



# The relationship between poverty and dorsolateral prefrontal activation

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## Introduction

Factors of poverty on preschool-aged children have been shown to influence brain development and function such as working memory (1). Numerous studies have shown

Although the relationship between the neural underpinnings of working memory and poverty exposure has been a growing interest, the research is limited (2). Previous studies have shown that low-income pre-adolescents displayed altered prefrontal functions and lower activation in the lateral prefrontal cortex(3) along with symmetrical, asymmetrical, verbal and visuospatial working memory deficits(4) compared to their higher SES counterparts.

### Study Aim:

1)To what extent does poverty exposure based on family income correlate with dorsolateral prefrontal cortex (DLPFC) activation during the working memory task?

## Methods

**Sample:** The pilot study consisted of 25 multi-race, low-income families (child mean age = 5.24 years, SD = 0.84) recruited from the greater Houston area. Families' socioeconomic status was calculated using the Hollingshead Four-Factor Index of Social Status survey (5).

**Hollingshead Measures:** This survey measured the social status of each family based on: marital status, educational completion, retired/employed status, and occupational factors. Each variable was surveyed with point scales ranging from 1-9. We chose to calculate families' SES because SES predicts a broad range of important life outcomes such as physical health, mental health, intelligence and academic achievement

**Behavioral Task:** Children's brain activity was recorded using functional near-infrared spectroscopy (fNIRS), while they completed a working memory task. FNIRS is a non-invasive, child-friendly neuro-imaging approach that measures oxygenated and deoxygenated hemoglobin (HbO and HbR) in the cerebral cortex with near-infrared light. During the block design (6-7 blocks) participants watched a monkey jump from object to object and hide its bananas. Participants were then instructed to remember the object in which the monkey hid its bananas in during the delay period (2-6 sec). Accuracy and reaction time was recorded for all working memory blocks.

