

Visual-spatial and working memory in breast cancer patients: an fMRI study

Amélia Suddaby, B.Sc. in Psychology – Supervisor: Dr. Andra Smith, PhD

Introduction

Over the last decade, the term “chemo fog” has drawn more and more interest from researchers as well as breast cancer patients. This phrase refers to the post-chemotherapy cognitive impairment often experienced by breast cancer survivors. Women having undergone chemotherapy have been complaining of various cognitive difficulties, including problems with executive functions, working memory, attention and concentration^{1,2,3}. Although there is much controversy surrounding whether or not post-chemotherapy cognitive fog actually exists, several studies over the past few years have suggested that it is likely not a myth. The present study focused on establishing empirical evidence of such impairment through the use of functional Magnetic Resonance Imaging (fMRI). Patients were matched with controls and fMRI was performed during working memory and visual-spatial working memory tasks, before and after the patient’s chemotherapy. Expectations were that there would be a significant decline in performance and significantly more neural activation in parts of the brain typically not associated with working or visual-spatial memory in breast cancer patients post-chemotherapy.

Contact information

For any questions regarding this study, please contact Dr. Andra Smith at asmith@uottawa.ca

References:

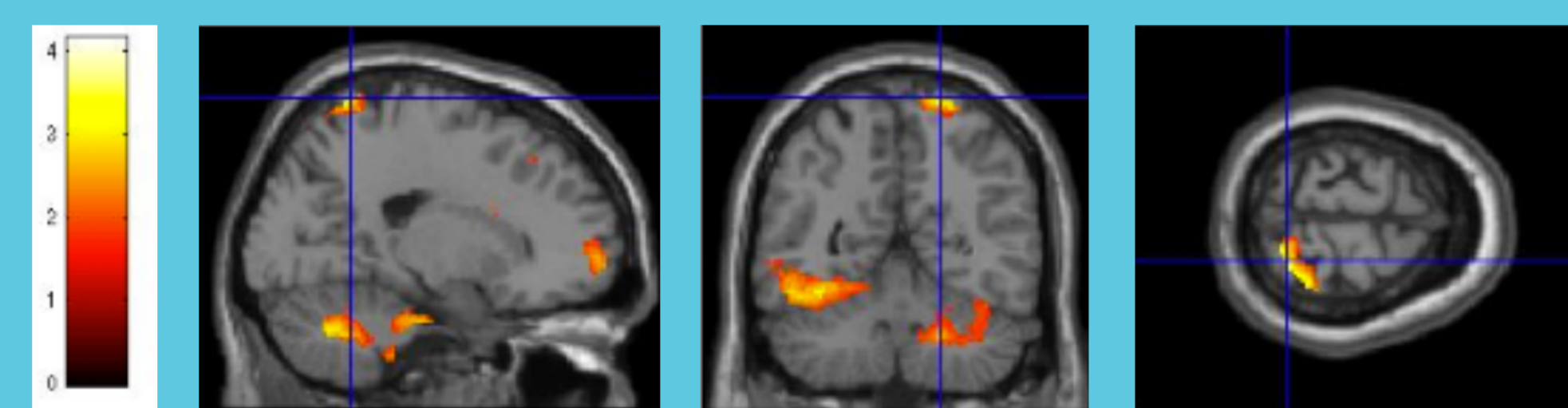
1. Ahles T.A., & Saykin A.J. (2002). Breast Cancer Chemotherapy-Related Cognitive Dysfunction. *Clinical Breast Cancer*, 3, S84-S90.
2. Janelsins M.C., Kohli S., Mohile S.G., Usuki K., Ahles T.A., & Morrow G.R. (2011). An Update on Cancer- and Chemotherapy-Related Cognitive Dysfunction: Current Status. *Seminars in Oncology*, 38, 431-438.
3. Scherling C., Collins, B., MacKenzie J., Bielajew C., & Smith, A. (2011). Pre-chemotherapy differences in visuospatial working memory in breast cancer patients compared to controls : an fMRI study. *Frontiers in Human Neuroscience*, 5. doi: 10.3389/fnhum.2011.00122
4. Smith, A.M., Longo C.A., Fried P.A., Hogan M.J., & Cameron I. (2010). Effects of marijuana on visuospatial working memory: an fMRI study in young adults. *Psychopharmacology*, 210, 429-438. doi: 10.1007/s00213-010-1841-8

