

The Relationship Between Sustained Attention and Parasympathetic Functioning: A Registered Report

Background

TERMINOLOGY TOOLBOX

- **Sustained attention (SA)** is a crucial ability that plays a key role in functional outcomes in academic, social communication, and driver safety
- **Heart rate variability (HRV)** is a non-invasive sensitive measure of parasympathetic influences on the heart

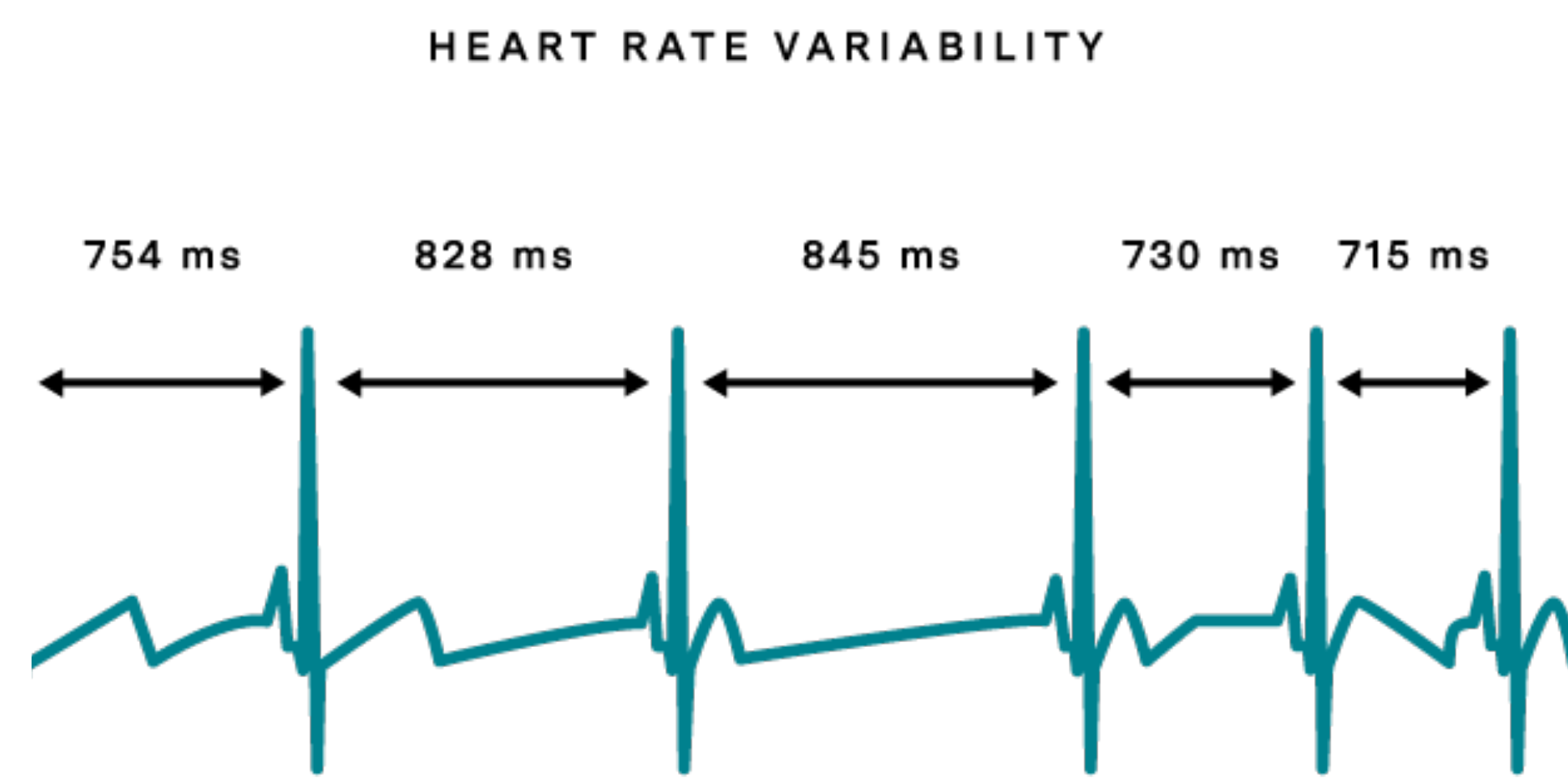


Figure 1. HRV shows how your heart rate varies between certain times as an outcome of doing different tasks

SCENARIO

Imagine you have trouble focusing and you realize you could use your own breathing techniques to improve your attention. My research links attention to parasympathetic function, which is easily modulated by behavioral intervention.

