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## Important Questions

Are patients with PNES neurologically normal, based on FDG-PET imaging?  
 Is there a difference between seizure-naïve controls (SNCs) and patients with PNES?

## Definition of PNES

PNES are temporary behavioral events similar to seizures but are *not* caused by epileptic neural activity, toxic or infectious exposure, or other organic disorders.

PNES are thought to be signs of conversion disorder, where patients convert psychological challenges to physical symptoms  
 (Dickinson & Loper, *Epilepsia* 2012).

## Structural Alterations in PNES

**Cortical Thinning:** Right Motor & Premotor Areas, Bilateral Cerebellum (Labate *et al. Epilepsia* 2012).

**Some abnormality on MRI in 30%;** half non-specified gliosis (Hovorka *et al. Epileptic Disord* 2007, Reuber *et al. Epilepsy Behav* 2002).

**Functional Connectivity** between Pre-central Sulcus & Insula Decreased; Parietal Lobe & Insula Increased (van der Kruijs *et al. J Neurol Neurosurg Psychiatry* 2012).

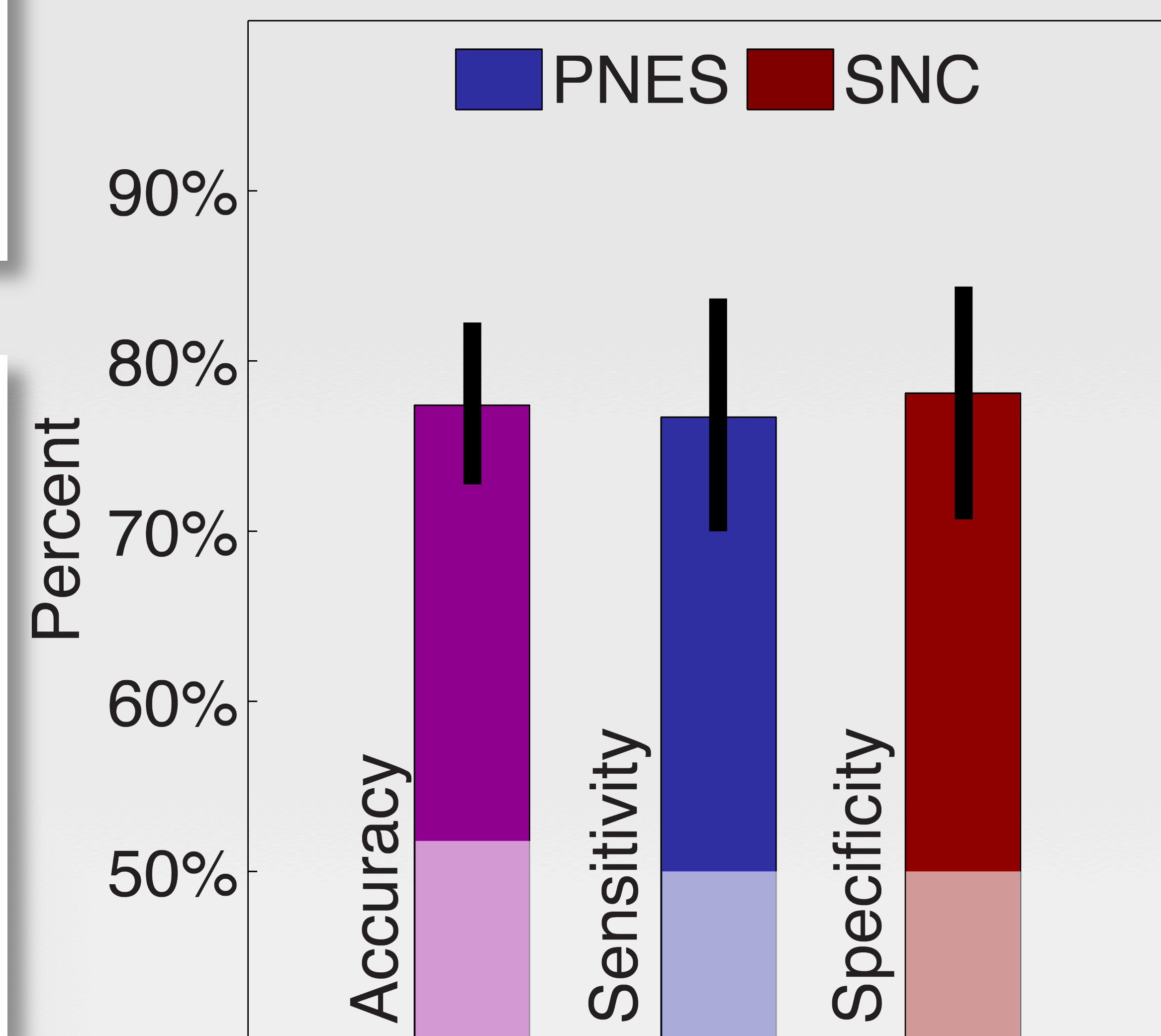
## Machine Learning Discrimination

We used leave-one-out cross-validation with a multilayer perceptron to discriminate patients with PNES were compared to SNCs based on average metabolism in VOIs determined by NeuroQ (Syntermed, CA), as in Kerr *et al. Front Neurol* 2013. VOIs were selected using a maximum-relevancy and minimum redundancy (mRMR) criterion (Peng *et al. IEEE PA & MI* 2005).

## Patient Selection

Patients with PNES (n=62) were admitted to the UCLA video-EEG epilepsy monitoring unit for definitive diagnosis between 2006 and 2013 (Kerr *et al., Front Neurol* 2013). SNCs (n=30) were underwent brain FDG-PET for non-neurologic disease at UCLA between 2006 and 2013. Visual inspection revealed no abnormality in all SNCs. Age-matched patients with PNES (n=32) versus SNCs were selected for classification.

