malloy	Research Asst	10%	6,689

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
Avants	Co-Investigator	5%
Whyte	Co-Investigator	1%
Hart	Co-Investigator	1%

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
None		

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:_)	03/2010	$ 1,625,949	$ 1,422,705

The results from this pilot project were not available at the time of the NIH R01 grant application. However, the mere fact that we were conducting a pilot study with the same study design and methodology may have worked favorably for our grant 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:

Encouraged by the award of the NIH grant, we will further continue our longitudinal investigation of neural correlates and predictors of functional recovery in TBI population. 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?

First goal is to successfully complete the NIH study. We have learned many valuable lessons while conducting this pilot project. Based on this experience, we will modify and refine the protocols for our larger NIH project for its successful completion. For unresolved issues, we will continue to make our efforts to reach the best solution.

After the completion of the NIH project, we plan to go one step further in terms of variety, sensitivity, and validity of neuroimaging indices of neuropathology to better examine the relationship between the neural-level changes and functional recovery. For example, our next grant application will adopt better "connection indices." New state-of-the-art imaging measures such as myelin water imaging and high-angular resolution diffusion imaging are

currently being validated by our collaborators at the University of Pennsylvania (Dr. Jongho Lee and Dr. Ragini Verma, respectively).

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.

While conducting this pilot study, we collaborated with the Penn Image Computing Science Lab. Their cutting-edge imaging data analysis techniques are likely to influence the way other labs at the Moss Rehabilitation Research Institute analyze their data.

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:

The Penn Image Computing Science Lab provides imaging data analysis consultation for our project. This collaboration is already producing fruitful results, including a published article.

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 agreement). Summarize the progress made in achieving these goals, objectives and aims for the period that the project was funded (i.e., from project start date through end date). 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. Provide 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 Aims

We originally proposed three aims:

1. To demonstrate, under our recruitment and neuroimaging infrastructure, the feasibility of longitudinal, multi-modal neuroimaging data collection to study neural recovery after traumatic brain injury (TBI).
2. To develop and validate the "recovery potential index" that is based on the difference between structural and functional imaging measures obtained at different points of post-injury.
3. To estimate, for each neuroimaging modality, the sample size necessary to demonstrate longitudinal changes between 3 and 6 months. The largest sample size estimated will be used for planning the large-scale study to be proposed to the NIH.

Achieved Aims, Methods, and Results

1. We have successfully achieved Aim 1, by demonstrating that it is feasible, under our recruitment and neuroimaging infrastructure, to collect longitudinal and multi-modal neuroimaging data to investigate neural recovery after TBI. In total, we have thus far tested six patients both at 3- and 6-month post-injury. We will continue data collection under the new NIH grant. This pilot grant greatly helped us in refining our recruitment and screening strategies. For example, the frequency of the research staff meetings has

been adjusted. In addition, monthly consenting and testing accrual rates are being monitored and the reasons behind patient ineligibility and patient withdrawal from the study are discussed in the weekly meetings.

2. We attempted to build recovery potential index in our patients in order to assess the validity of the index. However, we encountered an obstacle that we did not expect at the planning phase—i.e., a thresholding issue across structural and functional images. Depending on which threshold levels are used (e.g., $p < .05$ or $p < .01$), the extent of the affected regions greatly varied. It seems that the issue gets exacerbated when a small set of controls are used. A better method of operationally defining structure-function discrepancy is warranted in the future.

3. We have successfully achieved Aim 3, by calculating the sample size under the framework of linear mixed effect model. Based on previous studies, we selected the thalamus as a TBI-relevant region of interest. We quantified, for each subject and each time point, the mean CBF, FA and volume in thalamus. We then used a standard approach based on the R^2 to assess the sample size for a regression model including an imaging variable, education and time since injury (see Equation 1 below). We set alpha = 0.05 and desired power at 0.8. Results show that 17 subjects are required for the volumetric measurement, 17 for a FA measurement and 8 for the CBF measurement to achieve the target power. Similarly, we tested the power of the three imaging variables to predict a mean improvement of 14 in processing speed index from 3 to 6 months post-injury. Results showed that 26 subjects are required for the volumetric measurement, 18 for a FA measurement and 13 for the CBF measurement to achieve the target power. Given these results, we are confident that our sample size for the larger NIH grant (i.e., 44 subjects) is adequate.

