Optimizing fPET-FDG

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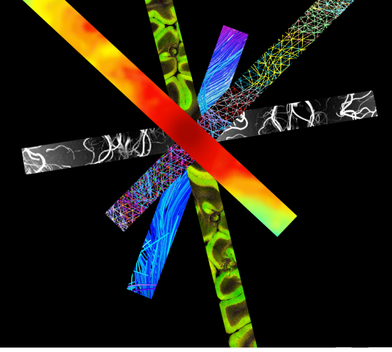


Background

Measuring changes in cerebral glucose metabolism with PET

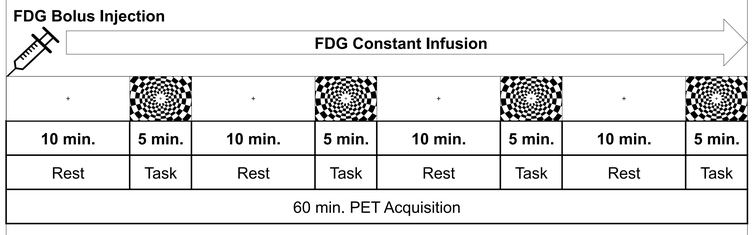
- Measuring **dynamic** changes in glucose metabolism could unearth new details about how metabolic changes influence cognitive processes like working memory and attention
- 2-[^{18}F]-fluorodeoxyglucose (FDG) is a radiotracer that acts as an **analogue for glucose** in the brain
- The development of **fPET-FDG** showed for the first time that multiple **task-specific changes in glucose metabolism** can be measured in a single PET scan[1,2]
- The original fPET-FDG method required a **20-30 minute equilibration period** before any task-stimulus could be displayed, and a 90-minute long scan

Hypothesis

We hypothesized that with an **improved protocol** for the administration of the FDG radiotracer, we could detect task-specific changes in FDG signal at **earlier time points** than was previously possible with fPET-FDG

Methods

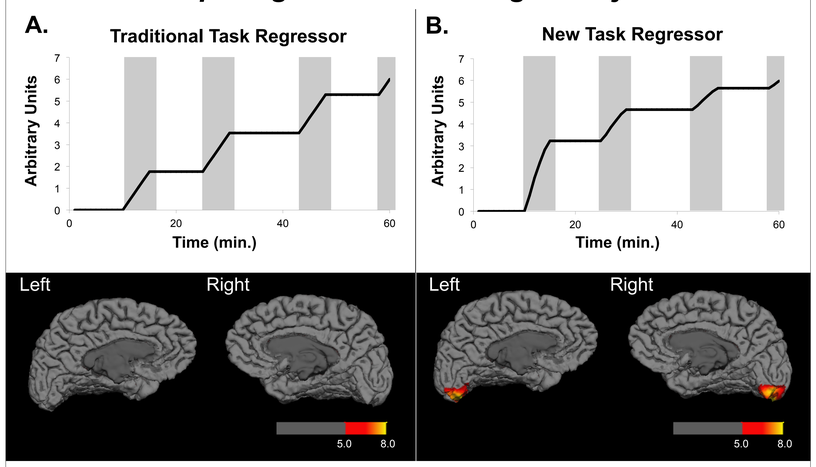
Experimental Procedure



- Participants were scanned using a simultaneous MR/PET scanner for 60 minutes
- FDG was administered via a **bolus plus continuous infusion** (B/I) protocol (K_{bol} = 60 min.)
- Participants alternated viewing a fixation cross on a blank screen (rest period) with a flashing checkerboard pattern (task period)

Results

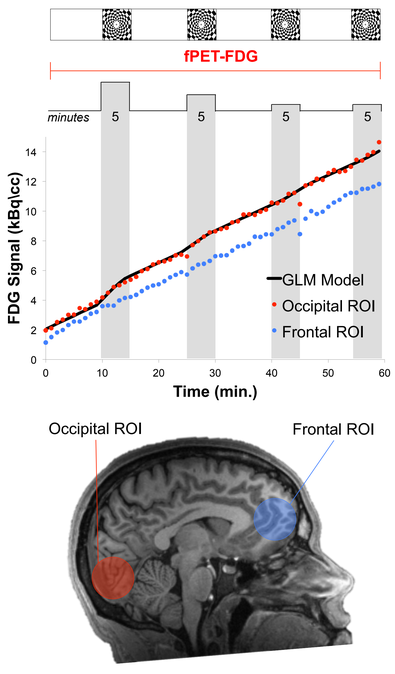
Comparing Models in a Single Subject



(A) The traditional GLM predicted identical levels of activation for every task. No voxels significantly matched this model.