Results

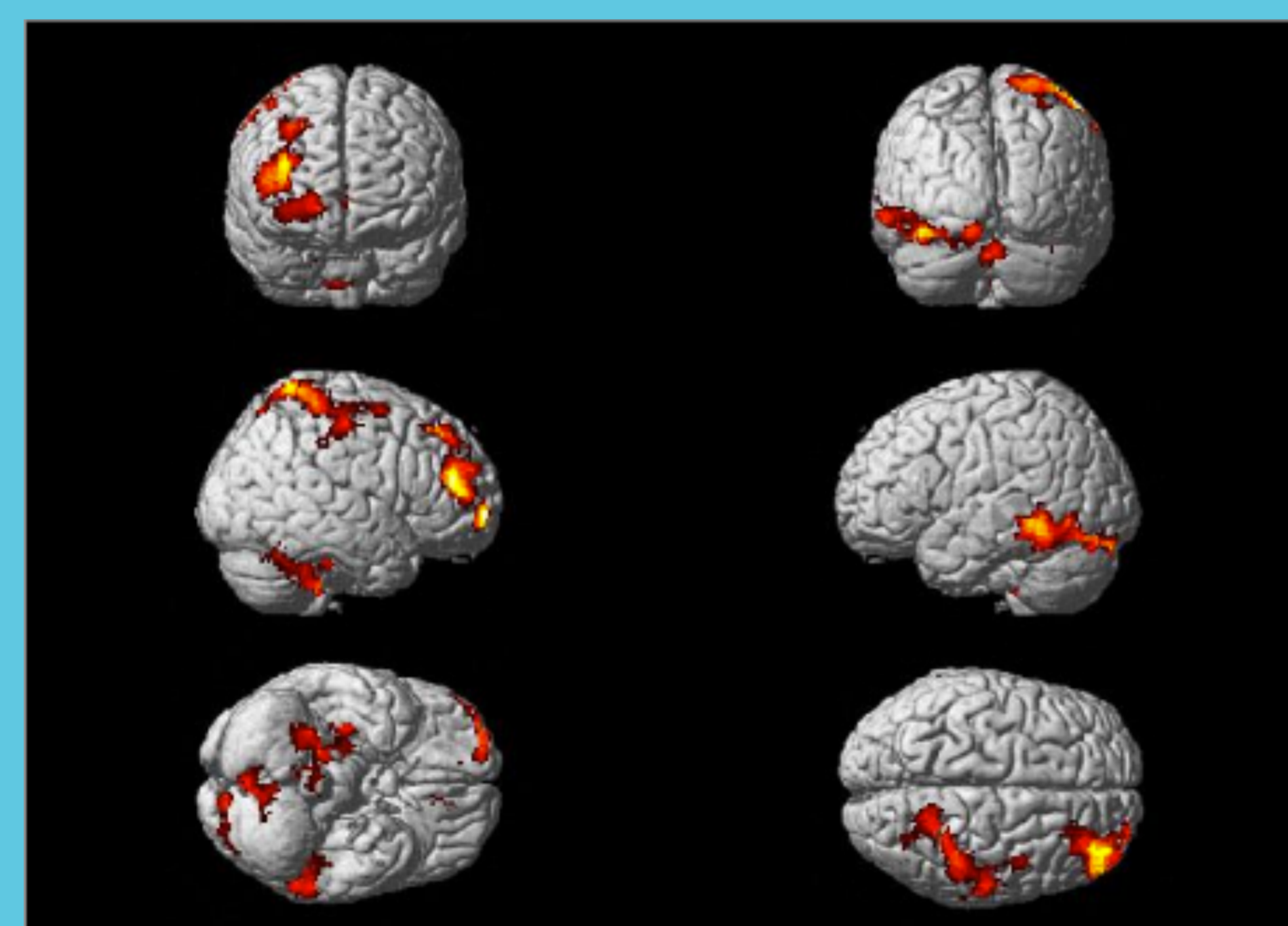
Working memory (Letter N-back)

There were no significant differences in errors or reaction times between time 1 (before chemotherapy) and time 2 (after chemotherapy) for breast cancer patients.