MOTIVATION

We are interested in the relationship between the parasympathetic nervous system and sustained attention, due to its potential for noninvasive cognitive enhancement.

RESEARCH QUESTION

- Previous studies suggest resting HRV may be a key predictor of one's ability to sustain attention, but no study to date has investigated this question with a validated measure of SA.

- We hypothesize participants with higher resting HRV will exhibit better SA on a validated measure of SA, as well as report greater SA in their daily life through questionnaires

Projected Results

- We hypothesize higher resting HRV will be associated with better discrimination ability (d') and lower reaction time variability on an assessment of sustained attention (**higher HRV = better sustained attention and better gradCPT performance**)
- We further hypothesize that a higher resting HRV will be associated with mindful awareness, fewer attentional errors, greater self regulation, and less media multitasking (**higher HRV = better sustained attention in daily life**)
- We are currently in the middle of data collection and intend to have results in the next few months

Methods

Participants:

- 100 young adults (roughly equal gender distribution)

Protocol:

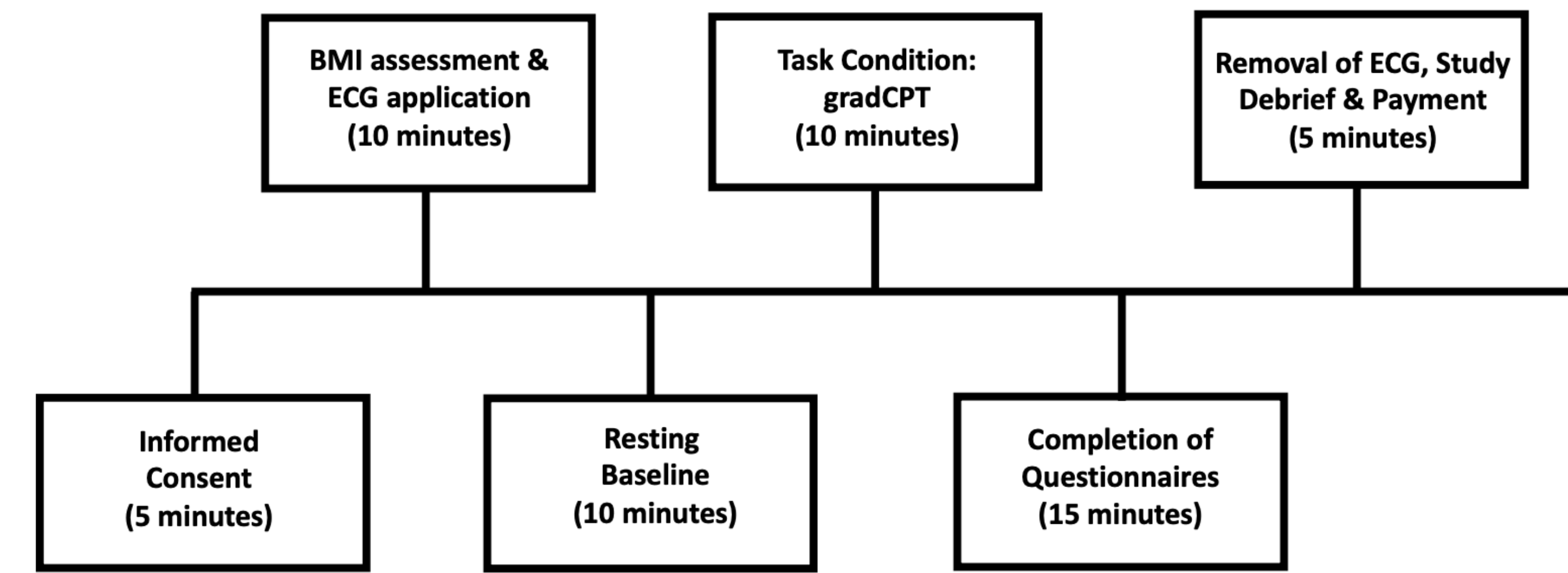


Figure 1. Study protocol

Questionnaires:

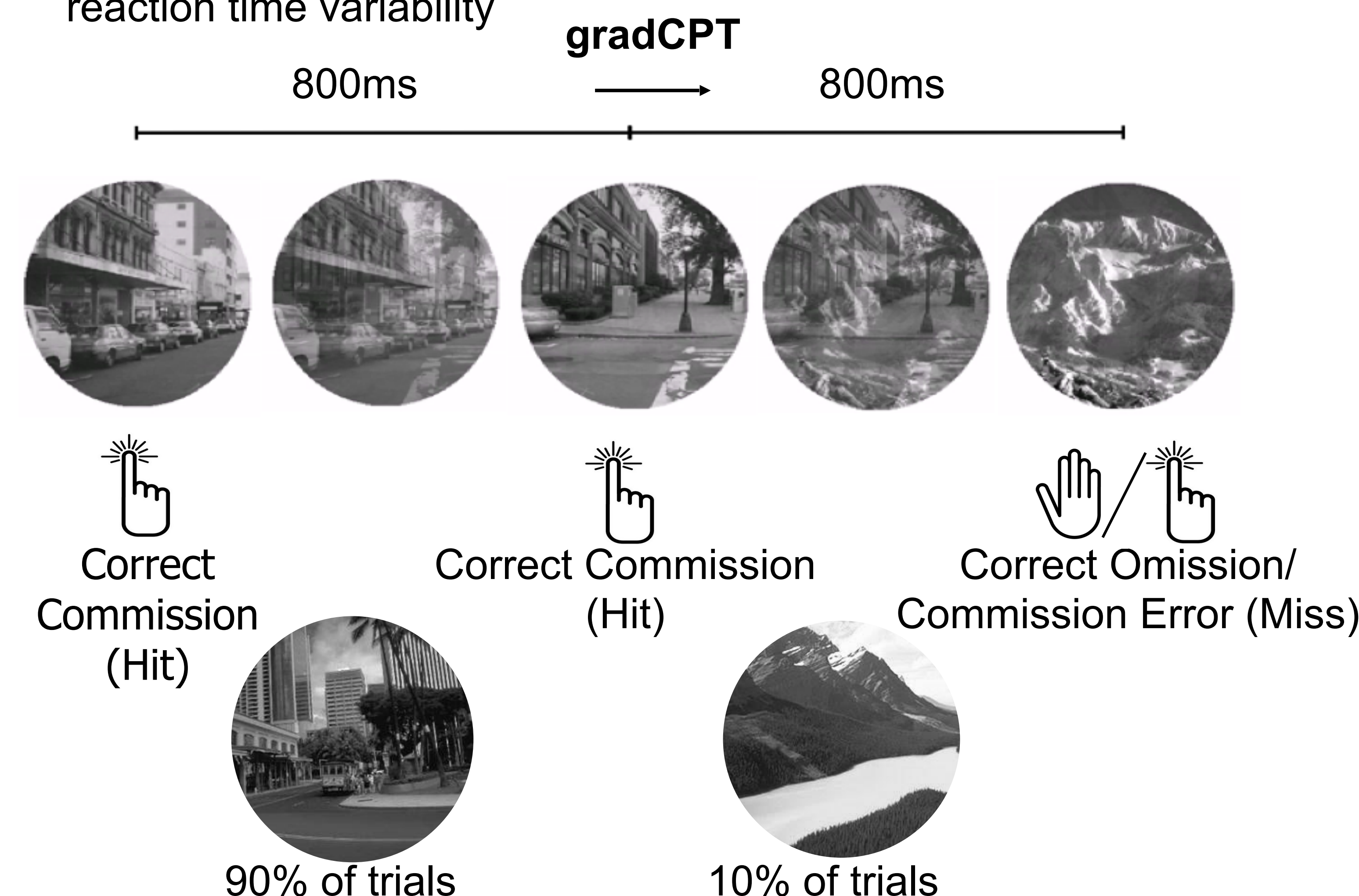
- Attention-related cognitive errors survey (ARCES)
- Short self-regulation questionnaire (SSRQ)
- Short media-multitasking measure (MMM-S)
- Mindful attention awareness scale (MAAS)

Heart Rate Variability Assessment:

- Zephyr Bioharness
- Non-invasive technique of measuring HRV
- Primary measure of vmHRV will be the time domain metric RMSSD
- RMSSD is considered a marker of vmHRV, largely independent of the potential effects of respiration rate and a predictor of individual differences in attentional maintenance and performance variability

Gradual-onset continuous performance task

- Participants are instructed to respond via button press when presented with gradually fading city scenes, and withhold a button press to gradually fading mountain scenes
- Sustained attention ability is best characterized by accuracy (d') and reaction time variability



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Intended Analysis

Proposed Regression Analyses:

