Characterizing Optimal Sustained Attention States in Older vs Young Adults Using EEG

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Sustained Attention

Definition: The ability to maintain attentional stability under over a period of time

Neural dynamics of "in the zone" vs "out of the zone" states while sustaining attention have been characterized using fMRI [1]

Temporal dynamics of these states have yet to be characterized in EEG

Goals

1. Characterize "in the zone" vs "out of the zone" sustained attention states in EEG using the variance-course time-series approach [1]

2. Identify age-related differences in the neural processes that give rise to "in the zone" attention states

Participants

YA: *n* = 88, age range: 18-35 years

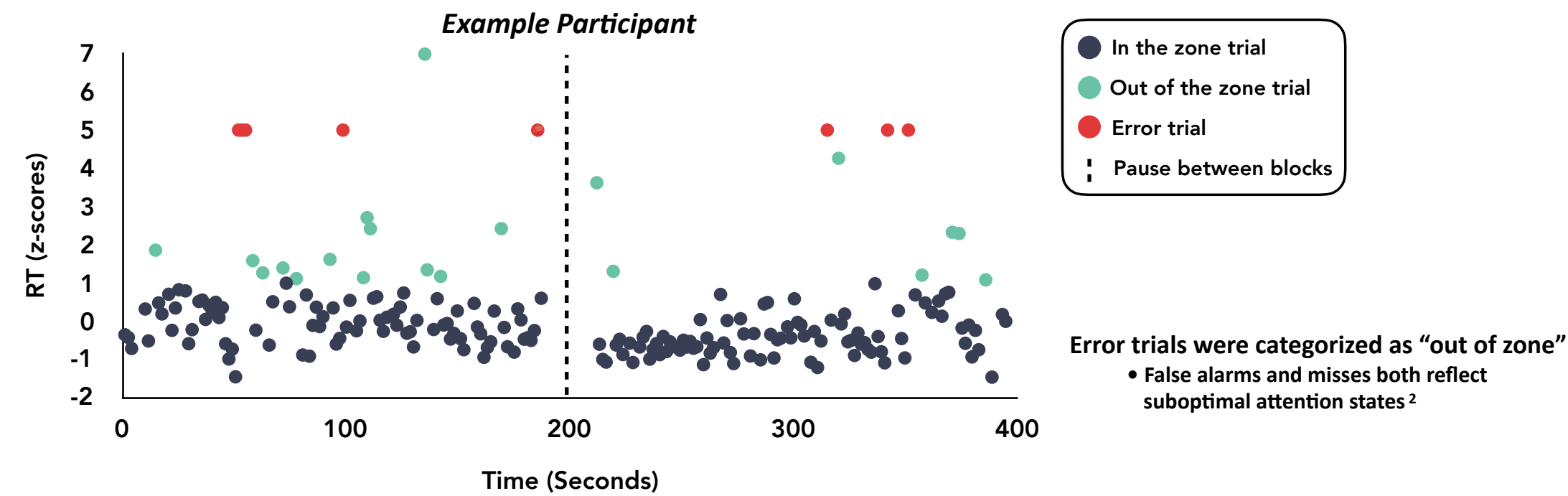OA: *n* = 91, age range: 60-85 years

Continuous Performance Task

4:1 Target to Non-Target ratio
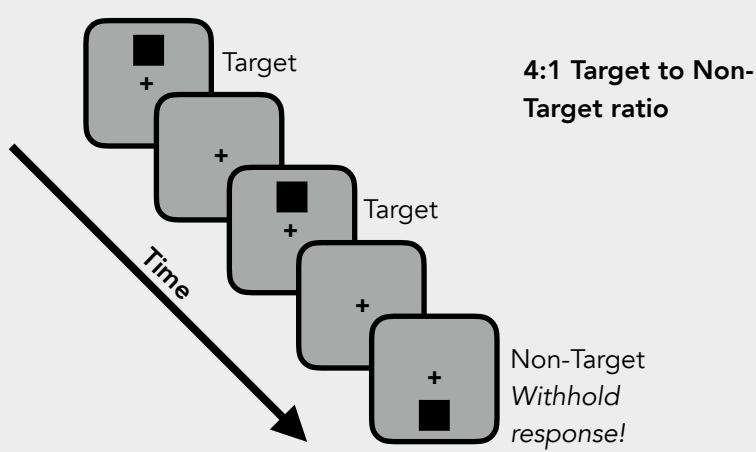
1.4 second fixed ITI

2 blocks of 250 trials (125 each block)

Performed while recording EEG

Identifying in and out of zone trials

Example Participant

- In the zone trial
- Out of the zone trial
- Error trial
- Pause between blocks

Error trials were categorized as "out of zone"
- False alarms and misses both reflect suboptimal attention states [2]

