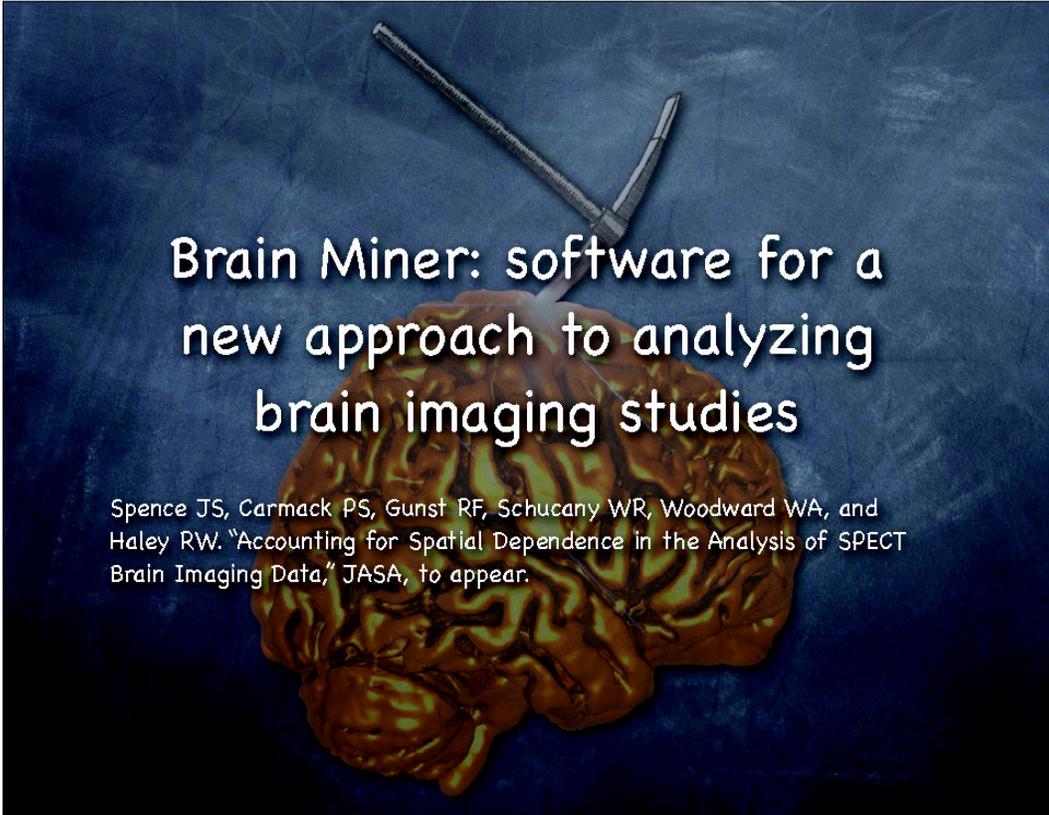


Presentation 3 - Jeffrey Spence



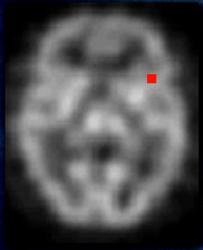
Brain Miner: software for a  
new approach to analyzing  
brain imaging studies

Spence JS, Carmack PS, Gunst RF, Schucany WR, Woodward WA, and  
Haley RW. "Accounting for Spatial Dependence in the Analysis of SPECT  
Brain Imaging Data," JASA, to appear.

