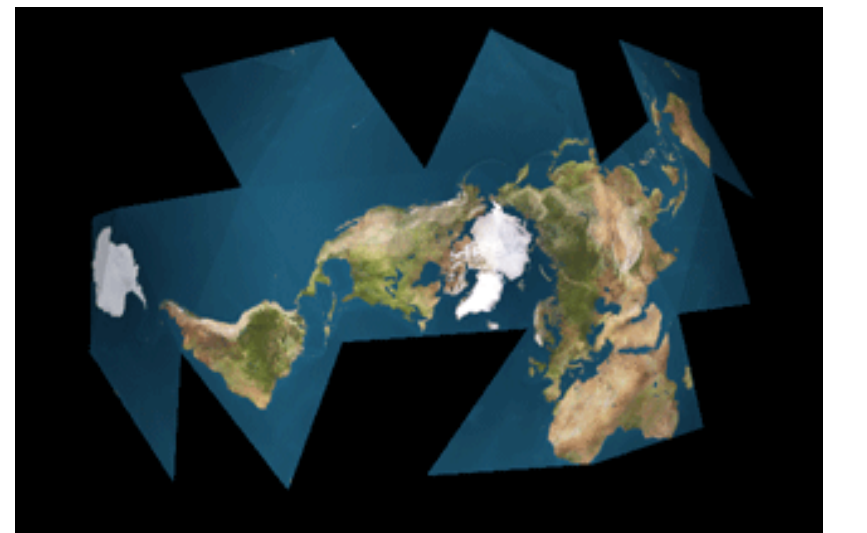


# Determining the Associations Among Stress, Gait, and Cognition: A Study of Functional Ability



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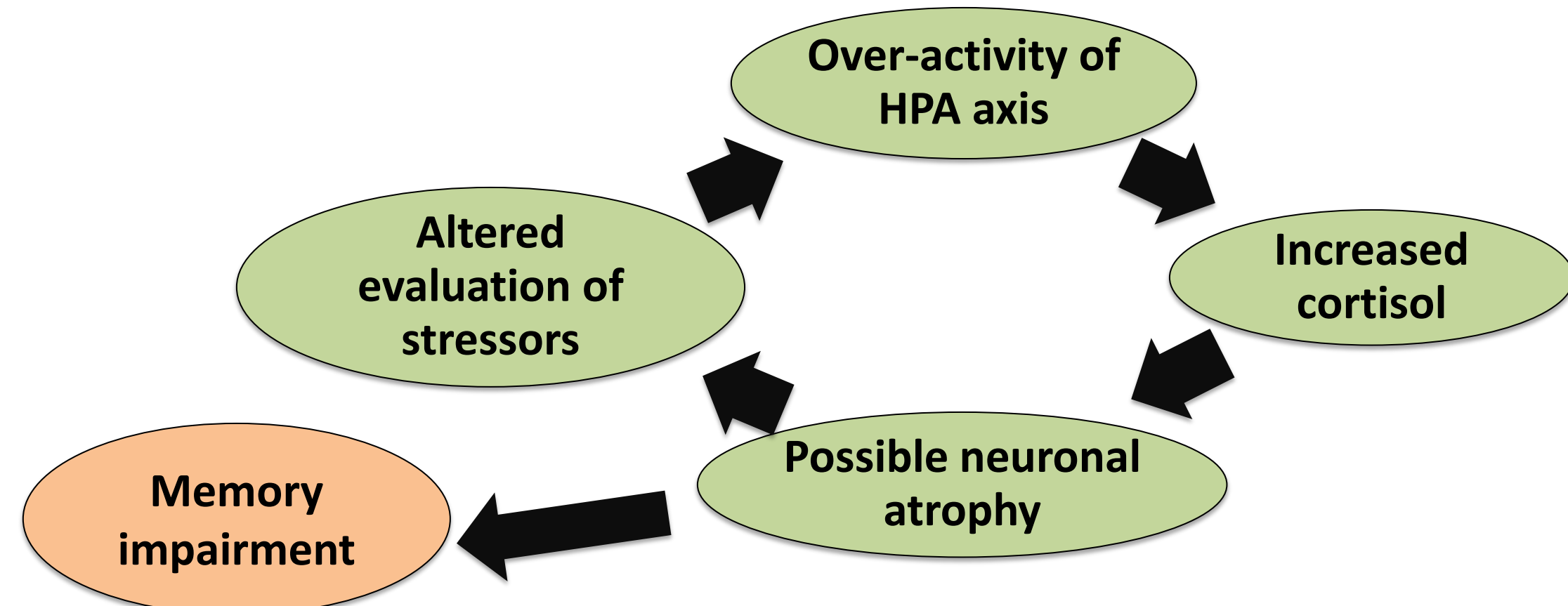
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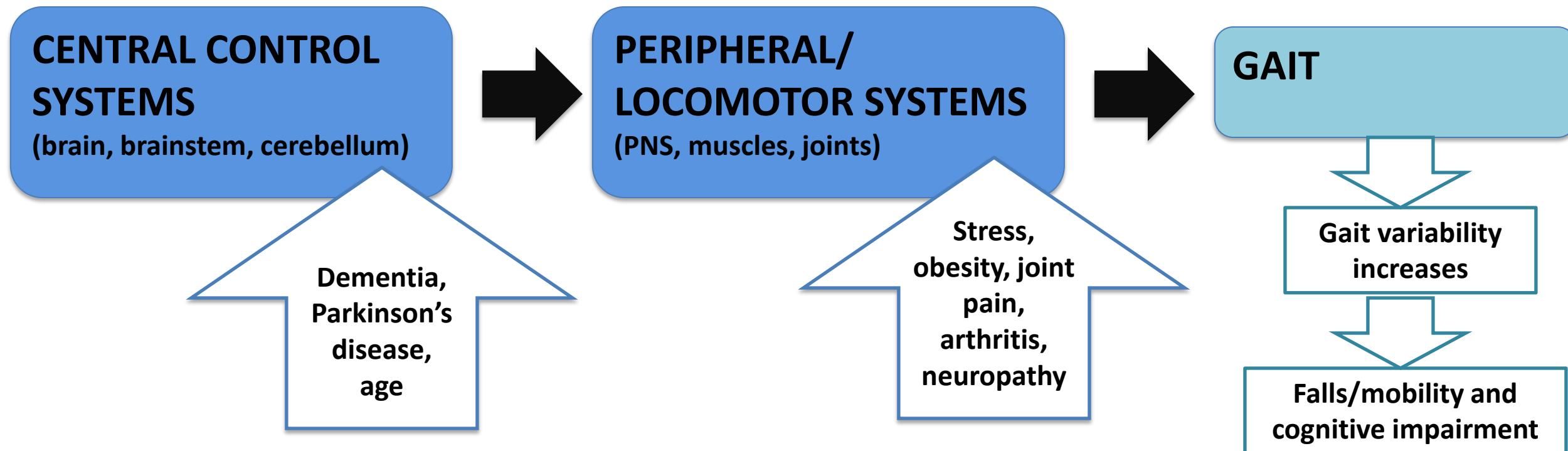
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## BACKGROUND