Characterizing Optimal States Using EEG

Young Adults

Pre-stimulus Alpha Power — p = 0.872

Mid-Frontal Theta Power — * — p = 0.041*

Visual ERP — ** — p = 0.004** ; ** — p < 0.001**

Older Adults

Pre-stimulus Alpha Power — ** — p = 0.004**

Mid-Frontal Theta Power — ** — p < 0.001**

Visual ERP — * — p = 0.025* ; ** — p < 0.001**
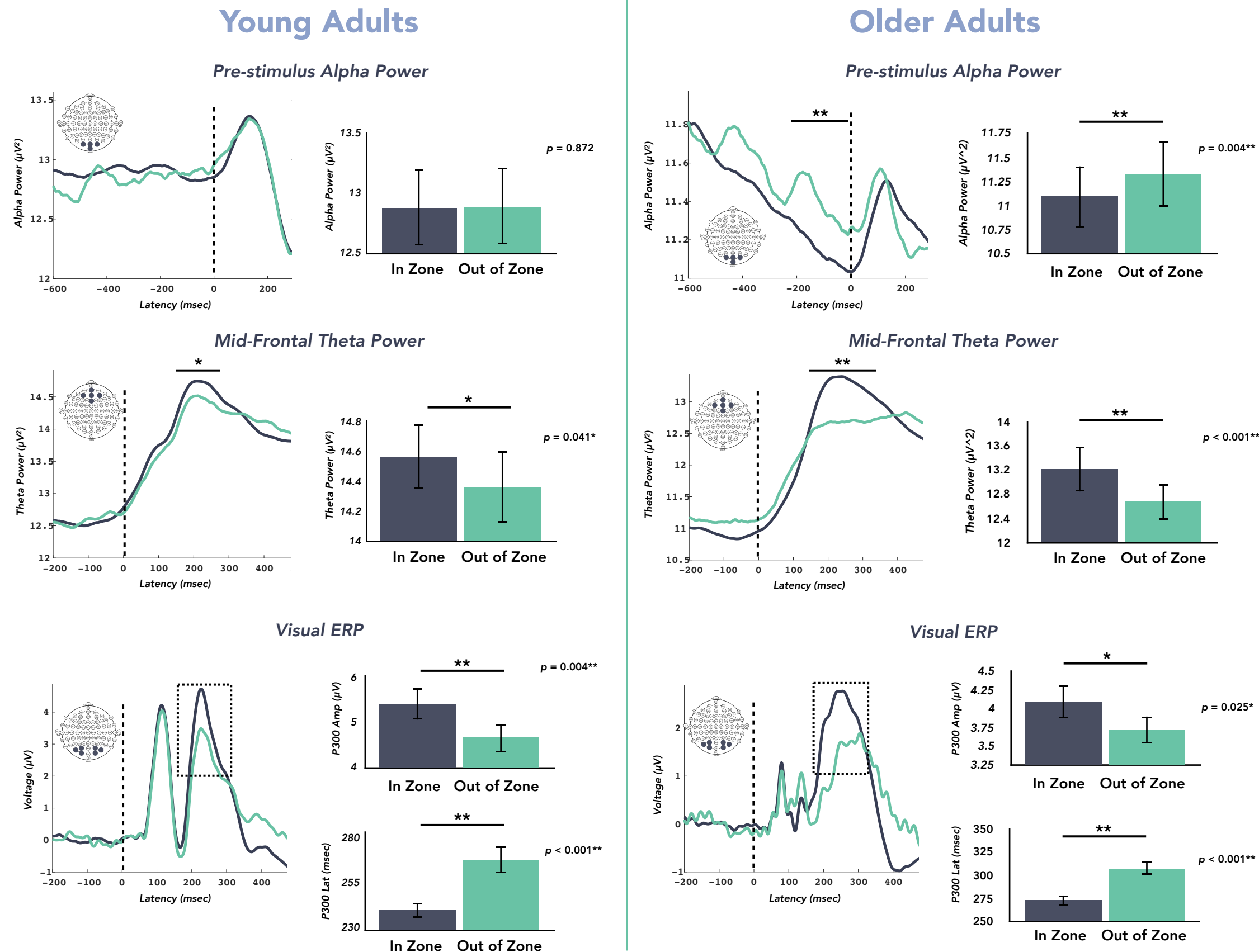
Summary

- The following neural processes facilitate optimal attention in young adults:
  - Mid-frontal theta
  - Visual P300
- The following neural processes facilitate optimal attention in older adults:
  - Anticipatory posterior alpha
  - Mid-frontal theta
  - Visual P300

Conclusion

- Older adults rely on more diverse neural processes to maintain an optimal sustained attention state than young adults

Future Work

- How are these features different in kids and in psychiatric populations?

- Can we use ML on these EEG features to predict attention states in real time?

- What can alterations in these neural signatures of optimal sustained attention tell us about an individual?

References

1. *In the zone or zoning out? Tracking behavioral and neural fluctuations during sustained attention.* Esterman et al., Cerebral Cortex (2013)

2. *Anatomy of an error: a bidirectional state model of task engagement/disengagement and attention-related errors.* Cheyne et al., Cognition (2009)

Acknowledgements