The imaging data found significantly more neural activation in time 1 than in time 2 in the left inferior temporal gyrus, Brodmann areas 18 and 37, the right post central gyrus and the right superior parietal lobule.



Letter N-back ROIs
Time 1-2

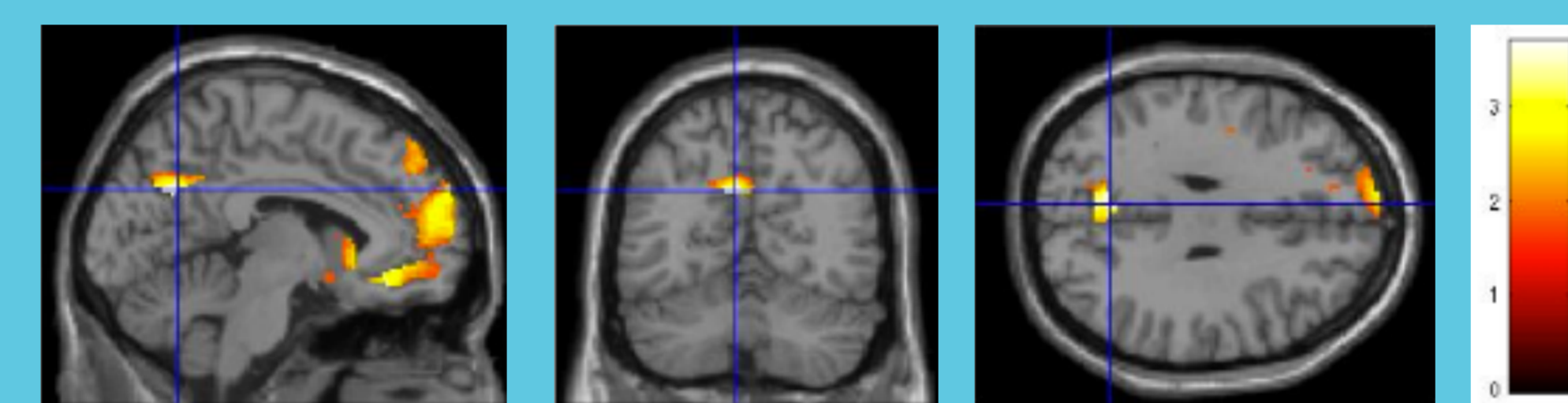


Render of letter N-back ROIs
Time 1-2

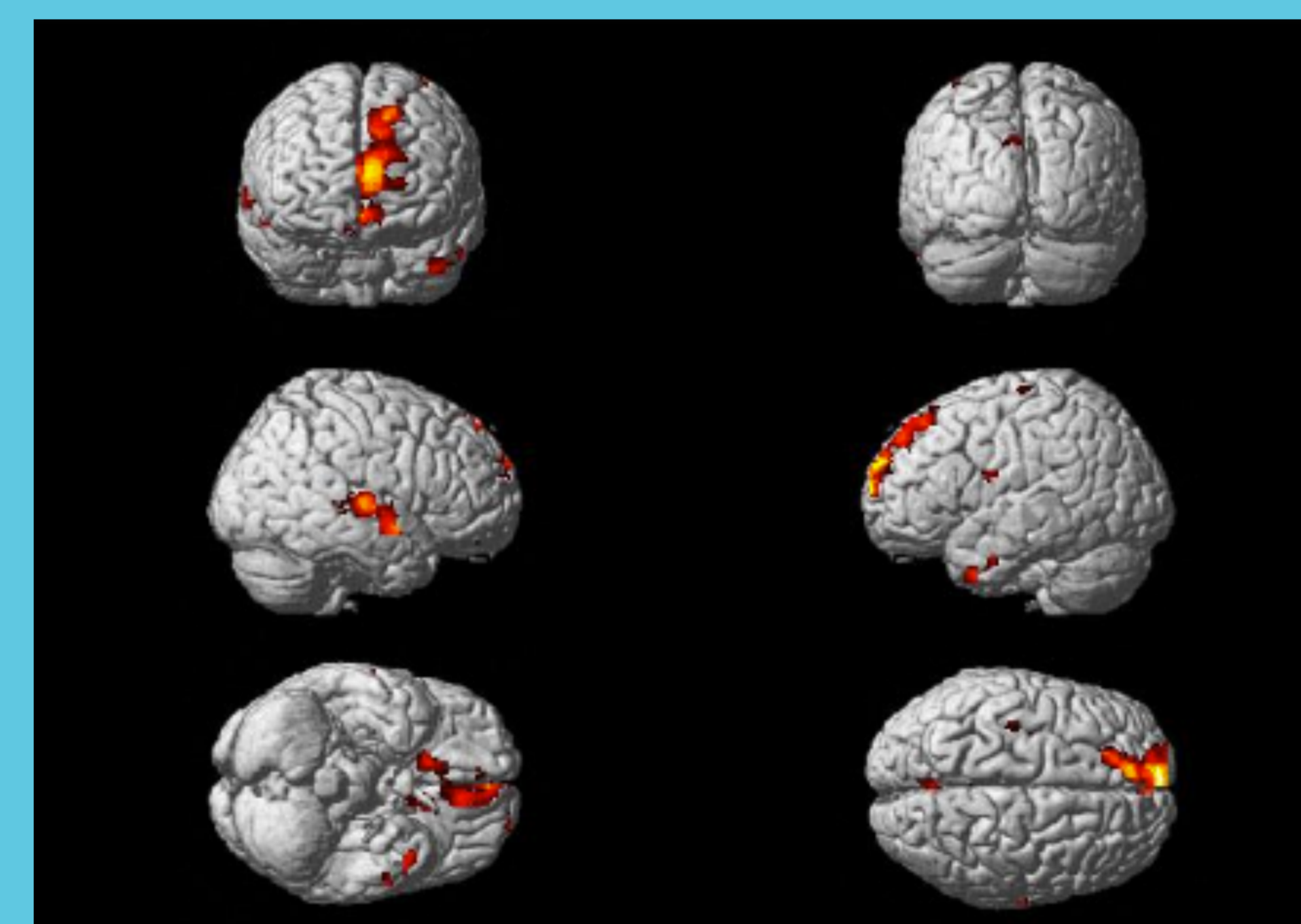
Visual-spatial memory (Visual-spatial N-back)

Patients made significantly fewer omission errors and had a significantly higher percentage of correct answers following chemotherapy.

There was significantly higher neural activation in patients after chemotherapy in the following areas: the temporal pole, Brodmann areas 8, 10, 21 and 38, the left frontal medial orbital gyrus, the left superior frontal gyrus, the subcallosal gyrus, the left caudate, the left frontal superior medial gyrus, the left precuneus and the pre-central gyrus. The area of the brain showing the most significant activation was the left precuneus.



Visual-spatial N-back precuneus and medial frontal ROIs
Time 2-1



Render of visual-spatial N-back ROIs
Time 2-1

Discussion

Working memory (Letter N-back)

Performance results from the letter N-back task show no significant differences in performance before and after chemotherapy. However, there is significant evidence of certain neural pathways being more activated before chemotherapy, which is contrary to the expected results. Perhaps the patients were showing a practice effect as they had already performed the task once before.

Visual-spatial memory (Visual-spatial N-back)

Patients performed significantly better after chemotherapy during the visual-spatial N-back task. However, a rather large number of brain regions were significantly more activated in time 2 compared to time 1, which indicates that although patients performed better after chemotherapy, they required the use of more of their brain to do so. It is also important to keep in mind that the significantly higher performance results may have been influenced to a certain degree by a practice effect.