- Cognitive performance** changes differentially with increasing age.
  - Crystallized, knowledge-dependent abilities are typically preserved until age 70 or older.
    - Non-normative (early) decline can be a sign of pre-clinical dementia.
  - Fluid, executively-demanding tasks begin to show deficits starting at approximately 30 or 40 years of age (Horn & Cattell, 1967).
- Variability** of an individual's performance on attention-demanding tasks is predicted by variability in daily stress (Sliwinski et al., 2006).
  - Latency and accuracy variability in cognitive performance is linked to decreases in processing speed and can be predictive of neurological decline (Hultsch et al., 2000).
  - There is a positive feedback loop between **chronic stress** and over-activity of the hypothalamic-pituitary-adrenocortical (HPA) axis (Miller et al., 2007).



- Protracted stress** can impair the metabolic system, thereby increasing the risk of metabolic syndromes and overloading the **central nervous system** (CNS) (Lupien et al., 2007, Rosano, et al., 2007).
- Both the **CNS** and the **peripheral nervous system** (PNS) play a role in gait change.
  - Gait variability** increases with impairment of the **CNS** (e.g. dementia, Parkinson's disease) or overloading of the **CNS** by the **PNS/locomotor system** (e.g. stress, obesity, joint pain) (Rosano et al., 2007).
  - Gait speed** is linked to risk of morbidity.
    - Slower walking pace is linked to morbidity and shorter life expectancy.
    - Gait speed** provides a snapshot of the health of various bodily systems, such as the cardiovascular system (Studenski et al., 2011).



Role of central and peripheral nervous systems on gait (adapted from Rosano et al., 2007).

## RESEARCH OBJECTIVES AND HYPOTHESES

To explore the potential moderating effect of stress on gait-cognition associations. Negative associations are hypothesized between cognitive function and: (1) self-reported stress; (2) gait pace; and (3) gait variability. (4) Stress is hypothesized to moderate the relationship between gait and cognitive function.

## METHOD AND DESIGN

Sample: N = 64, M<sub>age</sub> = 71.65 (SD 7.48), 73.8% female.

