Virtual Nature Exposure and Slow Breathing Interactive Effect on Stress

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Background

The Impact of Maladaptive Stress on Well-being

- Chronic or severe stress has been implicated in numerous adverse physiological and psychological health outcomes (Kario et al., 2003; Poller et al., 2022; Smith, 2023)

How can we Reduce Stress?

- **Natural Environments**
  - Evidence for stress reduction found in real natural environments (Yu et al., 2017), 3-D virtual reality exposure (Anderson et al., 2017), and static 2-D images (Tang et al., 2017)

Theoretical Accounts for Nature as a Stress Reducer

- Evolutionary accounts (Wilson, 1984)
- Attention based account (Kaplan & Kaplan, 1989)
- Arousal based account (Ulrich et al., 1991)

- **Slow Breathing**

Biological Mechanisms (Boyadzhieva & Kayhan, 2021)

- Activates baroreceptors -> Stimulation of vagus nerve
  - Natural occurrence after resolution of threat or challenge
  - Shift towards parasympathetic dominance
- Hypothalamic-Pituitary-Adrenal (HPA) suppression (Herman et al., 2016)

How is Stress Measured?

- **Heart Rate Variability (HRV)**
  - HRV is a multidimensional measure of changes between heart-beat intervals
  - Relaxation = Increase in value (parasympathetic activation)
  - **Standard deviation of NN intervals (SDNN)**
    - Spread of NN intervals: provides overall measure of change
  - **Root mean square of successive differences (RMSSD)**
    - Change between successive NN intervals: Provides moment-to moment changes

Research Question

Does controlled breathing and exposure to a virtual natural environment reduce physiological stress?

Hypotheses

- **Environment X Breathing Interaction**
  - Nature Image + Slow Breathing > All Other Conditions
- **Main Effect: Environment**
  - Nature Image > Control
- **Main Effect: Breathing**
  - Slow Breathing > Control

Method

Participants

- Cal Poly Humboldt students (N = 73); 45 female, 17 male, 10 other gender, 1 decline to answer
  - Ethnicity: American Indian/Alaska Native (2), Asian (5), Black/African American (1), Hispanic/Latino (10), White (33), Other (1), Multiple Ethnicities (21)

Materials and Measures

HRV Measurement Tools

- Polar H10 Heart Rate Monitor and Elite HRV Application
- Kubios HRV Scientific Lite and RStudio

Color-Word Stroop Task: Stress Task (Fig. 1)

- Participants say aloud font colors of color words that match or mismatch

Method (cont.)

Visual Stimuli (see Fig. 2)

- **Nature:** Contains forest, water, and mountain elements
- **Control:** Light grey screen

Breathing Condition: Breathing Instructions

- **Slow:** Instructed to inhale and exhale for 5 seconds each
- **Control:** No breathing instructions provided

Design

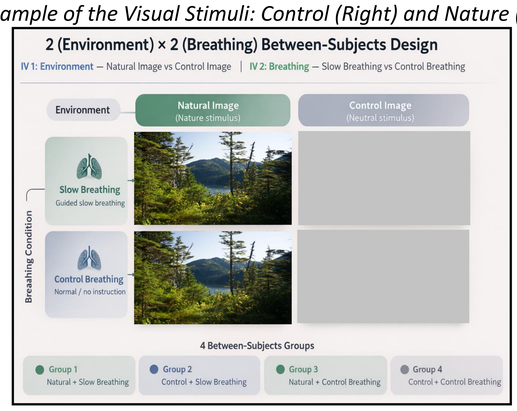
- **2 Environment (Nature v. Control) X 2 Breathing (Slow v Control) Between-Subjects (Figure 2)**
  - **DV 1: SDNN (logarithmically transformed for normalcy)**
    - Difference between Phase 3 and Phase 4
  - **DV 2: RMSSD (logarithmically transformed for normalcy)**
    - Difference between Phase 3 and Phase 4

Procedure

- **Phase 1:** Consent form, demographics
- **Phase 2:** Baseline HRV: 2 min.
- **Phase 3:** Stroop Task (Stress induction): 4 min. HRV is measured (Fig. 1)
- **Phase 4:** Experimental conditions: 5 min. HRV is measured (Fig. 2)
- **Phase 5:** Debriefing

Figure 1.
Representation of HRV Measurement Device and Stroop Task

Figure 2.
Representation of the Experimental Design and Conditions with example of the Visual Stimuli: Control (Right) and Nature (Left)



Cal Poly Humboldt.

Analysis

- Two 2 Environment (Nature v. Control) X 2 Breathing (Slow v. Control) Between-Subjects ANOVAs: DVs = SDNN and RMSSD

Results

- **DV: log(SDNN)**
  - **No Interaction or Main Effect of Environment**
  - **Main Effect: Breathing (Figure 3)**
    - Those in the Slow condition demonstrated significantly higher log(SDNN) levels than those in the Control Breathing condition [$F(1, 59) = 19.49$, $p < .001$, $\eta^2 = .247$
- **DV: log(RMSSD)**
  - **No Interaction or Main Effect of Environment**
  - **Main Effect: Breathing (Figure 4)**
    - Those in the Slow condition demonstrated significantly higher log(RMSSD) levels than those in the Control Breathing condition [$F(1, 58) = 4.63$, $p = .036$, $\eta^2 = .071$

Figure 3
Main Effect for Breathing in log(SDNN)

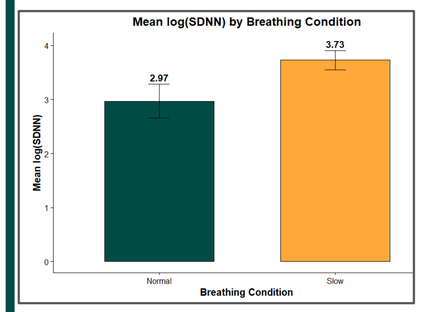
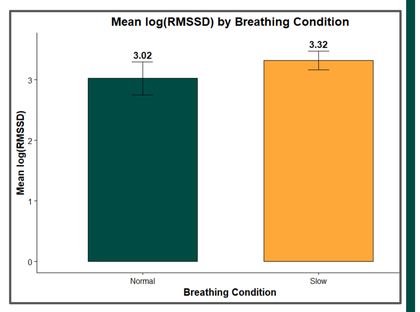


Figure 4
Main Effect for Breathing in log(RMSSD)



Discussion

- The current study examined two accessible research-based methods of stress reduction: Nature Exposure and Slow Breathing.

Effectiveness of Slow Breathing

- Slow breathing significantly increased log(SDNN) and log(RMSSD), consistent with improved automatic regulation during stress recovery
  - In line with past research (Lee et al., 2021)
- ***Considerations:*** Respiratory sinus arrhythmia (RSA) can mechanically influence HRV during controlled breathing, it is still commonly interpreted as reflecting greater parasympathetic influence (Zaccaro et al., 2018)

Limitations

- Small sample = limited explanatory power
- No direct measurement of respiration
- **IV: Environment**
  - Ineffective: Contrary to past research (Park et al., 2009)
  - 2-D static image, not as effective as immersion in real or virtual nature
  - Possible Ceiling effect: Cal Poly Humboldt is situated next to redwood forest

Conclusions

- In terms of SDNN and RMSSD slow breathing is an accessible and effective stress reducer
- Further research needed on the effects of environment

Scan for poster link; References in notes section