

# Anxiety Severity Predicts Relative Slow Wave Power during NREM Sleep in Preadolescent Girls

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## Background

- Childhood Anxiety Disorders (ADs) affect up to 30% of children<sup>1</sup>
- Early life anxiety is known to be a risk factor for developing stress-related psychopathology later in life
- Risk doubles for females in reproductive years
- Up to 90% of children with anxiety disorders report sleep related problems<sup>2</sup>
- Few studies have used objective measures like EEG to characterize sleep in youth with ADs so neural underpinnings of reported sleep problems are unknown
- Deep, slow wave sleep (SWS) may be relevant to anxiety due to its association with emotion regulation, fear learning, and memory<sup>3</sup>
- High frequency EEG (e.g. alpha, beta) during NREM sleep may also be relevant as it is characteristic of lighter sleep
- We examined the relation between anxiety severity and 1) slow-wave activity (SWA) and 2) high-frequency EEG activity (alpha, beta) during sleep in a sample of preadolescent girls with a range of anxiety symptoms.

## Sample Demographics

- 41 preadolescent females (ages 8-12) with range of anxiety symptoms
- Unmedicated and not currently receiving any psychiatric treatment (treatment free for last 6 months)
- No primary history of other psychiatric disorders (PTSD, OCD, MDD, psychosis, bipolar disorder)
- Girls with comorbid ADHD are included if not significantly interfering with function and AD is the primary diagnosis
- At study intake, each participant was categorized as either: 1) healthy control, 2) subthreshold-AD (sub-AD), or 3) AD (generalized, separation, or social) based on clinician KSADS and CGI
  - Control: CGI=1 (not ill)
  - Sub-AD: CGI=2,3 (borderline/mildly ill)
  - AD: CGI=4,5 (moderately/markedly ill)

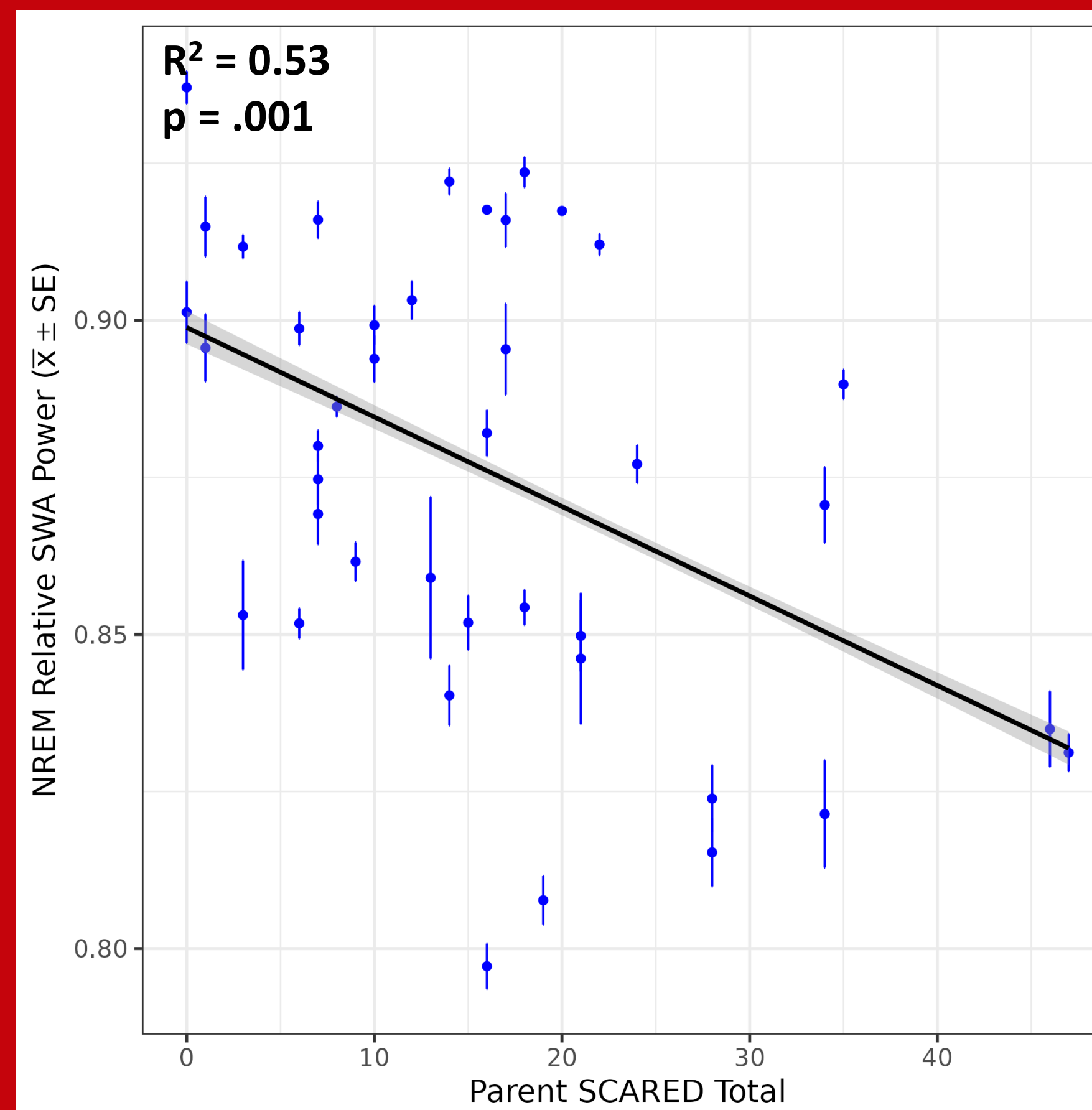
Group	Age (years, Mean ± SD)	Parent SCARED (Mean ± SD)	Child SCARED (Mean ± SD)
Control (N=21)	10.2 (1.3)	11.3 (8.2)	11.7 (7.2)
Sub-AD (N=15)	9.7 (0.9)	15.6 (10.3)	21.9 (14.1)
AD (N=5)	11 (0.7)	35.6 (6.9)	41.8 (12.6)