4. After achieving these aims, we went one step further and related changes in imaging indices to improvement in function measured by Disability Rating Scale. This type of analysis is not possible in a small sample. However, with our powerful and unbiased longitudinal multivariate approach (i.e., sparse canonical correlation analysis for neuroimaging) that we originally developed to detect the longitudinal changes in Alzheimer's disease (Avants et al., 2010a; 2010b), we were able to demonstrate some significant changes in volume reduction to functional recovery. The following is a detailed description of the analysis.

Introduction: We imaged 6 TBI survivors at ~3 months post-injury with a follow-up of ~6months post-injury, collecting both T1 and DT MRI of the brain. These preliminary findings illustrate our ability to accurately identify and quantify the longitudinal atrophy in this cohort. We report mean atrophy rate in brain regions that undergo rapid change post-TBI and associate these findings with the subject's disability rating scale (DRS).

Image Processing: We employed Advanced Normalization Tools (ANTs) to process the DTI and T1 neuroimaging in a manner appropriate to longitudinal imaging. Unbiased registration maps multiple modality subject spatiotemporal datasets into a common template space. Within this template space, we extracted the log-jacobian as a measure of structural volumetric change over

time and the fractional anisotropy (FA) from the DTI in order to estimate change in white matter integrity. We masked these complementary metrics within the cerebrum and accumulated their values into a data matrix for further analysis within the R statistical environment. We excluded subject p003 due to poor image quality in the follow-up DT image.

Demographics: The subject's average age was 24.3+/-5.5 with average duration from injury 0.28 +/- 0.04 years and time to follow-up of 0.26 +/-0.05 years. All subjects were male with mean education 12.1 +/- 1.8 years and DRS 3.8 +/- 2.7.

Statistical analysis: We decomposed the dense voxel-wise neuroimaging metrics into regions that capture a large portion (~75%) of the total variation in the population while using less than 5% of the brain. The SCCAN tool extracts 5 eigenanatomy regions of interest for each measurement, volume and FA. An eigenanatomy region is an automatically determined region of interest with sparse (mostly zero) spatially varying weights. We choose eigenanatomy over standard region of interest analysis to increase detection power which ensues from increased sensitivity to population specific effects, reduced sensitivity to noise and automation (optimally assigned weights).

We tested hypothetical relationships between traumatic brain injury and longitudinal brain changes, as measured by eigenanatomy, within the R statistical environment. Linear mixed effects (LME) allow one to statistically describe both within-subject variability and between subject variability within the same model. We used LME to compare the following nested models:

Model1 = ChangeInVolumeOrFA ~ SubjectIntercept + Age + TimeSinceInjury + Edu
+ TimeInterval

Model1 = ChangeInVolumeOrFA ~ SubjectIntercept + Age + TimeSinceInjury + Edu
+ TimeInterval + DRS

Equation 1. Linear mixed effects model to relate imaging changes to behavioral improvement

In several brain regions, ANOVA revealed that Model2 gives a significantly better fit when compared to Model1. Within these brain regions, the annualized atrophy rate averaged 2.6%. These gray matter regions include frontal and cingulate cortex. Figure 1 illustrates the regions. No changes in FA were significantly predictive though one orbitofrontal region showed a trend, not significant after FDR correction (0.088).

<u>Summary</u>

Due to an issue of optimal thresholding, Aim 2 of our original plan has not been fully achieved. However, we have successfully achieved Aim 1 and 3, demonstrating that 1) our infrastructure and protocols for data acquisition and analysis are appropriate for conducting this longitudinal imaging study; and 2) the sample size proposed for the NIH study is adequate. In addition to achieving these aims, we went one step further and first 1) identified and reviewed various methodological issues in longitudinal imaging studies including power and bias and 2) applied

our powerful and unbiased longitudinal multivariate analysis protocol (i.e., sparse canonical correlation analysis for neuroimaging) to a small TBI sample (see item 20 for a peer-reviewed publication).

