EEG- Derived Spectral Processing and the Development of Working Memory through Adolescence

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INTRODUCTION

- Adolescence begins with the onset of puberty and is characterized by unique neurobiological and cognitive development, supporting improved executive function, increased inhibitory control, and the continual refinement of behavior[1]
- Associated with sensation seeking, risk- taking behavior, peer and parental influence, substance use, and increased vulnerability to psychopathology[2,3]
- During adolescence, the brain undergoes significant specialization in structure and function, including synaptic pruning, myelination, and connectivity[4]
- Previous developmental studies have shown maturational fluctuations, such as increased white matter integrity[5,6], prefrontal GABA concentration increases[7], and significant decreases in frequency band power across age in all frequency bands[8,9]
- To better understand brain maturation during adolescence, we investigated developmental changes in transient EEG activity

STUDY AIMS

- To investigate age- related changes in transient EEG activity across adolescence
- To characterize age- related changes in executive function, using a memory guided saccade task
- Evaluate relationships between age-related changes in EEG activity and age-related behavioral changes

METHODS

Participants:

- 140 healthy participants with ages 10- 30 years old (60 subjects evenly distributed between 10-17, and 80 participants distributed between 18-30)

Memory Guided Saccade Task:

- Participant maintains central fixation until a peripheral cue appears
- Participant saccades to the cue until it disappears, and the delay epoch begins in which the participant must remember the location of the cue until the memory guided saccade epoch begins

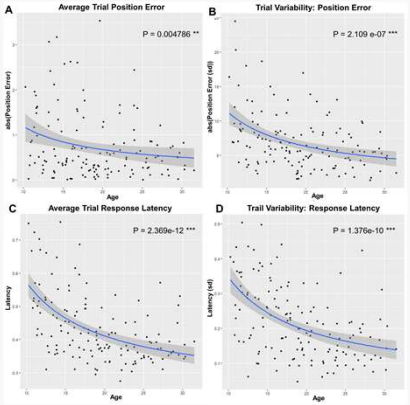
EEG Acquisition:

- Biosemi ActiveTwo 64- channel EEG system
- Sampled at 1024 Hz
- Memory guided saccade task was presented by a computer approximately 80 cm away

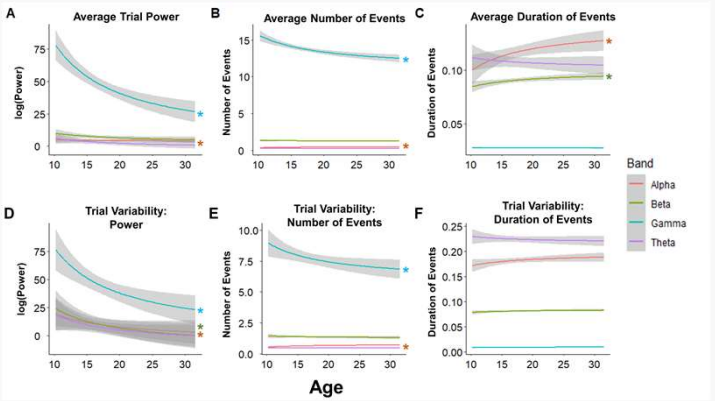
EEG Preprocessing:

- The data was resampled to 150 Hz and referenced to the mastoids
- Initial bandpass filter (0.5 – 75 Hz)
- A revised Makoto pipeline was utilized for preprocessing compatible with EEGLAB
  - Removes flatline channels, low frequency drifts, noisy channels, short spontaneous bursts, and incomplete segments of data
- Deleted channels were replaced with interpolated data
- Continuous signals were divided into epochs, time-locked to stimulus onset
- Cleaned with amplitude threshold of -500 to 500μV
- Independent Component Analysis (ICA) was preformed to identify eye- blink artifacts

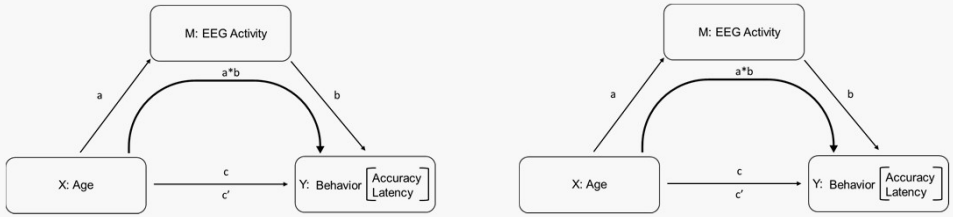
BEHAVIORAL ANALYSIS



TRANSIENT EEG ANALYSIS



BEHAVIOR- EEG RELATIONSHIP



CONCLUSIONS

- Adolescence is associated with maturational changes in structural, chemical, and electrophysiological changes, including increases in white matter integrity, prefrontal GABA concentrations, and decrease in frequency band power
- Consistent with previous findings, response latency and position error decreased across adolescence, as well as, between trial variability
- Significant age-related changes were found in the gamma, beta, and alpha frequency bands
- The number of spectral events during the delay period, rather than their power or duration, was most strongly associated with age-related performance improvements
- Spectral events were strongly associated with MGS performance, with gamma mediating age- related accuracy increases, and alpha mediating age- related latency reductions

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