UT Southwestern and SMU  
Brain Mining Development Team



## What Brain Miner accomplishes



 **Data reduction:** due to spatial correlation, neighboring voxels give redundant information about measured signal

 **How?** group voxels together and average them in a manner that is statistically optimal

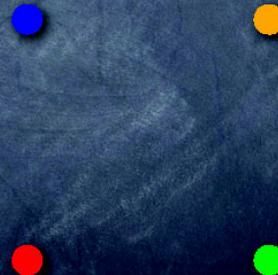
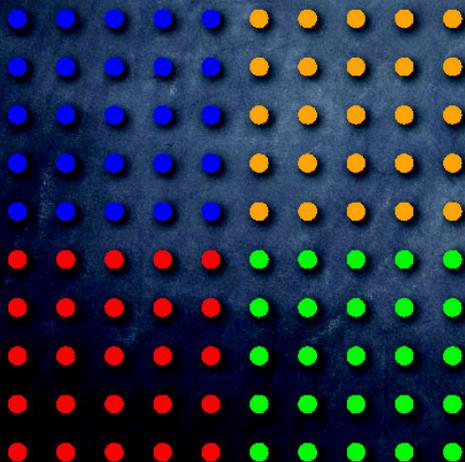
 **What is gained?** POWER! There is statistical power in averages

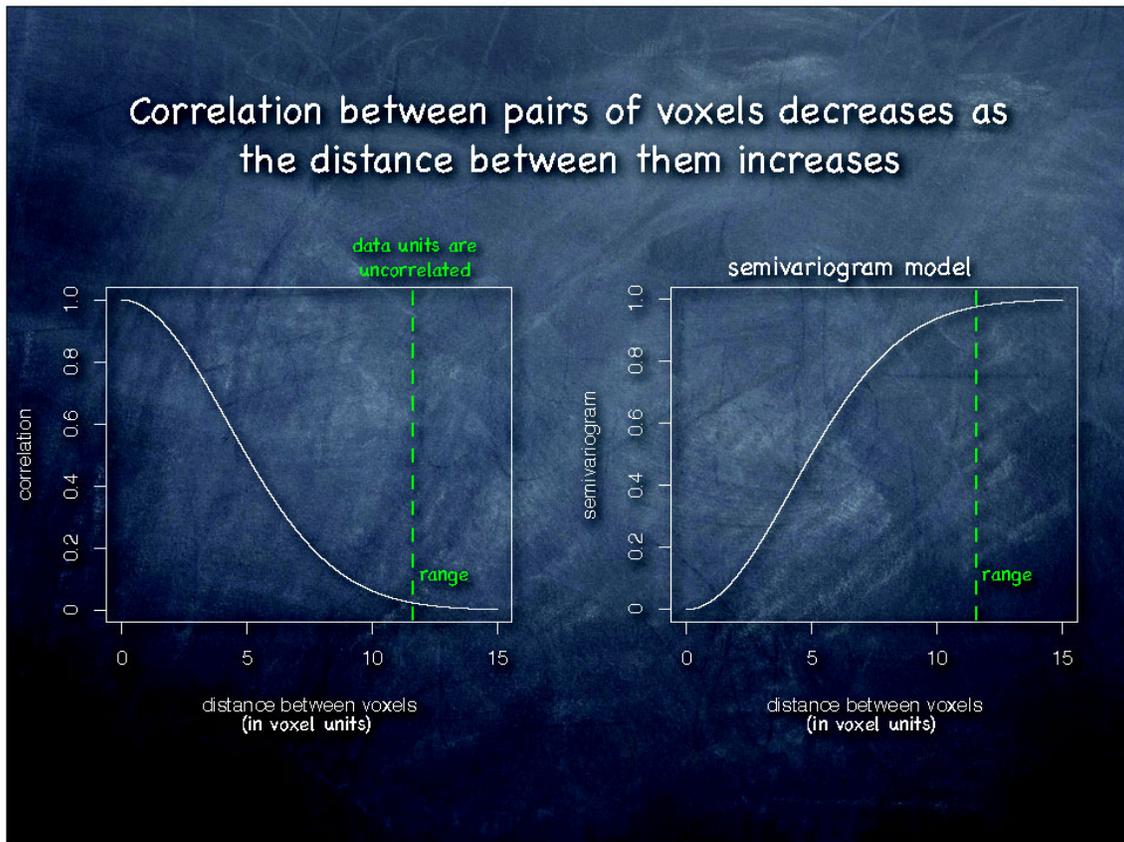
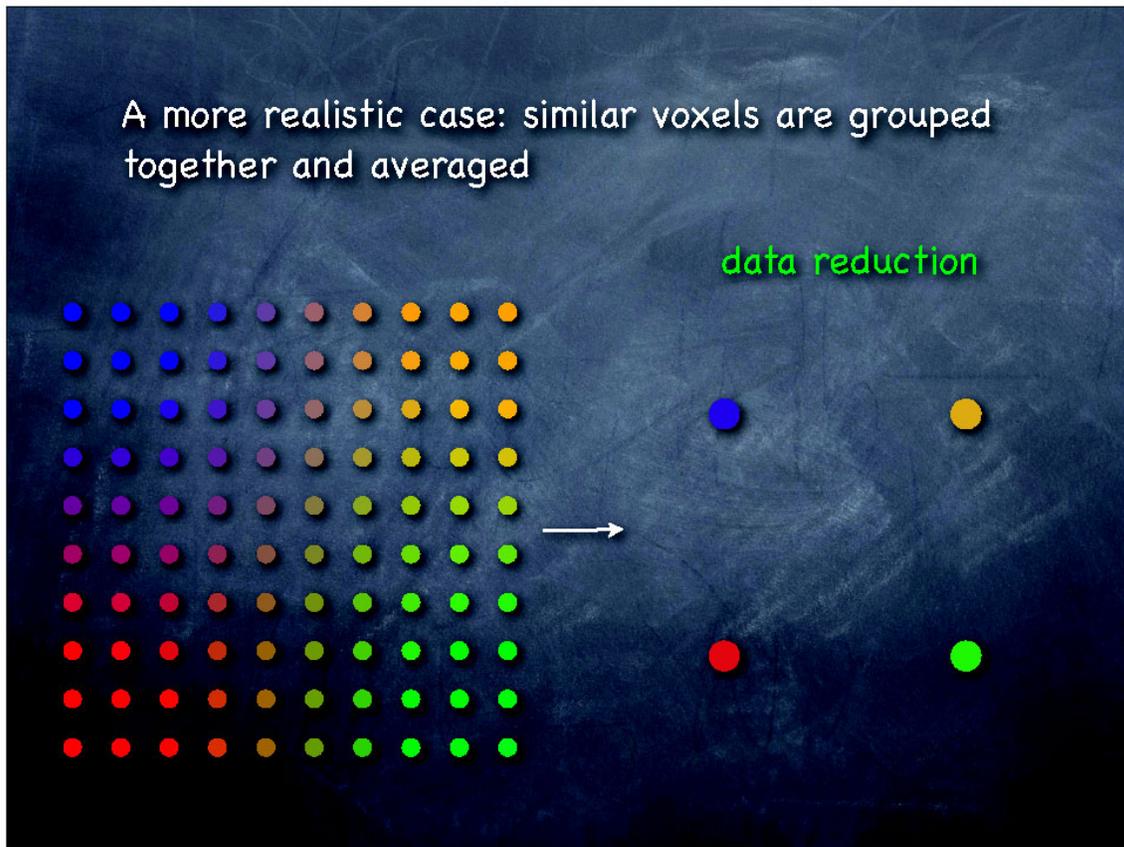
 **Independence of statistical errors:** the reduced data units are spatially uncorrelated

