

## INTRODUCTION

- From adolescence to adulthood there are significant improvements in executive function, notably in working memory, believed to be underlined by refinements in brain process that optimize whole brain function<sup>1</sup>
- Previous developmental EEG studies show age-related decreases in mean resting state transient brain rhythms across frequencies and band power<sup>5,6</sup>
- Single-cell studies, however, indicate that average brain rhythms cannot measure trial level transient activity, which is more directly associated with neural activation supporting higher-order cognitive tasks<sup>7,8</sup>
- Thus, we do not understand what aspects of age-related changes in neural function underlie improvements in executive function

## STUDY AIMS

- To delineate age-related changes in trial level transient EEG activity through adolescence into adulthood
- To investigate the relationships between age-related changes in EEG activity and age-related improvements in working memory

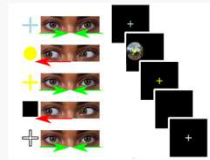
## METHODS

### Participants:

- 140 healthy 10- 30 years olds (60 subjects evenly distributed between 10-17, and 80 participants distributed between 18-30) (73 = females)

### Memory Guided Saccade (MGS) Task:

- Visuospatial working memory task (Fig)
- Participants look at a peripheral target and after a varied fixation delay period (6-10 sec), move their eyes to the remembered location



### EEG Acquisition:

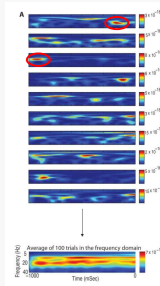
- Biosemi ActiveTwo 64- channel EEG system

### EEG Preprocessing:

- Utilized a revised Makoto pipeline:
  - Removed flatline channels, low frequency drifts, noisy channels, short spontaneous bursts, and incomplete segments of data
- Independent Component Analysis (ICA) was performed to identify eye-blink and eye- movement artifacts

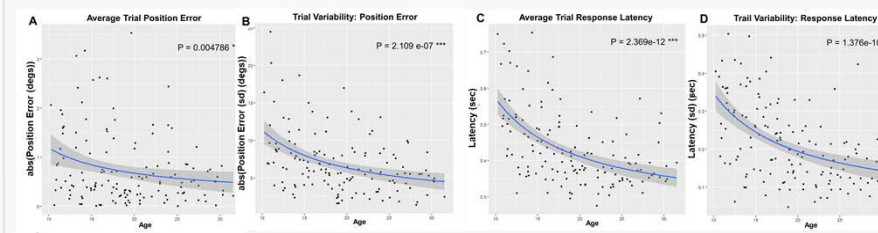
### Spectral Event Processing

- Computed from 1s data windows
  - Delay and fixation epochs
- Gamma (30- 75 Hz), theta (4- 7 Hz), beta (13- 30 Hz), and alpha (8- 12 Hz) frequency bands were analyzed using an established protocol in *Shin et al*<sup>8</sup>
- A time-frequency responses (TFR)
  - Morlet wavelet equation
  - Normalized to the median power
- The average value and trial-by-trial variability was calculated for event power, duration, and number of events per trial

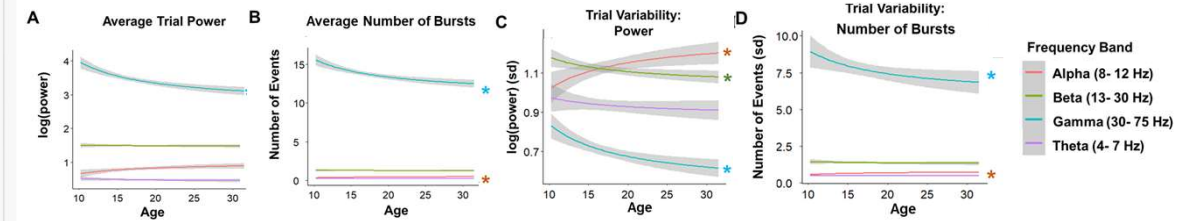


EEG is averaged across trials. Creating what looks like a sustained rhythm

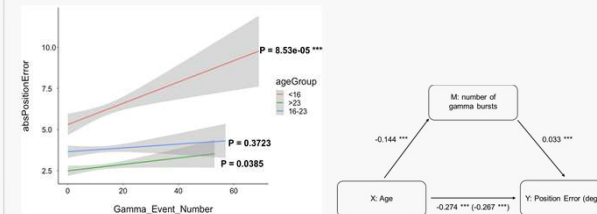
## WM MEAN ACCURACY AND LATENCY AS WELL AS VARIABILITY IMPROVE INTO ADULTHOOD



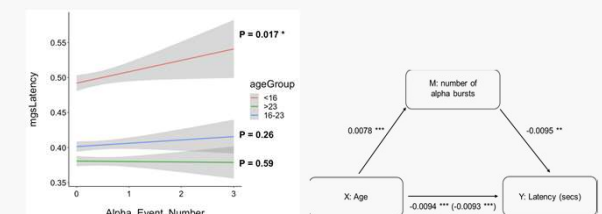
## TRIAL LEVEL TRANSIENT EEG ACTIVITY DURING WM DELAY CHANGED WITH AGE IN GAMMA, BETA, AND ALPHA FREQUENCY BANDS



## THE NUMBER OF GAMMA SPECTRAL EVENTS DURING DELAY MEDIATES AGE- RELATED IMPROVEMENTS IN ACCURACY



## THE NUMBER OF ALPHA SPECTRAL EVENTS DURING FIXATION MEDIATES AGE- RELATED IMPROVEMENTS IN RESPONSE LATENCY



## CONCLUSIONS

- Age-related trial level decreases in whole brain mean gamma and alpha power and variability in gamma, alpha, and beta bands suggest developmental improvements in the degree of neural activation supporting the ability to retain information on-line (gamma), controlling and integrating neural signals (alpha), and engaging top-down control (beta). Age related changes in gamma and beta bands may be underlined by developmental changes in GABA inhibitory and glutamate excitatory processing
- Age-related decreases in the number of spectral bursts in gamma and alpha bands and its association with performance suggest that improvements in WM may be supported by the optimization of neural spiking. Decreases in power may support this process.
- Results indicating that gamma mediates age-related improvements in WM accuracy suggest that critical to WM development is the ability to sustain WM information on-line.
- Results indicating that alpha mediates age-related decreases in latency suggest maturational improvements in controlling and integrating neural signals
- Together, results suggest that underlying developmental improvements in WM are optimization of neural processes that enhance sustaining information on-line (gamma), controlling and integrating neural signals (alpha), and implementing top-down control (beta)

## ACKNOWLEDGEMENTS

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