# Autonomic Arousal and Inhibitory Control in Aging

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## Purpose

To examine whether age affects the degree to which autonomic regulatory activity is related to response control and error-related ERPs during a complex Go/NoGo task involving three levels of working memory (WM) load.

## Background

According to the Neurovisceral Integration Model[1], mental processes are not isolated cortical phenomena, but rather, are influenced by autonomic regulation of other bodily systems

- Anterior cingulate cortex (ACC) is known for its role in
  - implementing response control[2]
  - generating error-related electrocortical responses (ERN/Pe)[3]
- Through links with the vagus nerve, ACC also exerts parasympathetic control over the heart increasing heart rate variability[4] and thus greater adaptability in response to attentional demands.

Although ACC is involved in performance monitoring and autonomic regulation, both of which decline with age, these functions are rarely examined together. However, from a neurovisceral integration perspective, both systems should be involved when high levels of response control are required.

## Present Study

- We recorded ERPs and cardiac activity while older and younger adults completed an inhibitory control task that varied WM load requirements.
- Cardiac measures included
  - Respiratory sinus arrhythmia (RSA) → An index of parasympathetic function
  - Rate Pressure Product (RPP) → An index of sympathetic predominance
- We expected
  - that autonomic activity would become increasingly important at higher WM loads, when fewer attentional resources were available.
  - that these relations would be strongest in the older adults who are at risk for a decline in both ACC function and autonomic regulatory control (RSA).

## Method

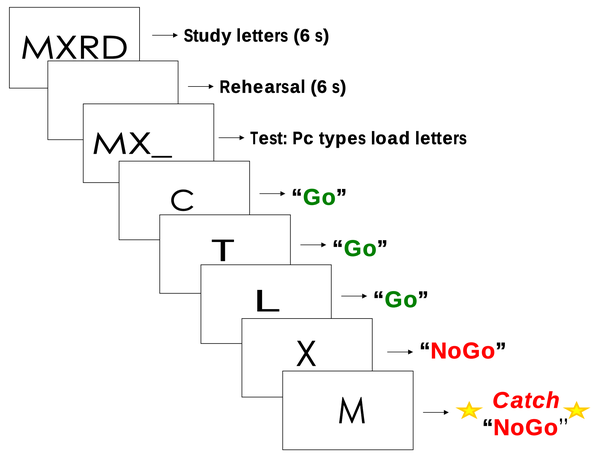
### Participants

| 21 Younger Adults | 18 Older Adults |
|---|---|
| 16 Female | 11 Female |
| M Age: 20.5 (SD = .50) | M Age: 71.9 (SD = 1.2) |

## Method (continued)

### Revised Working Memory Inhibitory Control Task[5]

- WM load varies (2, 4, or 6 letters)
- Participant memorizes letters associated with each trail
- Series of single letter probes follow
  - Go response → probe ***does not*** *match* load letters
  - NoGo (withhold) → probe ***does*** *match* load letters




### Electrophysiological Recordings

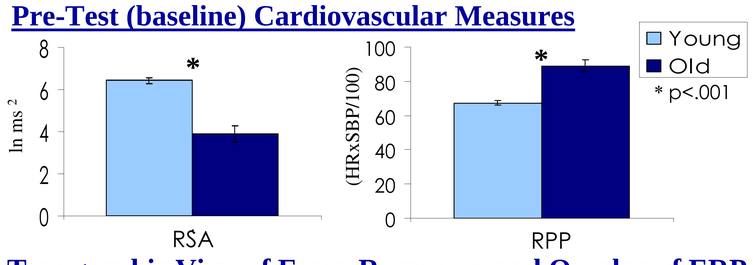
- 128-Channel BioSemi System with an averaged mastoids reference and impedance < 50 kΩ
- Data filtered offline at 1 – 30 Hz
- Regression-based correction for ocular artifact