 **What is gained?** Flexibility! The output can be exported to well-known software packages (e.g., SAS)

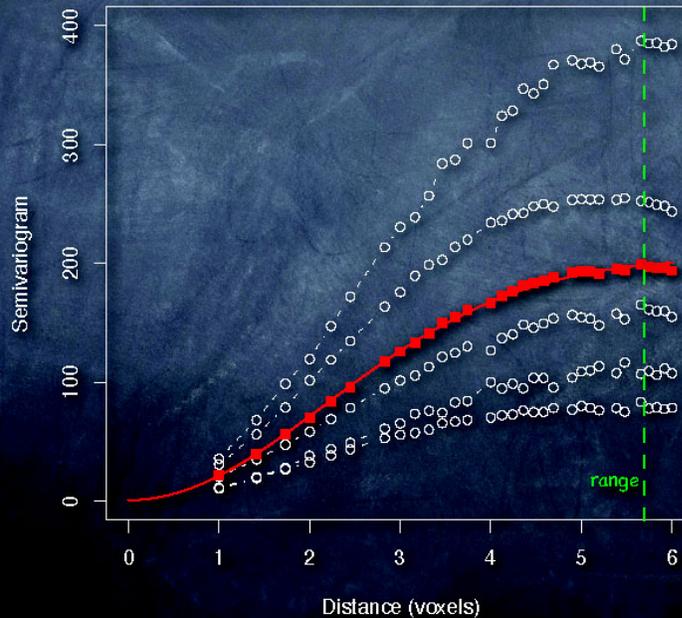
An ideal case: redundant voxels are grouped together and averaged