Main Effect of Group ns, p=.058  
Main Effect of Group p <.05, AD>Sub-AD, Con  
Main Effect of Group p <.05, AD>Sub-AD>Con

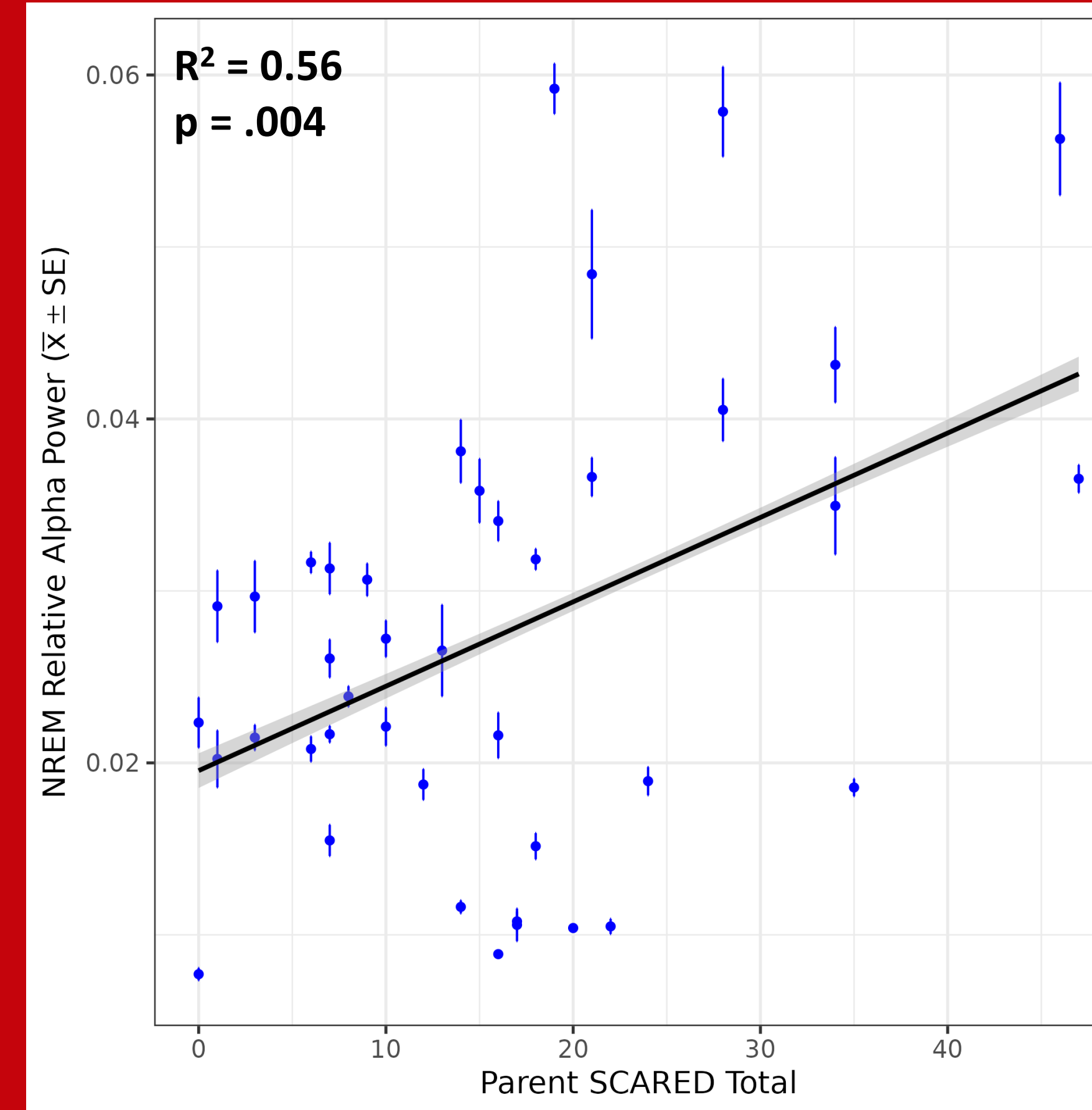
→ Preadolescent girls with increased anxiety severity experience less deep sleep during NREM sleep