Purpose	Approach	Independent Measures	Dependent Measures	Number of Tests	Covariates
Test: Association between resting vmHRV and dependent measures	Sequential Linear Regression and Bayes Factors regression	Resting RMSSD	GradCPT Performance (d' , CV) Dispositional Surveys (ARCES, SSRQ, MMM-S, MAAS)	6 (1 dependent measure) with FDR correction for multiple comparisons	Age, Sex, BMI, Time of day
Association between vagal reactivity and dependent measures	Sequential Linear Regression and Bayes Factors regression	Task based RMSSD – resting RMSSD with estimated respiration regressed out	GradCPT Performance (d' , CV) Dispositional Surveys (ARCES, SSRQ, MMM-S, MAAS)	6 (1 dependent measure) with FDR correction for multiple comparisons	Age, Sex, BMI, Time of day

Table 1. Note. vmHRV = vagally-mediated heart rate variability; RMSSD = root mean square of the successive differences between normal heartbeats; GradCPT = gradual-onset continuous performance task; d' prime = discrimination ability; CV = coefficient in variation of reaction time; ARCES = attention-related cognitive errors survey; SSRQ = short self-regulation questionnaire; MMM-S = short media-multitasking measure; MAAS = mindful attention awareness scale; BMI = body mass index.

Structural Regressions

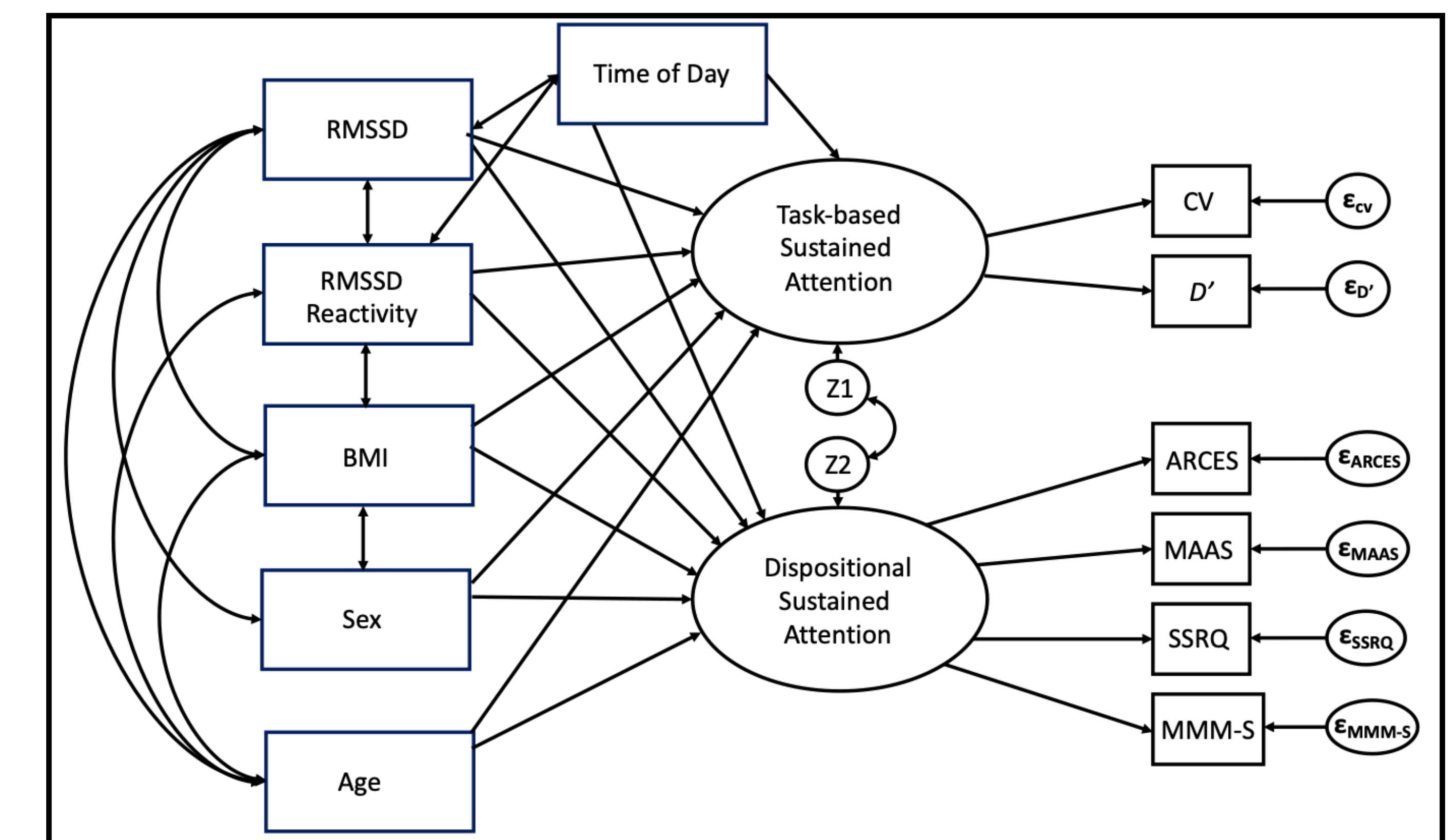


Figure 2. Structural regression for model 1 in which predictors (RMSSD, RMSSD reactivity, BMI, sex, age, and time of day) predict task-based and dispositional sustained attention.