**Cognitive Measures:** Vocabulary, Letter Series Task, Word Recall Task

**Function Measures:** GAITrite Computerized Walkway (CIR Systems, Inc.)

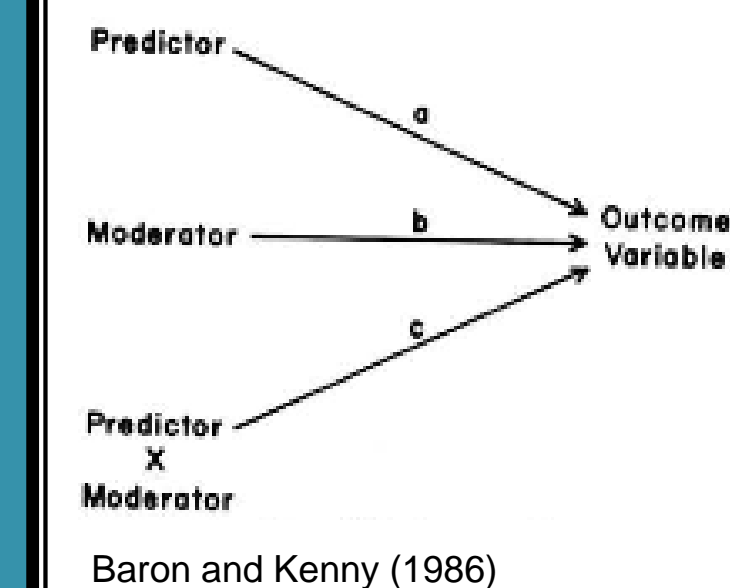
- A 16-foot computerized walkway with embedded pressure sensors.
- Walking conditions: Walk only; **walk + words spelled backwards**.
- Derived indicators included **gait pace** (ambulation time) and **gait variability** (stride length coefficient of variation, or CV).

**Stress Measure:** **Perceived Stress Scale (PSS)** (Cohen, 1983)

**Statistical Models:** Linear regression with stress as a moderator.

$$\text{Cognitive performance} = b_0 + b_1 (\text{Function}) + e$$

$$\text{Cognitive performance} = b_0 + b_1 (\text{Function}) + b_2 (\text{Stress}) + b_3 (\text{Function} * \text{Stress}) + e$$



## RESULTS

**Hypothesis 1: Negative correlation between stress and cognition.**

- No correlation was observed between stress and any of the cognitive tests.

**Hypothesis 2: Negative correlation between gait pace and cognition.**

- Significant negative correlation between gait pace and word recall:
 
$$r = -.275, p < .05$$
- No correlation was observed between gait pace and letter series task or vocabulary.

**Hypothesis 3: Negative correlation between gait variability and cognition.**

- Significant negative correlation between gait variability and letter series task:
 
$$r = -.269, p < .05$$
- No correlation was observed between gait variability and word recall or vocabulary.