data reduction





## Semivariogram estimates in the right putamen from five GW veterans and the group average

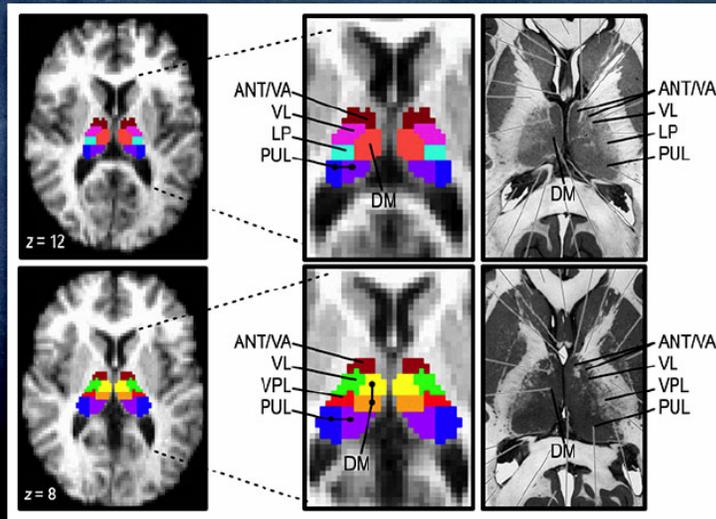


## Two ways of grouping correlated voxels together

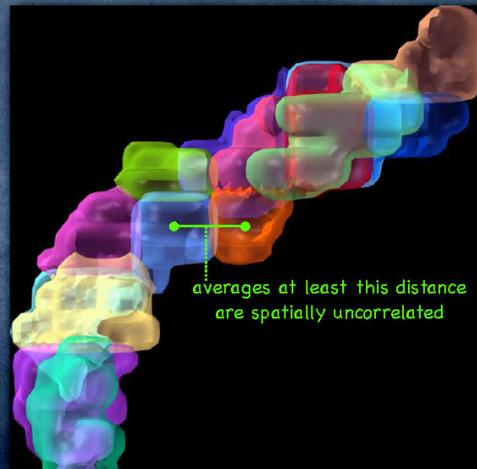
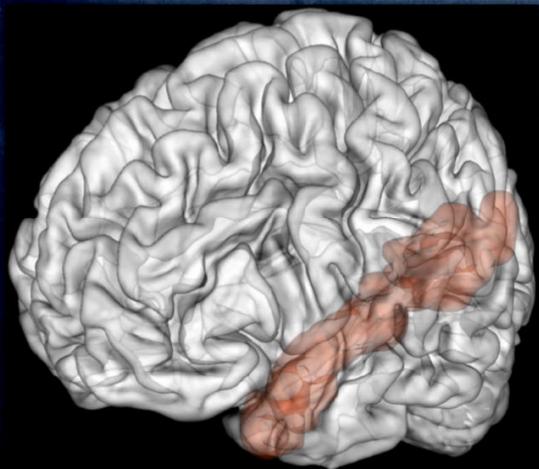
- 🍌 Group voxels within a region of interest based on known **functional anatomy** AND **range** of correlation
  - 🍌 e.g. anatomic grouping within the thalamus
- 🍌 Group voxels within a region of interest based only on **range** of correlation
  - 🍌 e.g. automated grouping within a cortical region