### Electrocardiogram Recordings

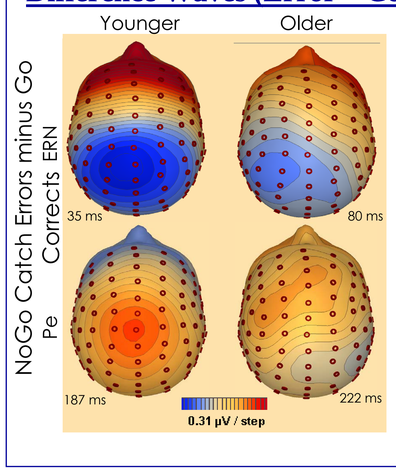
- Recorded using 2 chest electrodes
- RSA calculated offline from ECG by extracting high frequency oscillations associated with normal respiration
- RPP was calculated (Heart Rate x Systolic BP/ 100)

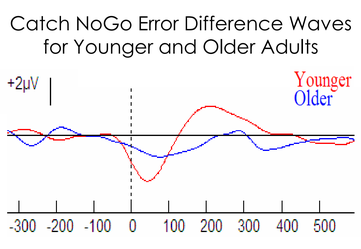
## Results

### Pre-Test (baseline) Cardiovascular Measures




### Topographic View of Error Responses and Overlay of ERP Difference Waves (Error – Correct) for Catch NoGo Errors

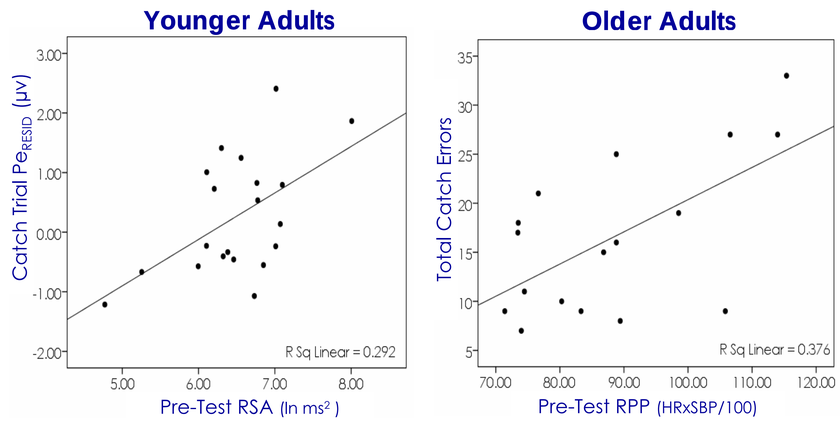



Electrocortical error response is less robust in older adults.

## Results (continued)

- Within each group, error rates increased and ERN/Pe amplitudes decreased across WM loads.
- Older adults responded more cautiously than younger adults, resulting in fewer NoGo errors, except on catch trials.
- Within the younger group, higher baseline RSA was associated with a larger Pe amplitude in response to catch-trial errors (stats).
- Within the older group, higher baseline RPP was associated with a greater error rate on the catch NoGo trials (stats).




## Conclusions

- Autonomic control was not related to WM load but was associated with behavioural and electrocortical responses to unexpected catch trails.
  - In the younger group, those with higher parasympathetic control of cardiac function (higher RSA) at baseline produced a larger electrocortical response to having made a catch-trial error during test, which might be considered an adaptive response.
  - In the older group, higher sympathetic predominance (higher RPP) at baseline, indicating poorer parasympathetic modulation of cardiac function, was associated with a higher rate of catch-trial errors, suggesting poorer response control.

Results indicate that links between cardiac control, electrocortical activity, and performance monitoring may vary as a function of age and provide support for the utility of a neurovisceral integration perspective in our attempts to understand age-related cognitive change.

## References

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**Acknowledgements**

Funded by the Natural Sciences and Engineering Research Council of Canada. Thanks to James Desjardins, Allison Flynn, Sarah Tisi, and Liu Liu for their invaluable assistance.

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**Presented at the 49th Annual Meeting of the Society for Psychophysiological Research. October 21 – 25, 2009. Berlin, Germany**