(B) The new GLM predicted increased activation for early tasks. Clusters of voxels in area V1 of the visual cortex match this model.

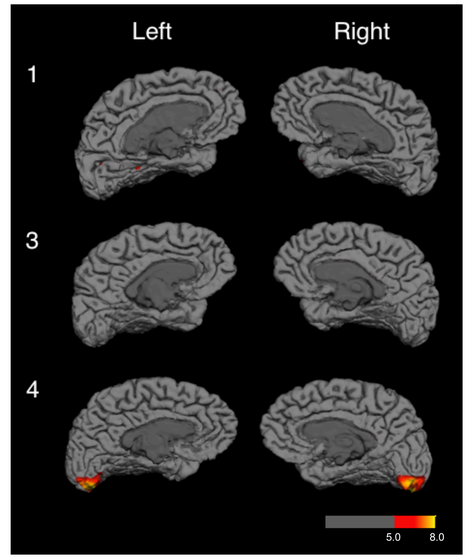
Single Subject Fit to the New GLM



- FDG signal over time is plotted here for two regions of interest (ROIs): one in the frontal lobe, and one in the occipital lobe.
- Overall, there was increased FDG signal in the occipital ROI compared to the frontal ROI
- Task-specific increases in FDG signal were modeled by the GLM in the occipital ROI, but not in the frontal ROI
- Task-specific changes in FDG signal were greater in magnitude at earlier time points than those at later time points, just as our new regressor predicts

Results

fPET-FDG Activation Maps



Subject Information

Subject	BMI (kg/m^2)	Baseline Glucose Level (mg/dL)
1	31.5 Obese	102 High
3	28.9 Overweight	99 Normal
4	23.1 Normal Weight	77 Normal

Summary

- Subject 2 excluded due to motion
- Subjects 1 and 3 were overweight, and had resting blood glucose levels on the high side of the normal range
- Statistical maps show significant task specific increases in FDG signal in area V1 of the visual cortex in subject 4, but no activation in subjects 1 or 3

Discussion

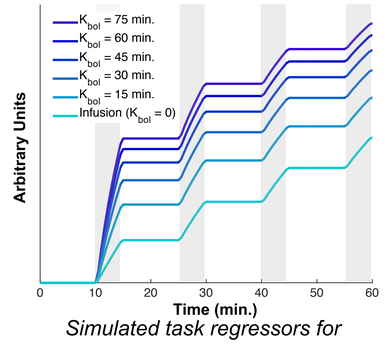
Explaining the Results

- Individual differences could be caused by biology or by the experimental design
  - The subjects who showed no activation were both overweight
  - Our ability to detect signal-change at late time points may be reduced because of the B/I protocol

Future Work

- Repeat with a different K_{bol}
- Use shorter/more frequent tasks
- Investigate dynamic changes in glucose metabolism during cognitive tasks of memory and attention in both healthy and unhealthy populations

Early/Late Time-point Tradeoff



Simulated task regressors for various K_{bol} values

Acknowledgements & References

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[1] Villien, M., Wey, H.-Y., Mandeville, J. B., Catana, C., Polimeni, J. R., Sander, C. Y., … Hooker, J. M. (2014). Dynamic functional imaging of brain glucose utilization using fPET-FDG. NeuroImage, 100, 192–199. https://doi.org/10.1016/j.neuroimage.2014.06.025 **[2]** Hahn, A., Gryglewski, G., Nics, L., Hienert, M., Rischka, L., Vraka, C., … Lanzenberger, R. (2016). Quantification of Task-Specific Glucose Metabolism with Constant Infusion of 18F-FDG. Journal of Nuclear Medicine, 57(12), 1933–1940. https://doi.org/10.2967/jnumed.116.176156