## Grouping voxels together in the thalamus

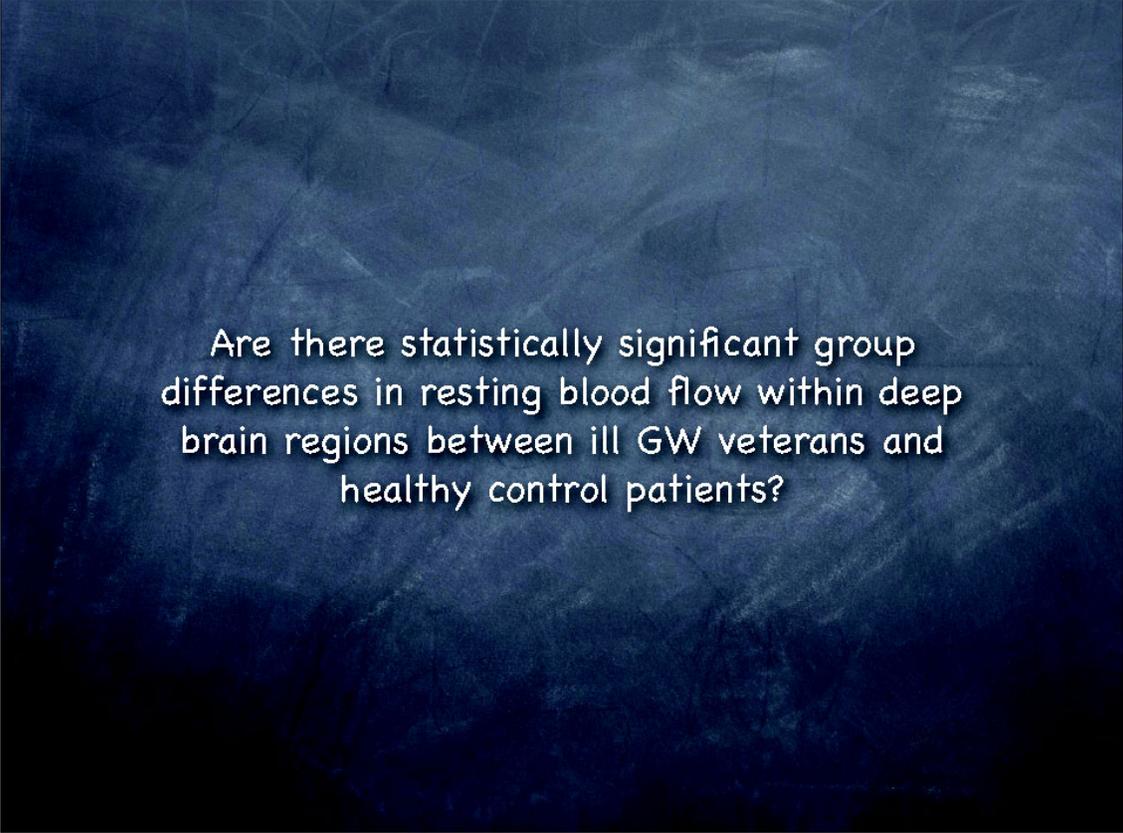
Each group of correlated voxels satisfies the range criterion but also fits the nuclear substructure