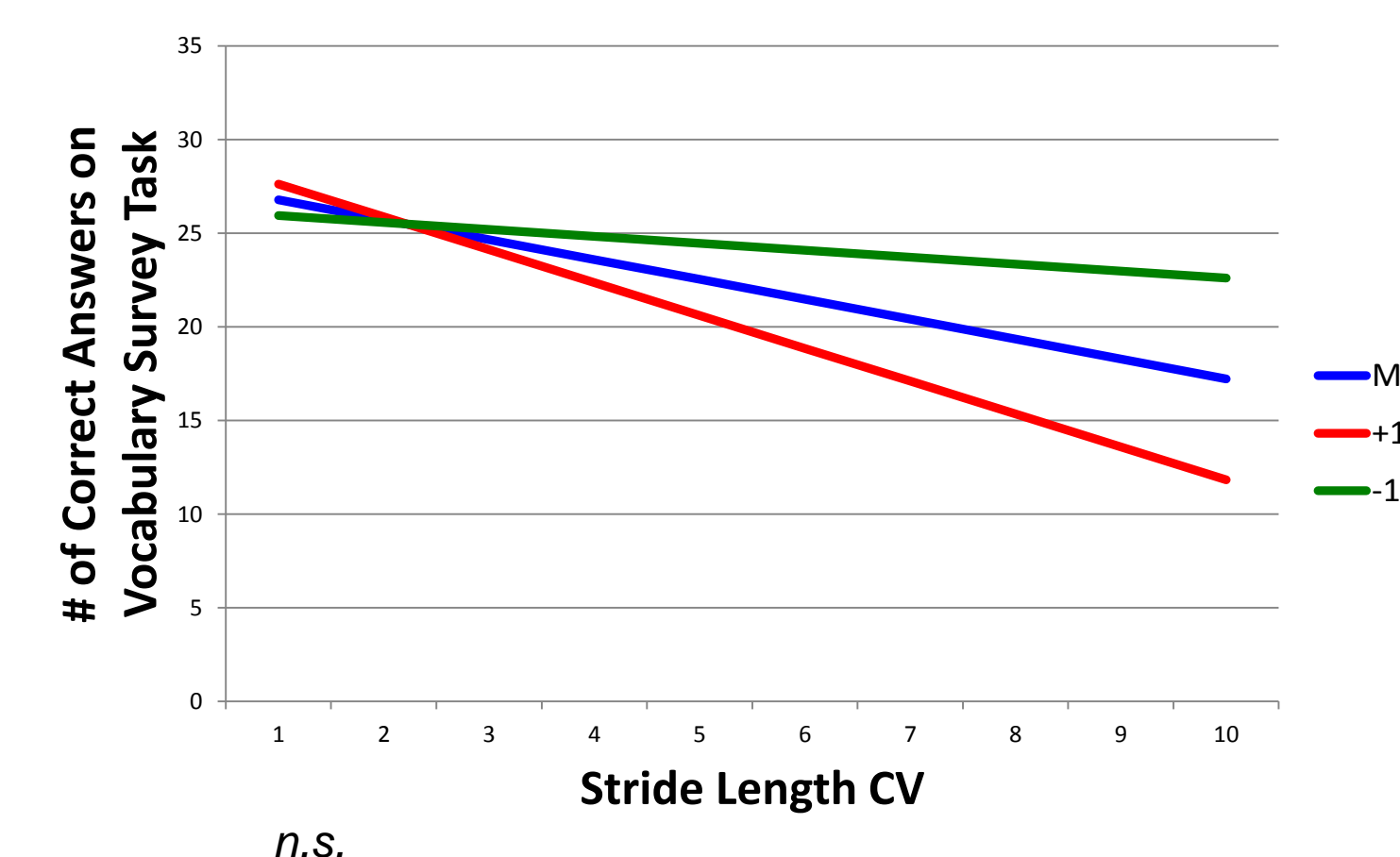
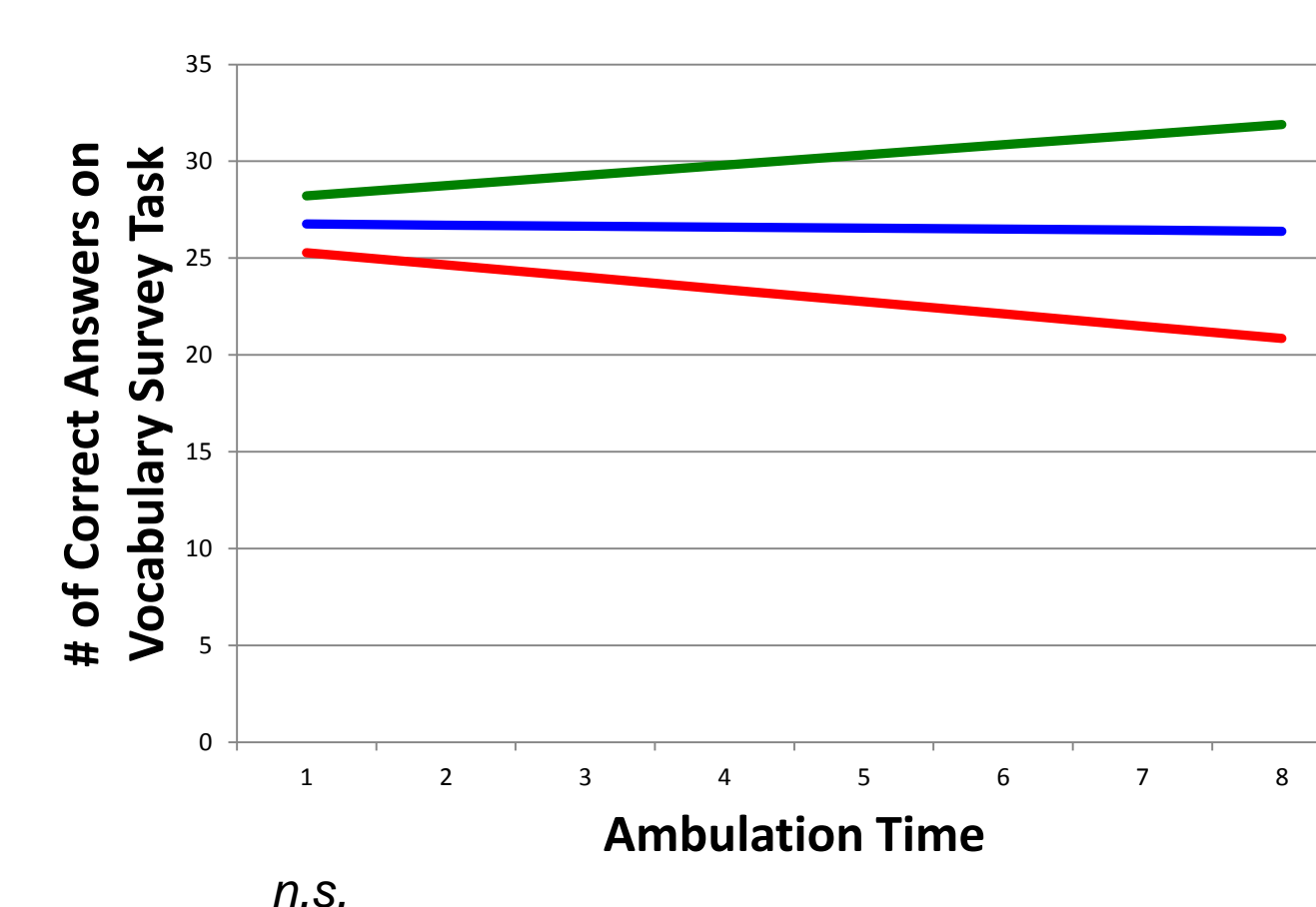