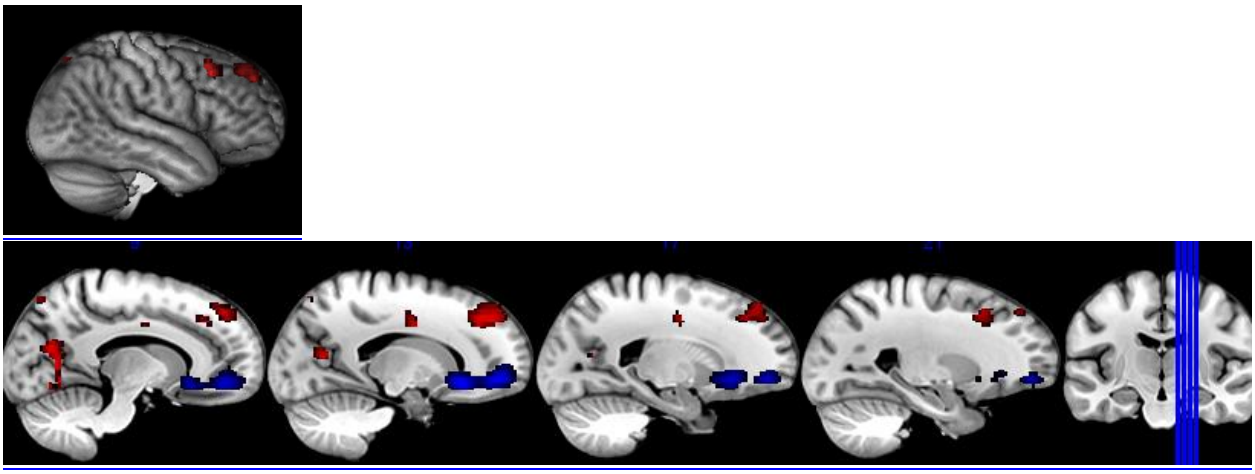

Figure 1. Red areas include frontal pole, superior frontal gyrus, insula, and parahippocampal gyrus. The improvements of DRS score were significantly associated with the magnitude of volume reduction in these areas across 3 and 6 months post-injury. Areas with FA change related to DRS are shown in blue.

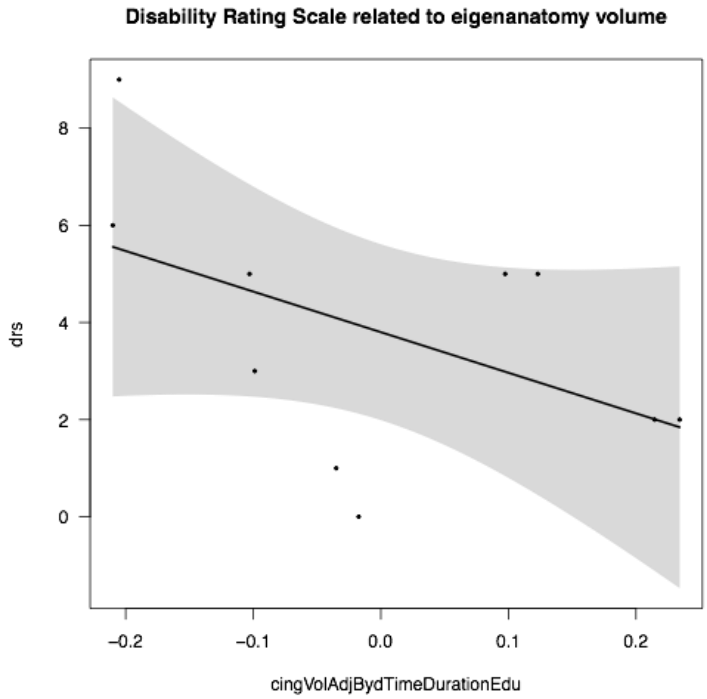

Figure 2. A scatterplot revealing the relationships between disability rating scale and volume in frontal lobe and cingulate cortex

References

Avants, B., Cook, P.A., Mcmillan, C., Grossman, M., Tustison, N.J., Zheng, Y., and Gee, J.C. (2010a). Sparse unbiased analysis of anatomical variance in longitudinal imaging. *Med Image Comput Comput Assist Interv* 13**,** 324-331.

Avants, B.B., Cook, P.A., Ungar, L., Gee, J.C., and Grossman, M. (2010b). Dementia induces correlated reductions in white matter integrity and cortical thickness: a multivariate neuroimaging study with sparse canonical correlation analysis. *Neuroimage* 50**,** 1004-1016.