Parent-rated Anxiety Severity

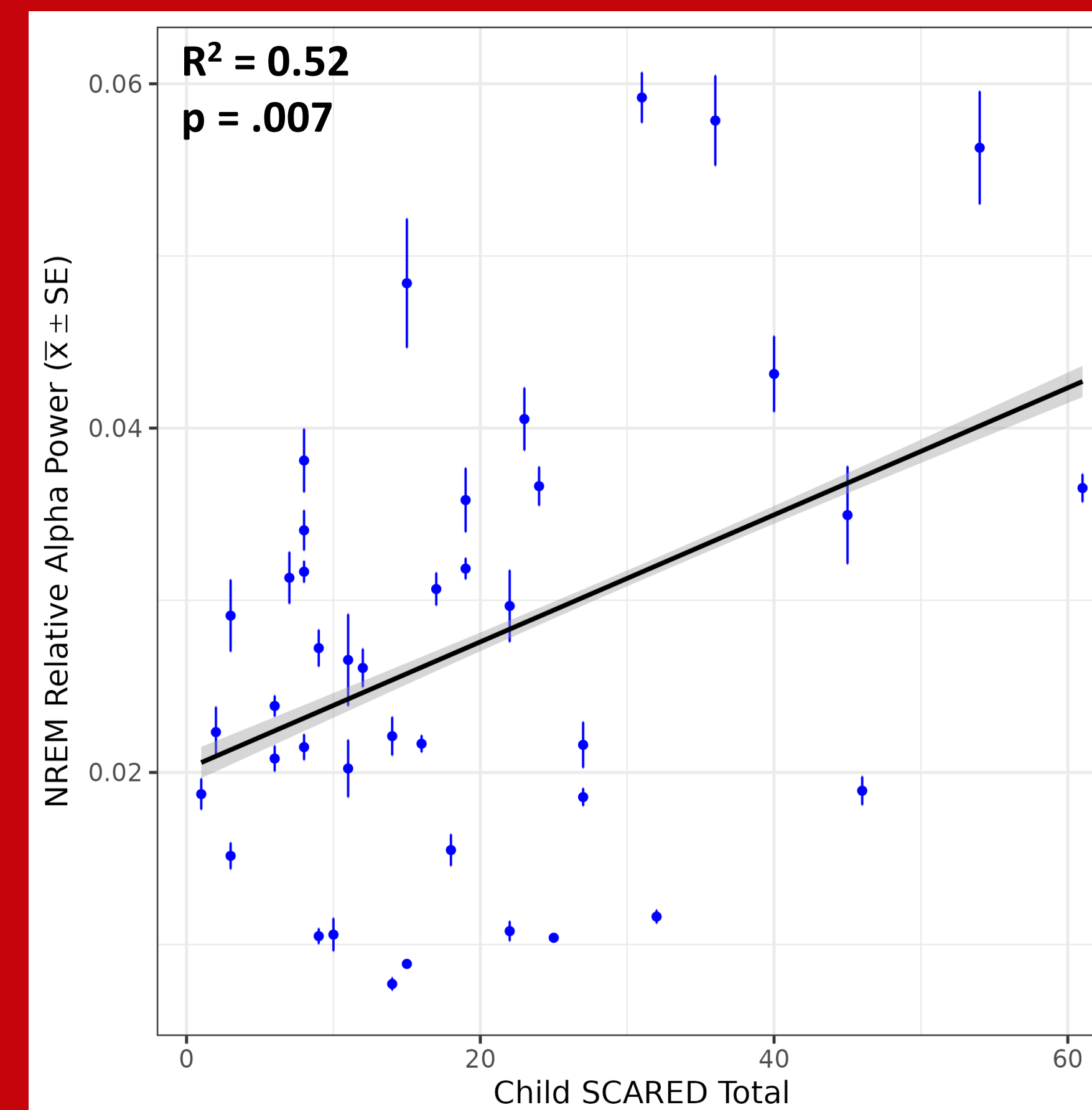
