

Fatty fish and key nutrients: their impact on stress resilience

Anita L. Hansen
Professor

- University of Bergen, Department of Psychosocial Science
- Centre for Research and Education in Forensic Psychiatry (CREFP), Haukeland University Hospital, Bergen, Norway

Interdisciplinary collaboration

- **Institute of Marine Research**
 - Lisbeth Dahl



- **University of Bergen**
 - **Department of Chemistry**
 - Bjørn Grung



- **Centre for Research and Education in Forensic Psychiatry,
Haukeland University Hospital/Correctional Service**
 - Leif Waage
 - Knut Rypdal



- **Mendota Mental Health Institute/Sand Ridge Secure Treatment Center, Wisconsin**
 - David Thornton, Gina Ambroziak, James Mundt and Rachel Kahn



Article

Vitamin D Supplementation during Winter: Effects on Stress Resilience in a Randomized Control Trial

Anita L. Hansen ^{1,2,*}, Gina Ambroziak ³, David Thornton ^{3,4}, James C. Mundt ³, Rachel E. Kahn ³, Lisbeth Dahl ⁵, Leif Waage ², Daniel Kattenbraker ³, Pedro Araujo ⁵, Robert Murison ⁶, Knut Rypdal ² and Bjørn Grung ⁷

¹ Department of Psychosocial Science, University of Bergen, Christiesgt. 12, 5015 Bergen, Norway

² Centre for Research and Education in Forensic Psychiatry, Haukeland University Hospital, 5021 Bergen, Norway; lwaage@online.no (L.W.); knut.rypdal@helse-bergen.no (K.R.)

³ Sand Ridge Secure Treatment Center (SRSTC), P.O. Box 0700, 1111 North Road, Mauston, WI 53948, USA; Gina.Ambroziak@dhs.wisconsin.gov (G.A.); davidsthornton@icloud.com (D.T.); James.Mundt@dhs.wisconsin.gov (J.C.M.); Rachel.Kahn@dhs.wisconsin.gov (R.E.K.); Daniel.Kattenbraker@dhs.wisconsin.gov (D.K.)

⁴ Forensic Assessment, Training and Research, LLC 1213 N. Sherman Avenue, Suite 334, Madison, WI 53704, USA

⁵ Department of Seafood, Nutrition and Environmental State, Institute of Marine Research, P.O. Box 1870, Nordnes, 5817 Bergen, Norway; lisbeth.dahl@hi.no (L.D.); Pedro.Araujo@hi.no (P.A.)

⁶ Department of Biological and Medical Psychology, University of Bergen, Jonas Lies vei 91, 5021 Bergen, Norway; murison@uib.no

⁷ Department of Chemistry, University of Bergen, Allégaten 41, 5007 Bergen, Norway; bjorn.grung@uib.no

* Correspondence: anita.hansen@uib.no; Tel.: +47-5558-3185

Received: 17 September 2020; Accepted: 22 October 2020; Published: 24 October 2020



Abstract: Vitamin D status may be important for stress resilience. This study investigated the effects of vitamin D supplements during winter on biological markers of stress resilience such as psychophysiological activity, serotonin, and cortisol in a placebo-controlled, randomized clinical trial. Eighty-six participants were randomly assigned to the Intervention (vitamin D) or Control (placebo) groups. Before and after the intervention participants were exposed to an experimental stress procedure. Psychophysiological activity was measured during three main conditions: baseline, stress, and recovery. Fasting blood samples were taken in the morning and saliva samples were collected at seven different time points across 24 h. Prior to intervention both groups had normal/sufficient vitamin D levels. Both groups showed a normal pattern of psychophysiological responses to the experimental stress procedure (i.e., increased psychophysiological responses from resting baseline to stress-condition, and decreased psychophysiological responses from stress-condition to recovery; all $p < 0.009$). Post-intervention, the Intervention group showed increased vitamin D levels ($p < 0.001$) and normal psychophysiological responses to the experimental stress procedure ($p < 0.001$). Importantly, the Control group demonstrated a classic nadir in vitamin D status post-intervention (spring) ($p < 0.001$) and did not show normal psychophysiological responses. Thus, physiologically the Control group showed a sustained stress response. No significant effects of vitamin D were found on serotonin and cortisol.