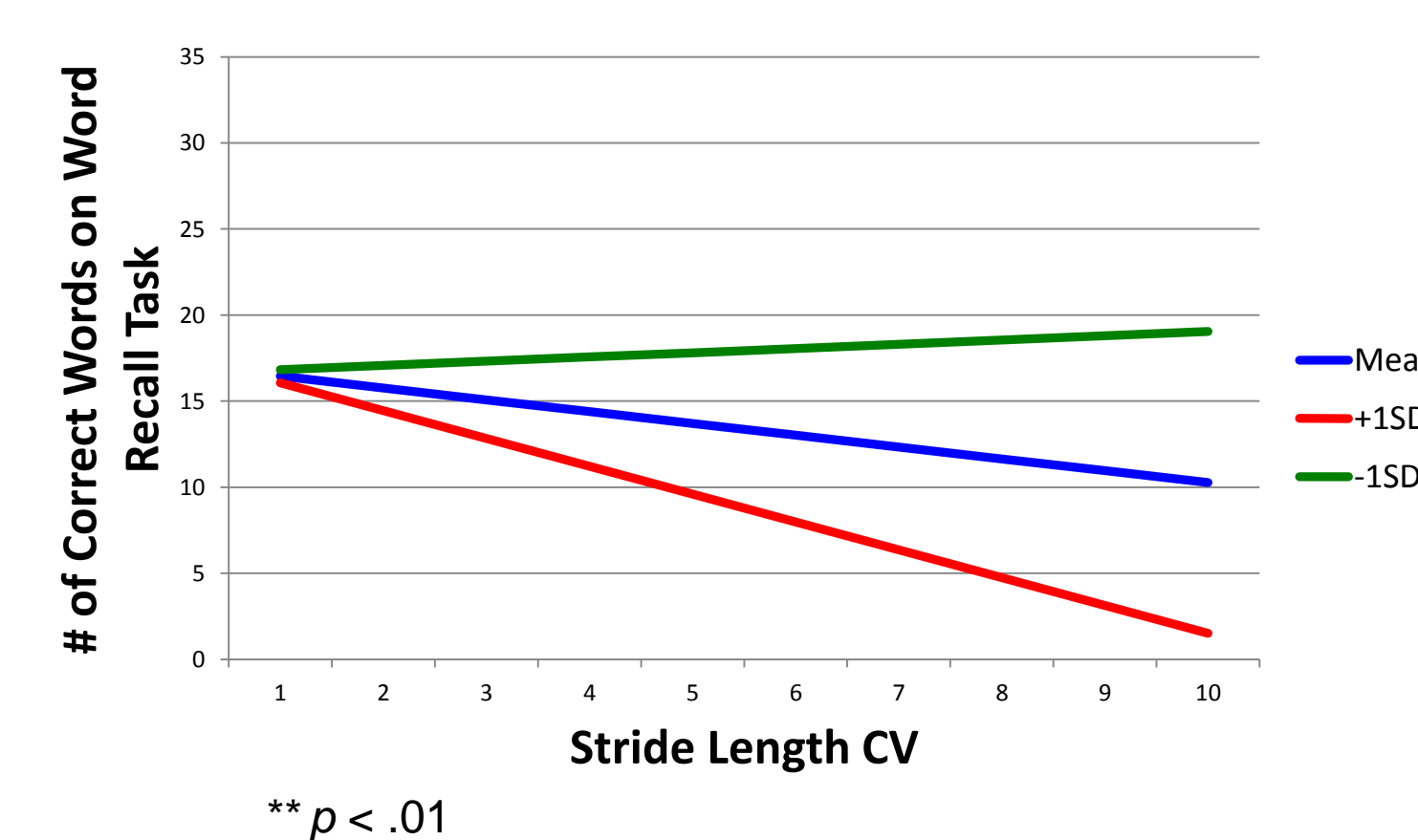
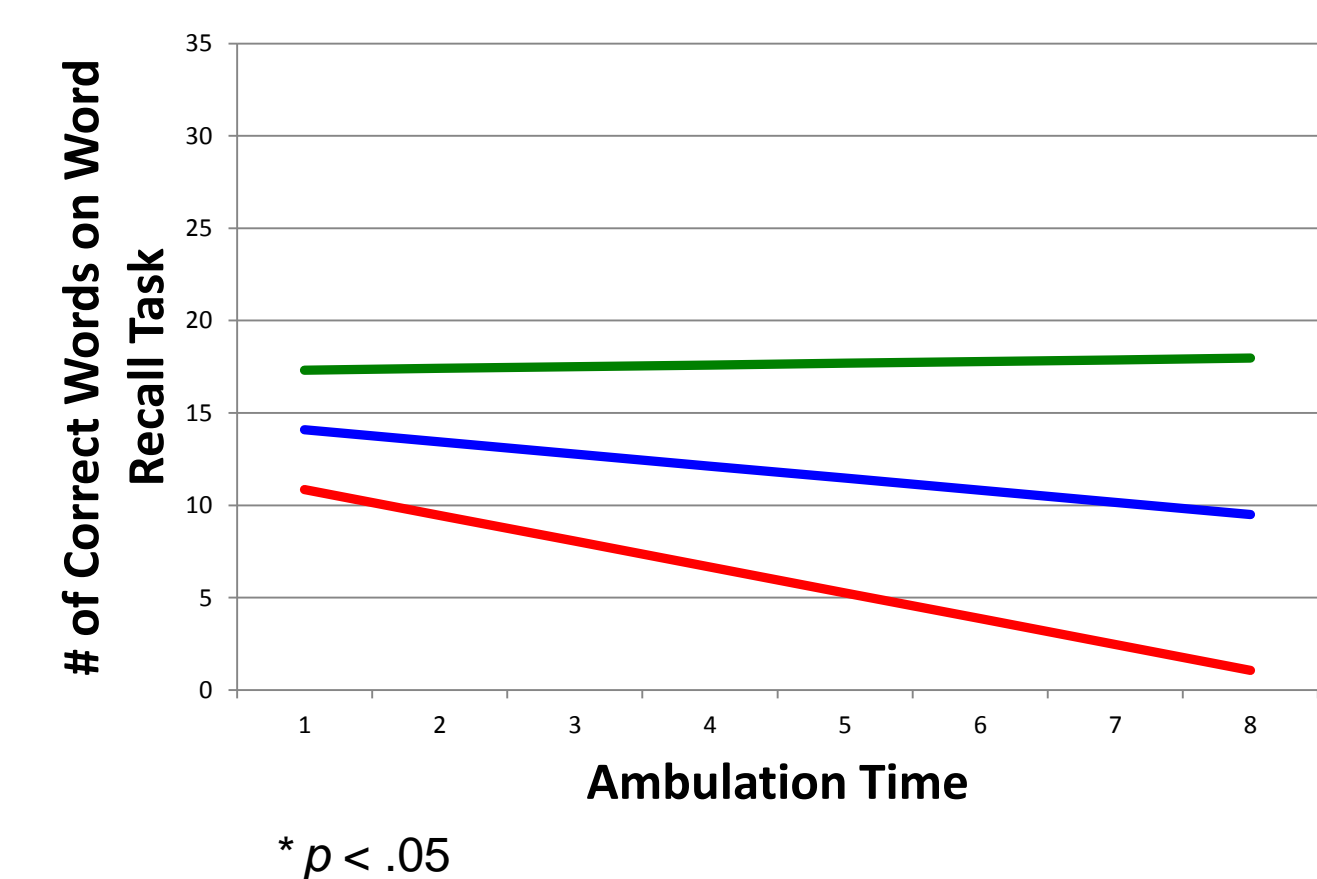