## Machine Learning Discrimination



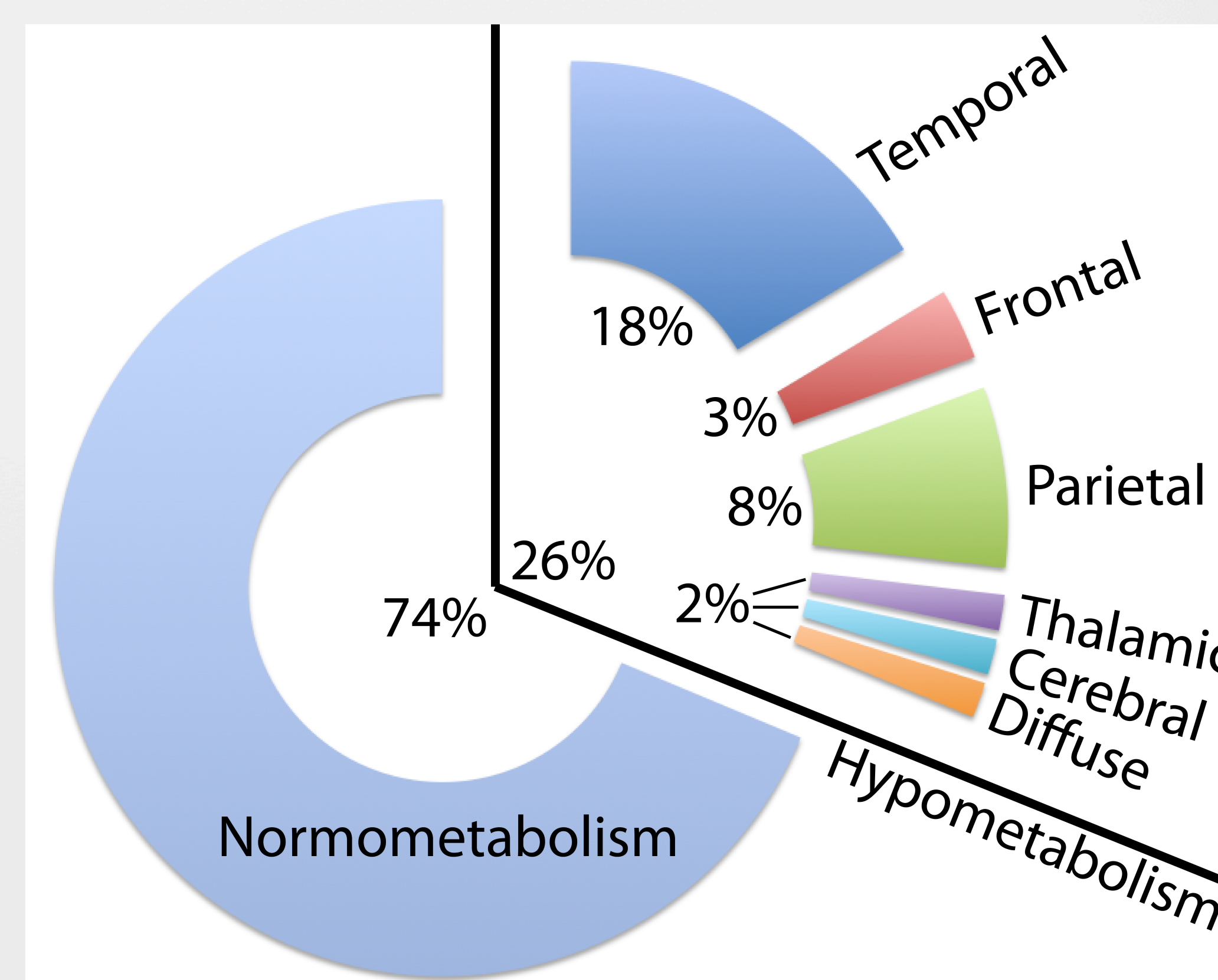
Summary statistics of classifier performance. Bars reflect standard error and shading reflects the chance performance.

Volume Rank	Direction	Volume Name
1		Cerebellar Vermis
2	↓	Left Inferior Parietal Cortex
3	↑	Right Superior-Lateral Temporal Cortex
4		Left Anterior-Medial Temporal Cortex
5	↑↑	Right Lentiform Nucleus
6		Left Parietotemporal Cortex
7		Left Superior-Lateral Temporal Cortex
8		Left Caudate Nucleus
9		Right Posterior Cingulate Cortex
10		Left Cerebellum
11		Left Thalamus
12	↓↓	Left Medial Frontal Cortex
13		Left Inferior Frontal Cortex
14		Right Sensorimotor Cortex
15		Left Posterior Cingular Cortex
16		Right Cerebellum
17		Left Lentiform Nucleus