Method

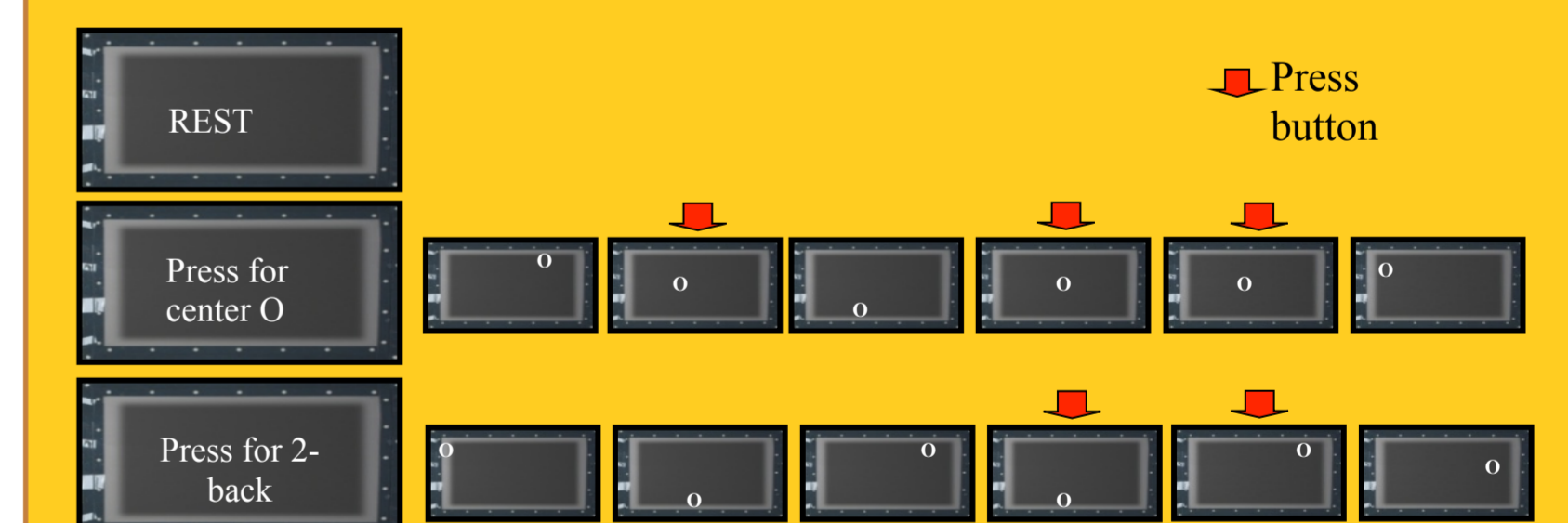
Participants: 21 early stage female breast cancer patients ranging in age from 35 to 64 years old were recruited through the Ottawa Hospital Regional Cancer Center and scanned before and after chemotherapy.

Inclusion/Exclusion criteria: No previous cancer diagnosis or cancer treatment, no claustrophobia, no history of mental illness or substance abuse, fluency in English, no metal implants or pacemakers and no sight problems.

Measures: Performance and neural activation were measured during a working memory letter N-back task and a visual-spatial memory N-back task.

Procedure: Patients underwent a variety of tasks during an hour-long MRI/fMRI scan. The Letter N-back task was the first in the series of tasks performed by patients and consisted of a series of white letters projected on a black screen. Patients were asked to press the finger pad when they were shown a letter that was shown two letters before (2-back).

The visual-spatial N-back task was the last task performed and was similar to the letter N-back task but included a visual-spatial element, whereby the stimuli were white circles presented in 1 of 9 positions at a time and patients were asked to press when the circle was in a position similar to that presented 2 positions before.



Statistical analyses: Performance and imaging data were analyzed using two-tailed, paired-sample t-tests with $p=0.05$ in SPSS (Statistical Package for the Social Sciences) and SPM (Statistical Parametric Mapping), respectively.

Summary

These results show that chemotherapy affects neural processing. This impact is different depending on the type of processing being tested. Further research is required to identify the neural mechanisms of chemo fog.

Acknowledgments:

Thanks are due to Dr. Andra Smith and the UROP office.