Keywords: vitamin D; stress resilience; heart rate variability; heart rate; serotonin; cortisol

1. Introduction

Regular consumption of fatty fish has been shown to have beneficial health effects [1–4]. In a recent study a long-term fatty fish intervention improved resilience to stress in a group of forensic inpatients





Background: Nutrition and mental health

- Investigated the effects of ***different diets*** on mental health in a group of participants with ***severe mental health problems*** over a period of 6 months
- The study was carried out during wintertime in a high secure forensic inpatient facility in the US

Overall results from “Nutrition and mental health” project

- **Regular fatty fish consumption caused beneficial effects on**

- Psychophysiological activity
- Anxiety
- Daily functioning
- Cognition (planning and decision making)
- Regular physical activity
- Stress resilience



- **No fatty fish consumption caused adverse effects**

- Increased resting heart rate during wintertime (risk factor for CVD)
- Increased sleep latency during wintertime
- Irregular physical activity and a successive decrease in PA during winter time
- Poor stress resilience during wintertime

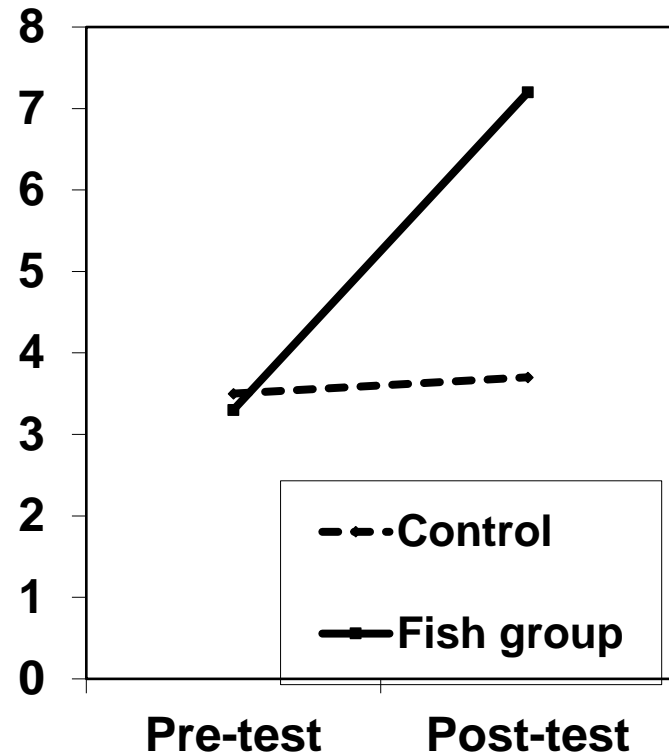


- No doubt that regular fatty fish consumption has beneficial effects
- But, what are the mechanisms of action?

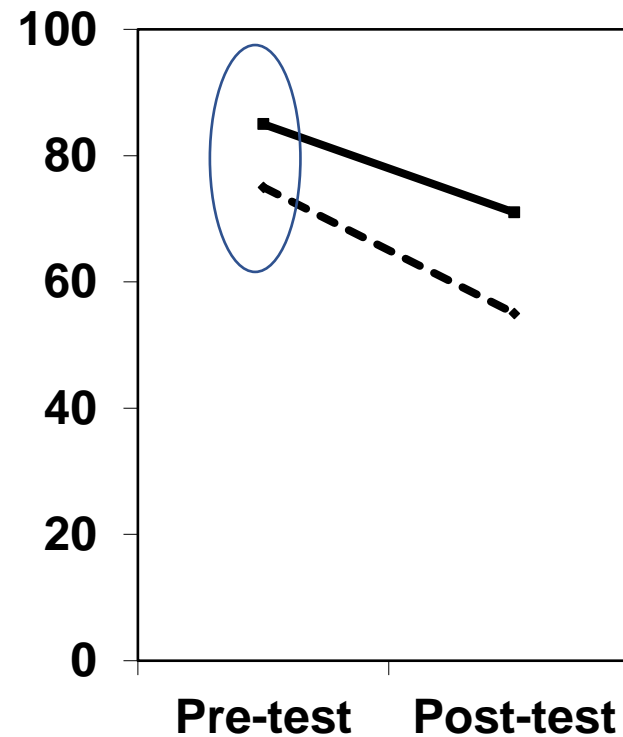
Omega-3
Vitamin D
Selenium
++



Omega-3 (EPA+DHA %)