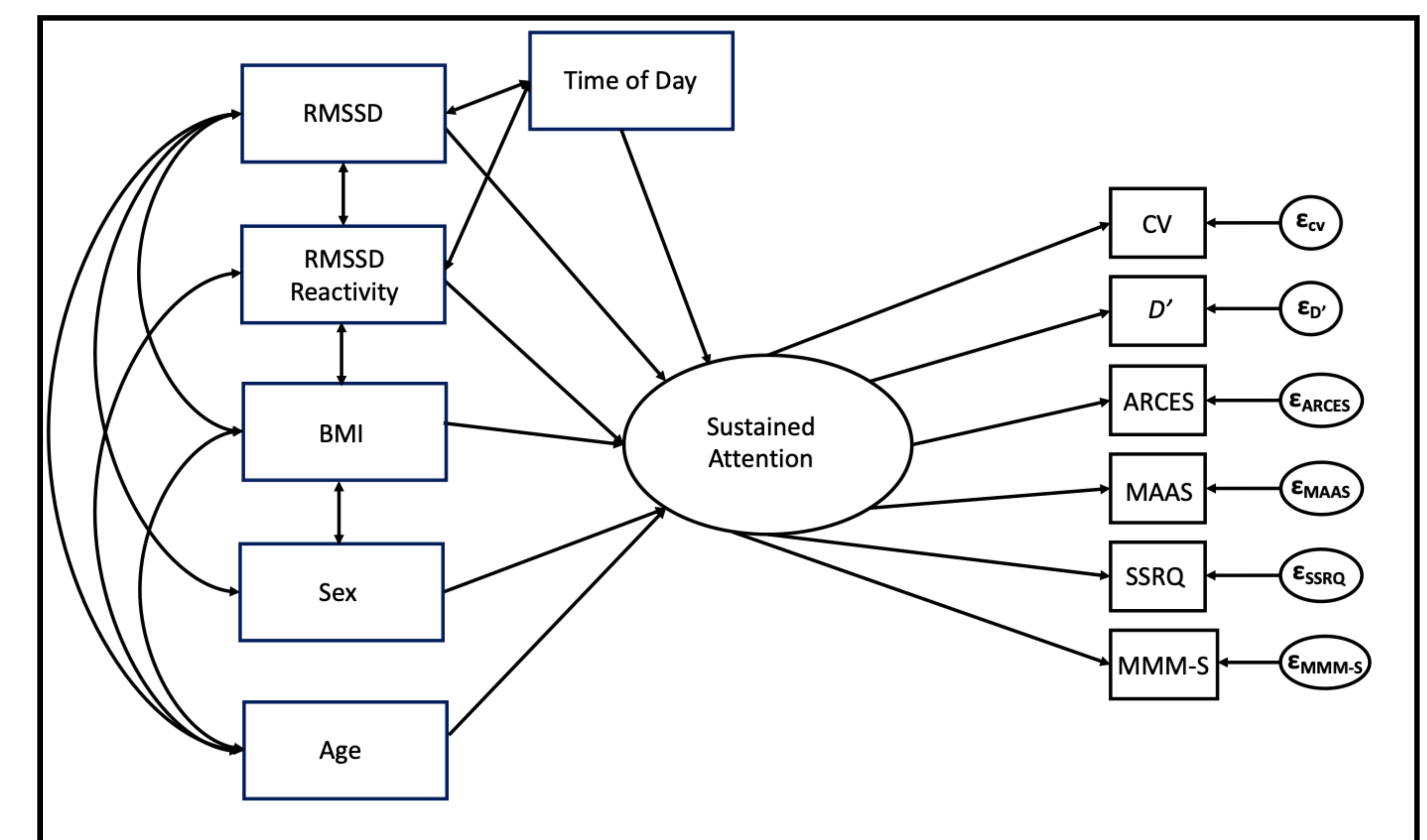


Figure 3. Structural regression for model 1 in which predictors (RMSSD, RMSSD reactivity, BMI, sex, age, and time of day) predict sustained attention.