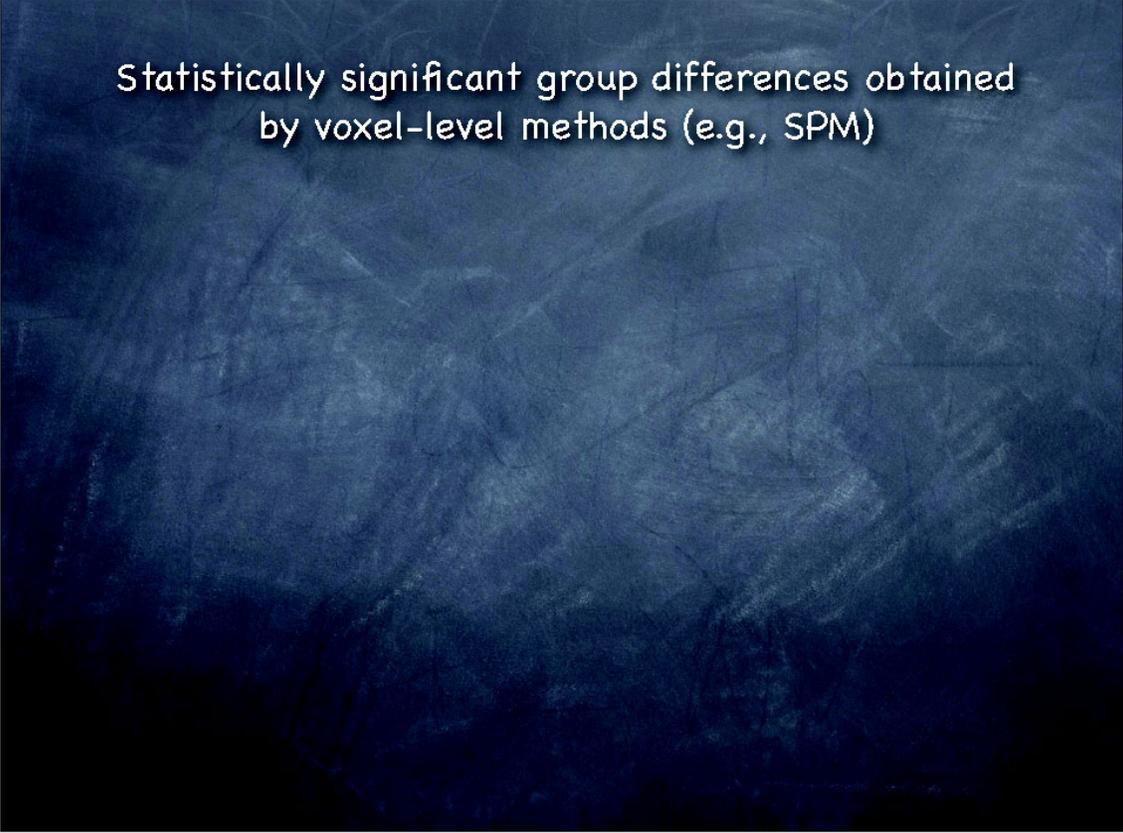
## Automated grouping of voxels in the superior temporal gyrus



Where there is no anatomic substructure of interest, the grouping is done based on the range criterion only



Are there statistically significant group differences in resting blood flow within deep brain regions between ill GW veterans and healthy control patients?

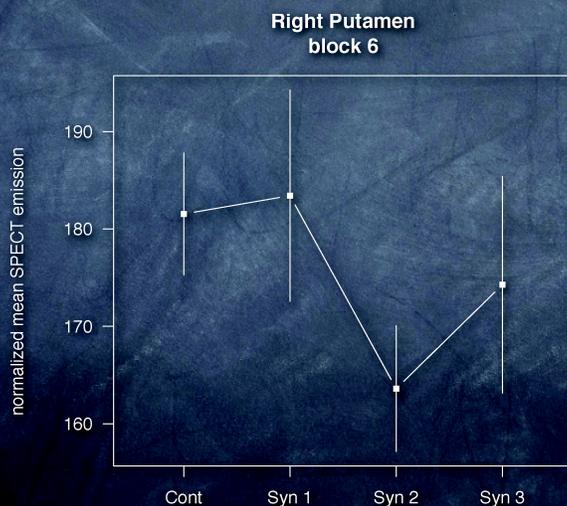


Statistically significant group differences obtained by voxel-level methods (e.g., SPM)

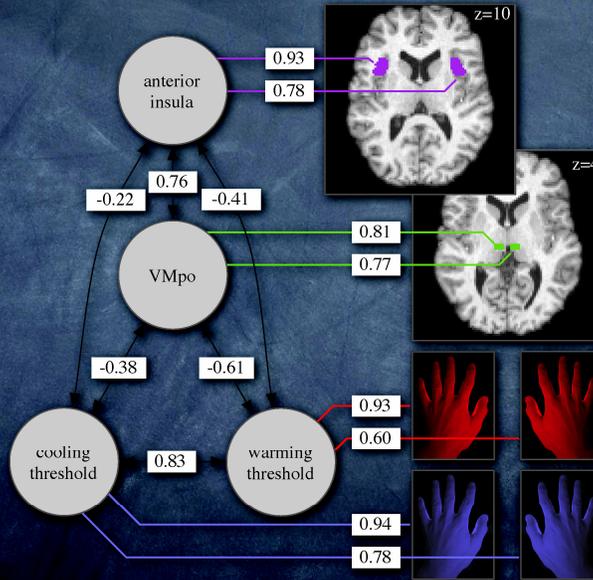
## Brain mining also allows a broader range of statistical applications