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 or paper submitted for publication, listed in the table, in a PDF version 5.0.5 (or greater) 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. Methodological considerations in longitudinal structural morphometry of traumatic brain injury	Kim, J., Avants, B. B., Whyte, J., & Gee, C. G.	Frontiers in Human Neuroscience	08/2012	☐Submitted ☐Accepted ☒Published

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:

One perspective article in Frontiers in Human Neuroscience has been published. The reported results from this pilot study will be combined with that of the larger NIH study and then submitted to a peer-reviewed journal in the future.

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 type of longitudinal studies are expected to increase our understanding of the natural recovery process from individuals with TBI. This will allow us to identify the key mechanisms underlying "good" recovery, consequently guiding rehabilitation efforts to target and influence the relevant processes more efficiently.

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.

None.

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.

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 longitudinal neuroimaging research in TBI poses substantial methodological challenges due to the complex nature of neuropathology and recovery. Thus, it is desirable that the principal investigator has 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 the TBI population under the mentorship of Drs. Whyte and Hart during my post-doctoral years at the Moss Rehabilitation Research Institute. Thus, I am confident that I have the right combination of expertise to conduct the proposed research successfully. I also believe that I have assembled the very best team of experts who can help me to lead this project to success. My collaborators are established scholars in their fields and can consult on solutions to any medical (Drs. Whyte and Coslett), neuropsychological/behavioral (Drs. Hart and Whyte), and neuroimaging data analysis (Drs. Avants, Gee, Wang, and Detre) issues. In fact, we have completed many preliminary studies that laid the groundwork for the proposed research. For example, we are the first group who utilized tensor-based morphometry to quantify the whole brain volume changes in TBI with unprecedented precision. We were also the first to use perfusion fMRI to assess hypoperfusion in a large group of chronic TBI survivors. We also have one of the best image registration methods (demonstrated by a third-party large-scale evaluation study) to morph images collected at different time points (and with different imaging methods) into one standard space, which will greatly facilitate the integration of data across time and imaging modalities. In conclusion, I and my research team have the right expertise, the appropriate tools, and demonstrated preparedness to tackle the questions posed by the proposed research.

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, Neuropsychologia

Honors

2011, Early Career Investigator Travel Award, the 10th International Neurotrauma Symposium, Shanghai, China

2006, Third place poster in the People's Choice Award at the 18th Annual Research Recognition Day, Albert Einstein Healthcare Network, Philadelphia, PA

1995-1997, Fellowship for Study Abroad, Korea Foundation for Advanced Studies, Seoul, Korea

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

1991, Cum Laude, Department of Psychology, Seoul National University, Seoul, Korea

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

C. Selected Peer-reviewed Publications

Kim, J., Avants, B. B., Whyte, J., & Gee, C. G. (in press). Methodological considerations in longitudinal structural morphometry of traumatic brain injury. Frontiers in Human Neuroscience.

Tustison, N. J., Avants, B. B., Cook, P. A., **Kim, J.**, Whyte, J., Gee, J. C., & Stone, J. R. (in press). Logical circularity in voxel-based analysis: Normalization strategy may induce statistical bias. Human Brain Mapping.

Schwartz, M. F., Faseyitan, O., **Kim, J.**, & Coslett, H. B. (2012). The dorsal stream contribution to phonological retrieval in object naming. Brain, 135: 3799-3814.

Kim, J., Whyte, J., Patel, S., Europa, E., Slattery, J., Coslett, H. B., & Detre, J.A. (2012). A perfusion fMRI study of the neural correlates of sustained attention and working memory deficits in chronic traumatic brain injury. Neurorehabilitation and Neural Repair, 26: 870-880.

Kim, J., Whyte, J., Patel, S., Europa, E., Wang, J., Coslett, H. B., & Detre, J.A. (2012). Methylphenidate modulates sustained attention and cortical activation in survivors of traumatic brain injury: A perfusion fMRI study. Psychopharmacology, 222: 47-57.

Kim, J., Whyte, J., Patel, S., Avants, B., Europa, E., Wang, J., Slattery, J., Gee, J. C., Coslett, H. B., & Detre, J. A. (2010). Resting CBF alterations in chronic traumatic brain injury: An arterial spin labeling perfusion fMRI study. Journal of Neurotrauma, 27: 1399-1411. [Cover Article]

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