

Introduction

- > We examined the pattern of cerebral activation during the N-Back task, a verbal working memory task, with a functional near infrared spectroscopy system (See Figure 1).
- > Prior fMRI studies have demonstrated both parietal and prefrontal regions are involved during both the maintenance and manipulation of information (working memory).
- > The N-Back paradigm (i.e., "0-back," "1-back," "2-back," and "3-back," see Figure 2) was presented auditorily.

Figure 1.
Multi-channel
Continuous
Wave Near
Infrared Imager
and Helmet



Methods cont.

Behavioral Task

N-Back Task

- > Consonant letters were presented every three seconds auditorily in 24 second epochs.
- > Four Conditions (0-back, 1-back, 2-back, 3-back)
- > Each condition randomly presented 3 times

Procedures

Apparatus

- > Multi-channel continuous wave near infrared imager (NIRx Medical Technologies; see Figure 2)
- > 30 source and 30 detector optodes (900 channels)
- > Dual wavelength of near infrared light (760nm and 830nm)
- > Optodes placed on forehead 10% above nasion in a 10 cm by 3 cm rectangle configuration, Figure 3.

Data Acquisition

- > 5 Minute Baseline
- > Practice trials of 0, 1, 2, 3-Back Conditions.
- > N-Back Task

Results

Table 1. N-Back conditions, Anatomical Regions, Broadman Areas (BA), Talairach Coordinates, and Volume (vox)

	Region	BA	Left			Right			Volume
			X	Y	Z	X	Y	Z	
1 > 0-back (Figure 4)	Middle Frontal Gyrus	47	-	-	-	40	38	-9	39
2 > 1-back (Figure 5)	Inferior/Middle Frontal Gyrus	10/46	-	-	-	40	38	6	32
	Middle Frontal Gyrus	47	-37	41	-6	-	-	-	481
3 > 2-back (Figure 6)	Inferior Frontal Gyrus	46	-	-	-	51	41	6	35

Figure 4. 1-Back Minus 0-Back Tasks [X Y Z = 40 38 -9]

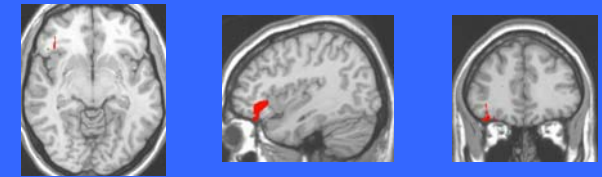
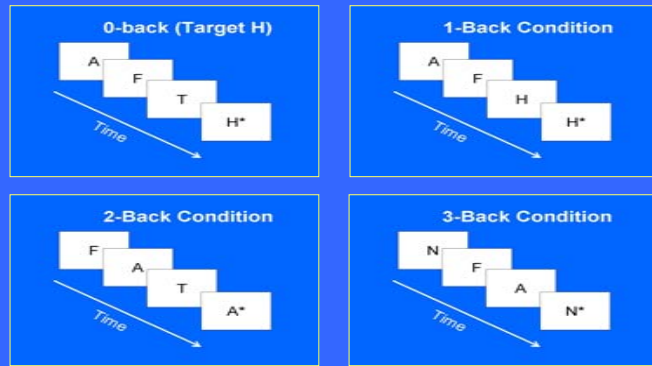


Figure 2. N-Back Paradigm Conditions



Methods

Participants

- > 9 Right-Handed Healthy Adults
- > Age: 30.7 (11.3) years
- > Education: 15.9 (2.7) years
- > Free of substance abuse and major psychiatric disorders
- > No history of neurological disease or trauma

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Data Preprocessing and Analysis

Preprocessing

- > Near Infrared Analysis, Visualization and Imaging (NAVI) software (NIRx Medical Technologies, LLC)
- > Low-band pass filter (.15 Hz)
- > 15% mean Coefficients of Variation threshold
- > Oxy-Hb concentration was modeled with a modified Lambert-Beer analysis for each time point in each voxel of modeled space (Figure 3).
- > Data converted to Analyze format

Data Analysis

- > AFNI image analysis software
- > Time-series deconvolved for each N-back Condition
- > N-Back conditions compared across participants with t-tests (random effects analysis).
- > Results corrected for multiple comparisons
- > $\alpha = 0.05$, cluster size = 31 contiguous voxels.

Figure 3. Three dimensional model of source-detector pairs.

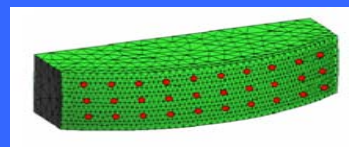


Figure 5. 2-Back Minus 1-Back Conditions [X Y Z = 40 38 6]

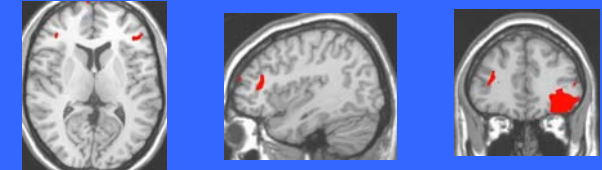
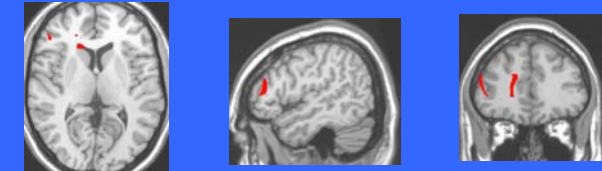


Figure 6. 3-Back Minus 2-Back Conditions [X Y Z = 51 41 6]



Conclusions

- > Functional Near Infrared Spectroscopy detects patterns of activation in the prefrontal lobe.
- > Increased oxy-Hb is associated with greater verbal working memory cognitive demand primarily in right ventro-lateral prefrontal cortex (middle/inferior frontal gyrus).
- > Pattern of activation is consistent with fMRI studies of verbal working memory studies.