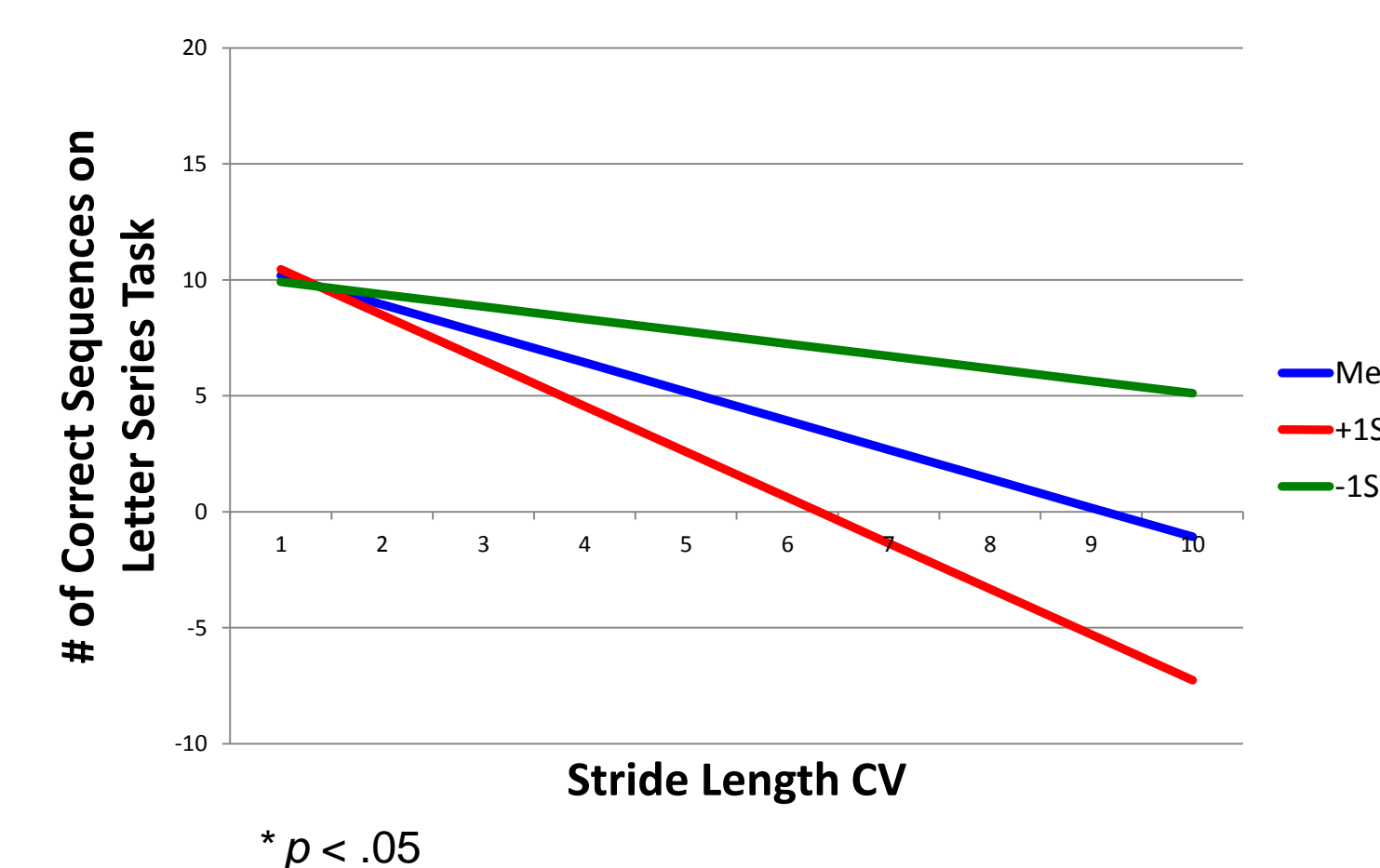
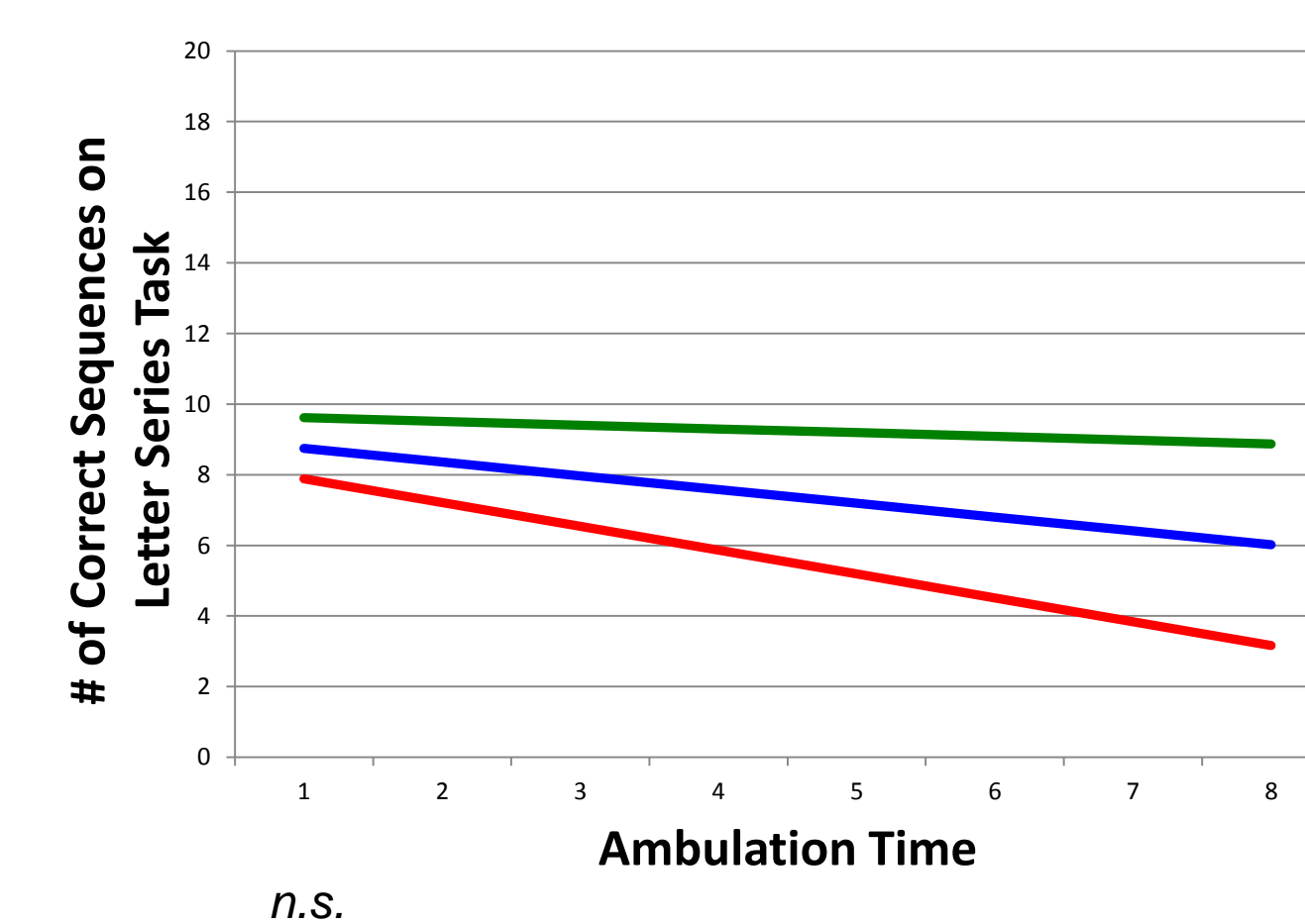
**Hypothesis 4: Stress as a moderator of gait-cognition associations:**