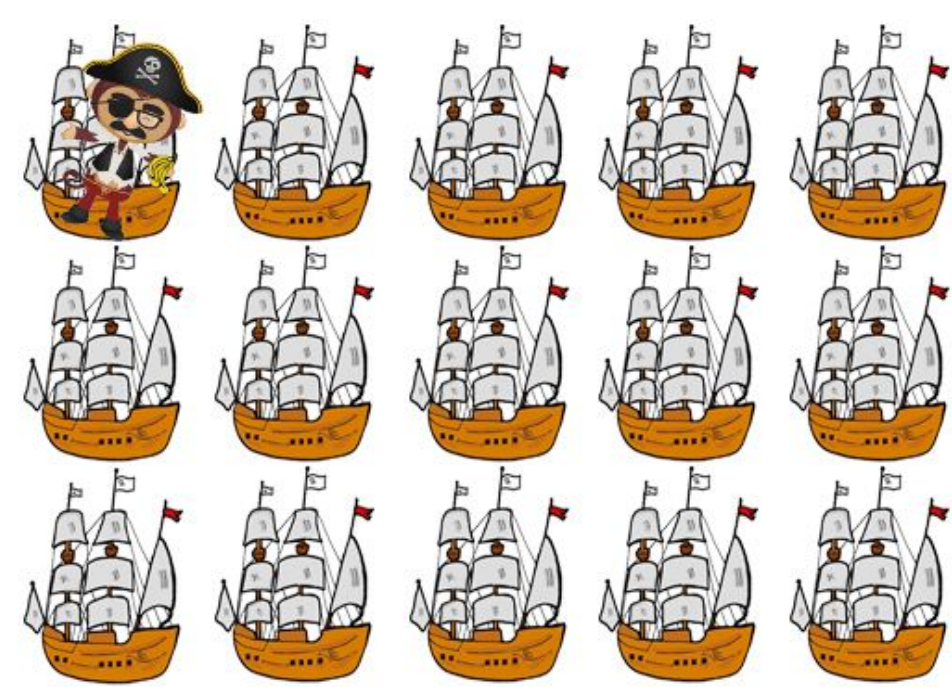


Figure 1: Working Memory task

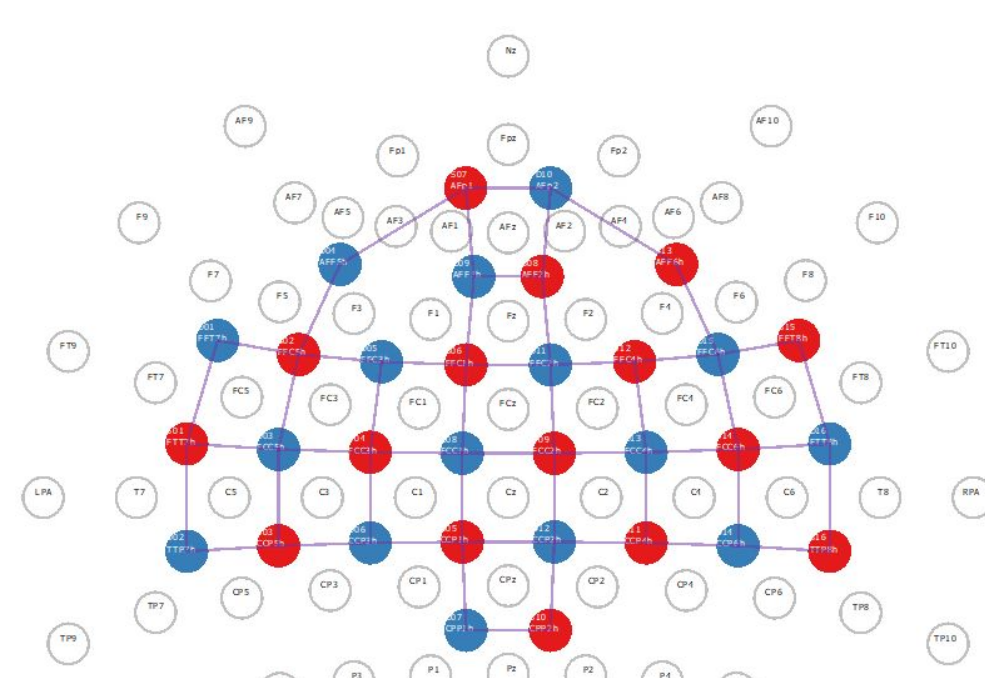


Figure 2. FNIR Montage

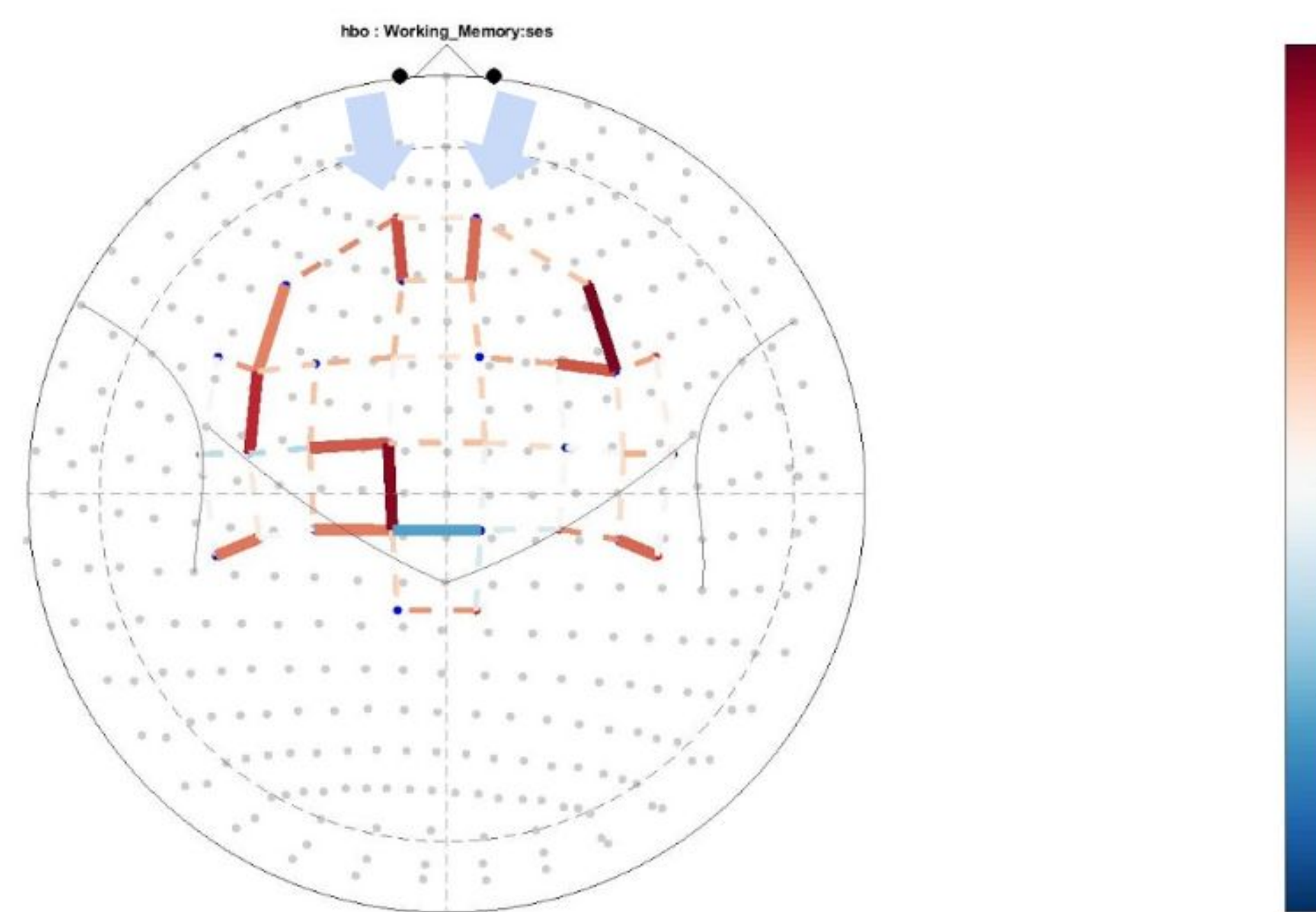


Figure 3. Brain activation during working memory task

Results from the mixed-effects model show a significant positive association between SES and left and right medial prefrontal cortex ( $p < .001$ ), see Figure 3.

## Results

Table 1. Sample Demographics

Variable	N (%) N = 25
Family Income	
Less than 25,000	9 (36)
25-50,000	12 (48)
50-75,000	4 (16)
75-100,000	0
100,000+	0
Child Age, M(SD)	5.24 (0.9)
Child Race	
White	8 (32)
Black	9 (36)
Other/Mixed	7 (28)
Hispanic	14 (56)

## Discussion and Future Directions

Our findings indicate that families with lower SES show children with significantly reduced activation in the DLPFC regions during the working memory task than children from families with higher SES.

The correlation of lower income with decreased oxygenated hemoglobin to the frontal regions of the brain provide neurophysiological evidence that poverty causes significant alterations to the prefrontal cortex (PFC) in preschool-aged children.

Numerous factors are associated with hindering PFC functions such as lack of cognitive stimulation, physical environment, and chronic stress.

These results give us further confirmation that there is a strong relationship between socioeconomic risk and brain development. Further research interests include:

- Further analysis on what components of SES affect activation of DLPFC, and the behavioral implications of decreased activation of DLPFC in terms of reaction time and accuracy.
- Investigating protective and risk factors that mediate SES and brain alteration.



Image Source: Nirx.net

### References:

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### Instrumentation and Analysis:

FNIRS collection and analysis: Hemodynamics signal was collected with the NIRx fNIRS system with a probe design of 16 sources and 16 detectors. During the task, we collected fNIRS data at a sample rate of 6.25 Hz through NIRxStar and used PHOEBE to let us monitor real-time signal quality among all optodes. First, we conducted quality check on all raw data with HOMER2 and Nirxplot. Next, the data was processed using fNIRS Brain AnalyzIR Toolbox. Raw signal was converted to optical density and subsequently to HbO and HbR, and then was regressed using an autoregressive whitened robust regression model. Lastly, we performed group-level mixed effects analysis to compute group level statistics.