- Effect sizes and confidence intervals can be estimated correctly because spatial correlation is accounted for rather than ignored
- Reduced data units (block averages) can be incorporated into more complicated models
  - Structural equation models
  - Group discrimination methods

### Example: group means and least significant intervals



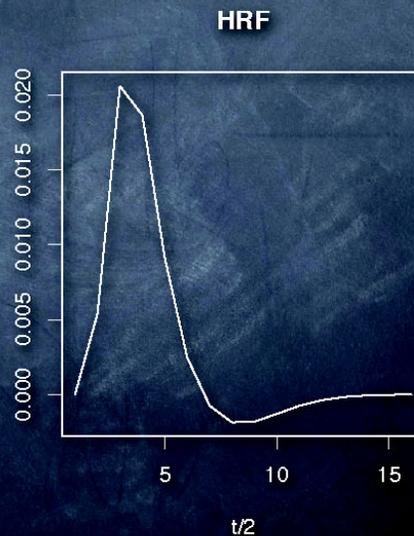
## Example: structural equation models



Brain miner will also include methods to handle a fourth dimension (time) in the analysis of functional magnetic resonance images (fMRI)

 In this setting a hemodynamic response evolves over time following a stimulus

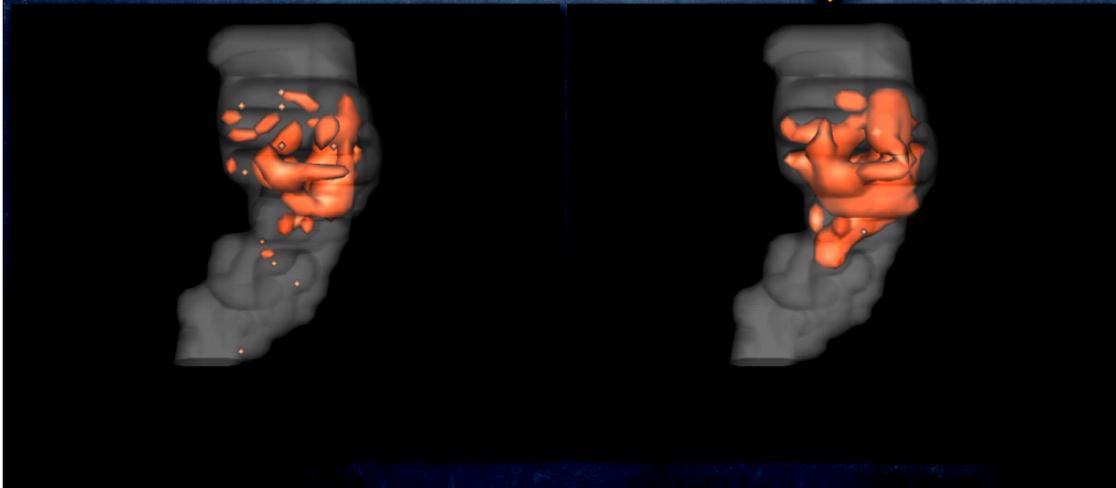
 Grouping and averaging allow for better estimation of the hemodynamic response because neighboring voxels are giving similar information about changes in blood flow over time



## Application of Brain Miner to an fMRI experiment with a large region of BOLD response

hemodynamic response to an auditory stimulus in the superior temporal gyrus

SPM



## Conclusion

 Modeling spatial correlation allows **optimal grouping** and **optimal averaging** of voxels

-  minimizes redundancy
-  obtains accurate summaries of brain functional regions
-  allows flexibility in choice of statistical approach
-  maximizes power to detect small regional signal changes between groups