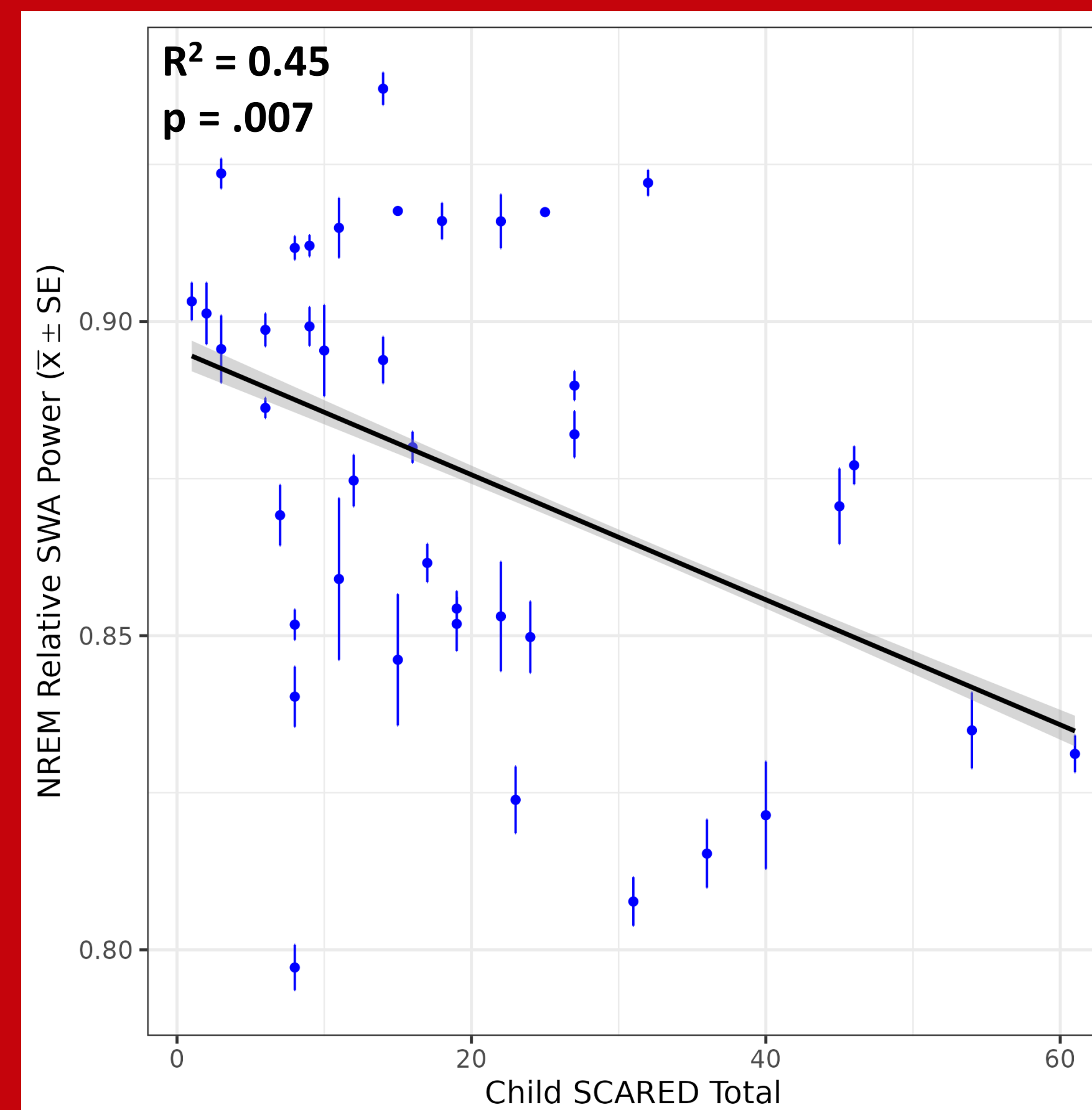
### Relative Slow Wave Power