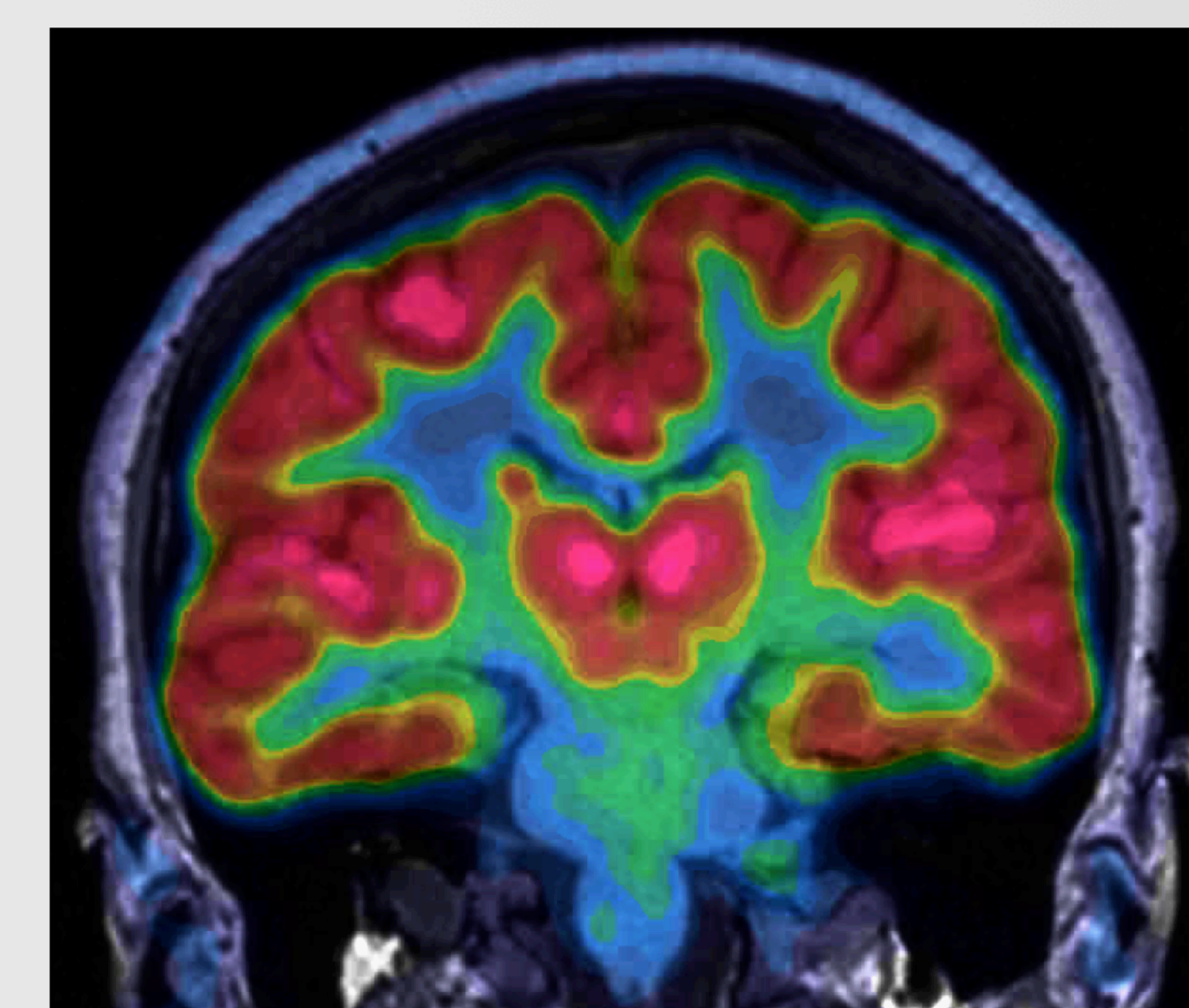
↓:hypometabolism  $p < 0.1$  ↓↓: hypometabolism  $p < 0.05$   
 ↑:hypermetabolism  $p < 0.1$  ↑↑: hypermetabolism  $p < 0.05$

mRMR-ranked VOIs that contributed to the non-linear classifier. Ranking uses full dataset, therefore it may not coincide with individual cross-validation subsets. Direction displayed when t-statistics suggested a linear relationship.

## Expert Visual Inspection



Visually notable metabolic findings observed by expert visual inspection of all patients with PNES (n=62). Hypermetabolism was not observed.



FDG-PET co-registered to MRI from a 25-year-old female with PNES. No visually apparent abnormality.

## Conclusions

1. PNES may be associated with quantifiable alterations in metabolic networks that can be used to reliably distinguish these patients. There may be a neurologic basis for this psychiatric condition (Ellenstein *et al. Curr Neurol Neurosci Rep* 2011).
2. Expert visual analysis reveals metabolic alterations in a substantial minority of patients with PNES, suggesting that focus hypometabolism is not always epilepsy.
3. Patients with PNES are discriminable from seizure-naïve controls, therefore one must carefully consider which population is appropriate to use in other research.