- Stress (Z) moderated the relationship between:
  - Gait pace (X) and word recall (Y).
 
$$XZ: R^2_{\text{chg}} = .084, b = .089, t(60) = 2.434, p < .05$$
  - Gait variability (X) and word recall (Y).
 
$$XZ: R^2_{\text{chg}} = .115, b = 11.175, t(60) = 2.816, p < .01$$
  - Gait variability (X) and letter series task (Y).
 
$$XZ: R^2_{\text{chg}} = .077, b = 8.603, t(59) = 2.291, p < .05$$

**In summary:**

- Participants with **>1SD** in PSS scores and with a slower pace had significantly lower scores on a task indexing fluid intelligence.
- Participants with **>1SD** in PSS scores and greater variability in stride length had significantly lower scores on two measures of fluid ability.

## Stress as a Moderator of Gait-Cognition Associations



## DISCUSSION

### Relevance

- Results support previous research showing a negative association between gait pace or gait variability and cognitive tasks.
  - Factors that influence the **PNS** in older adults, such as **stress levels**, show moderating effects on the relationship between gait and more demanding **cognitive tasks** (Rosano et al., 2007).
- With increasing age, impairments in walking and cognitive tasks may be experienced due to **declines in cognitive resources**.
  - With limited resources for performing cognitively demanding sensorimotor tasks, the increased demands stress poses on cognitive resources may manifest as further impairment (Lovden et al., 2008).
- Stress was not a significant predictor of cognitive performance; however, increased stress exacerbates gait-cognition associations on tasks requiring more fluid abilities, which is consistent with the **restricted resources hypothesis** (Lovden et al., 2008).

### Challenges

- PSS** is not a clinical diagnostic tool, therefore there exists no norms or classifications for high, moderate, and low stress.
- Results may not generalize to other populations due to the high socioeconomic status and above-average health of our participants.

### Future Research

- Further research investigating the relationship between stress, gait and cognition will aid in understanding the levels of stress in older adults and how this impacts functional ability.
  - Additional tools for measuring stress could include both physiological (e.g. salivary, urinary, hair measures) and psychological (e.g. normative scales) measures.

## ACKNOWLEDGEMENTS

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