### Relative Alpha Power



Child-rated Anxiety Severity



## Methods

### Screen for Child Anxiety Related Disorders (SCARED)

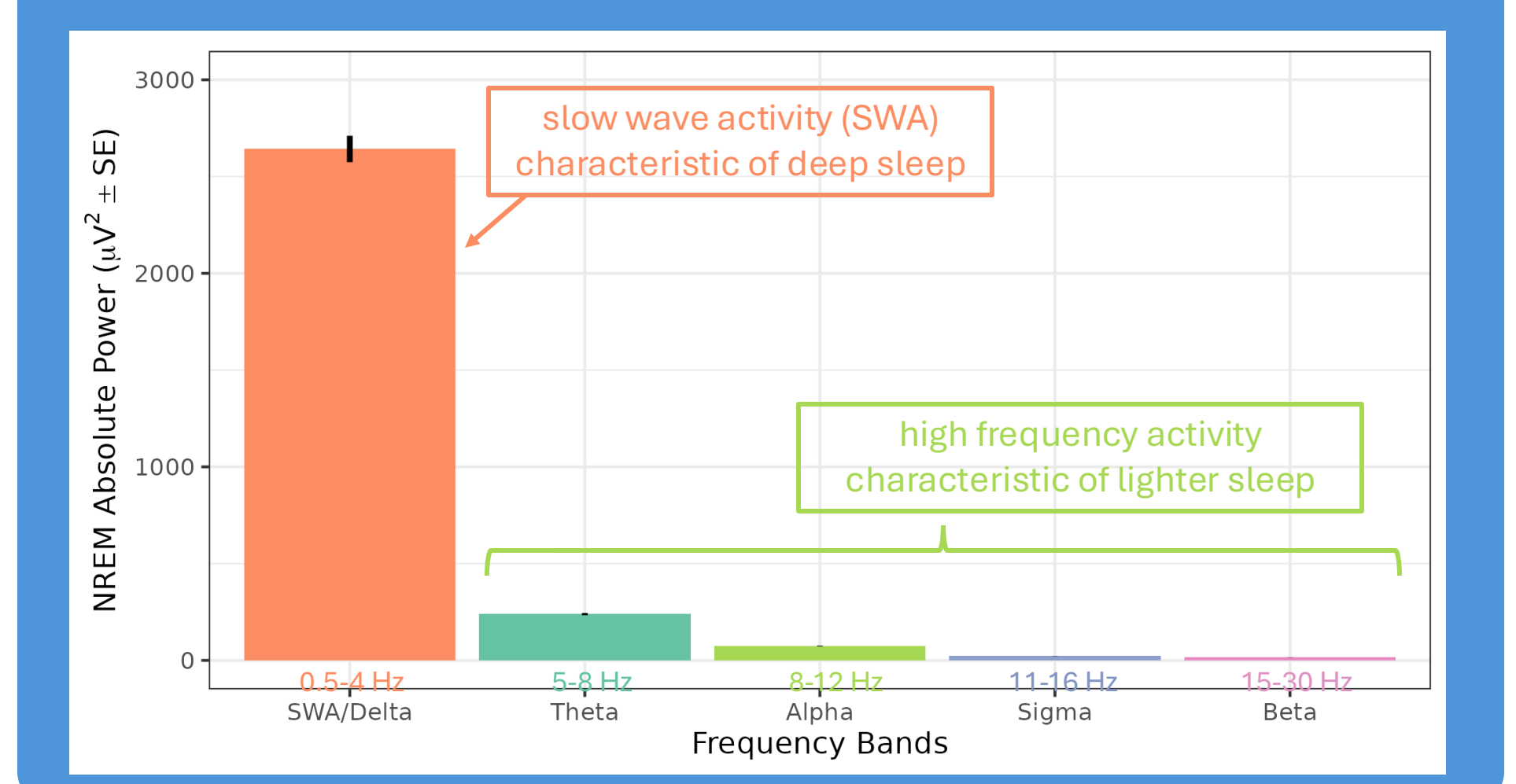
- Child's anxiety severity over the last 3 months rated by parent and child

### Home Sleep Data Collection

- SmartSleep EEG Headband worn on weeknights for 2 weeks (10 nights)
- Records sleep EEG with single frontal electrode referenced to mastoid reference electrode
- Headband labels each 4 second epoch of EEG as stage of sleep and provides power spectrum data



### Average absolute power in each frequency band during NREM sleep for the whole sample



## Analysis

- Only complete nights of sleep data were included
- Average of 6.4 complete nights per participant (range: 1-10 nights)
- Anxiety severity was examined in relation to:
  - NREM absolute spectral power (delta/SWA, alpha, and beta)
  - NREM relative spectral power (delta/SWA, alpha, and beta)
  - SWA/alpha and SWA/beta ratios. Higher ratio indicates greater proportion of deep-sleep activity during NREM.
- Linear mixed effects models, controlling for age

## Results

- Anxiety severity (as measured by Parent and Child SCARED) significantly predicts NREM relative SWA and relative alpha power (all  $p < .05$ , see figures).
- Parent SCARED was also significantly associated with NREM relative beta power ( $R = 0.23$ ,  $p = .024$ ) and NREM SWA/beta ratio ( $R = 0.26$ ,  $p = .028$ ) such that higher levels of parent-rated anxiety are associated with decreased relative beta power and decreased SWA/beta ratio.
- Anxiety severity did not predict duration of NREM sleep or NREM absolute power values.

## Discussion

- In a sample that includes girls with pathological anxiety, higher levels of anxiety are associated with parameters characteristic of less deep sleep.
- These findings highlight NREM slow wave sleep as a potential treatment target for childhood ADs. The SmartSleep headband was designed with an integrated closed-loop platform for active intervention during sleep using auditory tones that could be employed to enhance SWS in youth with pathological anxiety.<sup>4,5</sup>
- Future work will use high density sleep EEG to replicate these findings and explore regional differences in slow wave activity during sleep.

## Acknowledgments

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