Vitamin D status (nmol/L)



Both groups had optimal level (US population > 75 nmol/L) in vitamin D status at pre-test

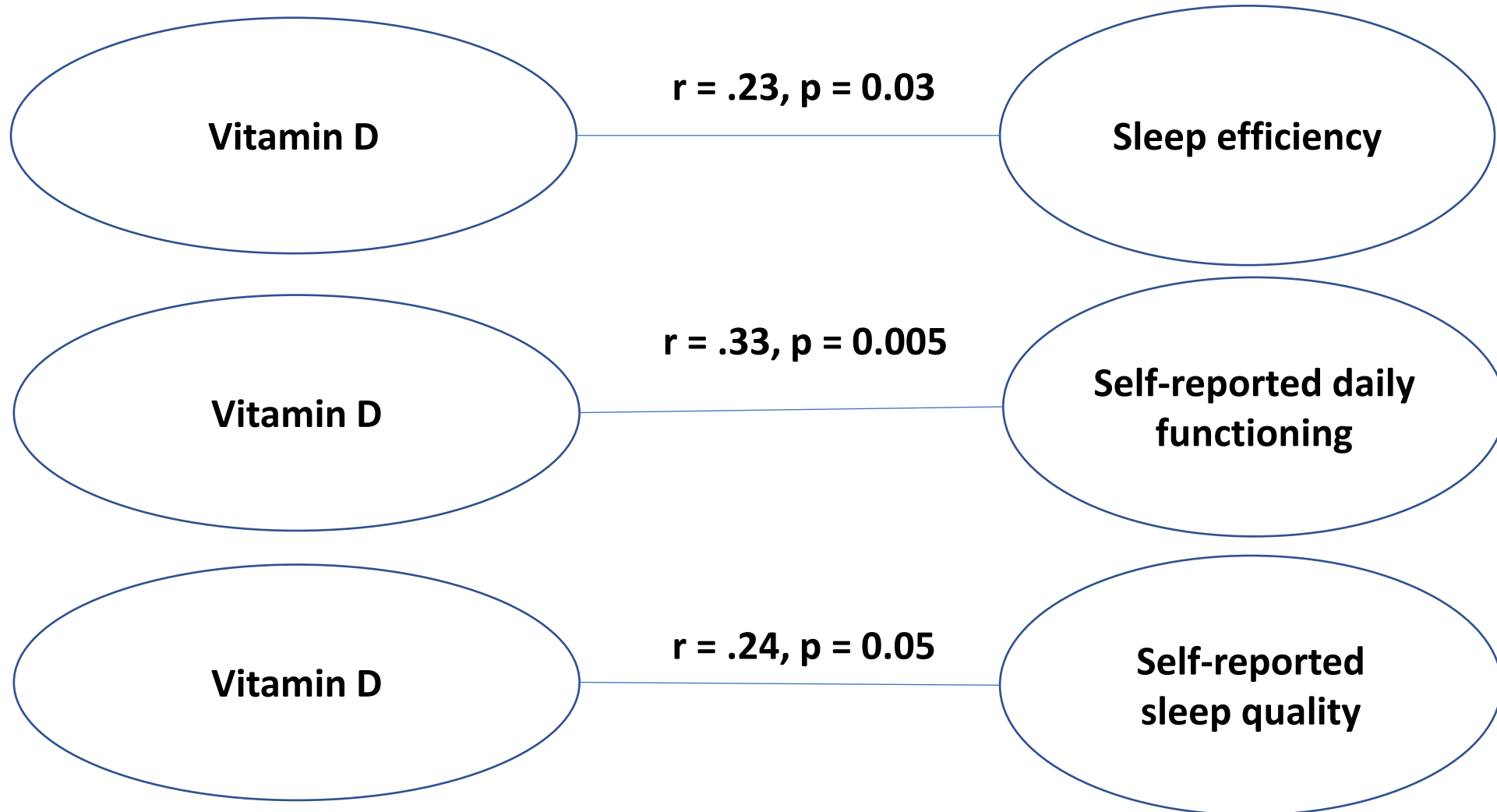
Fish group closer to optimal level than Control group at post-test:

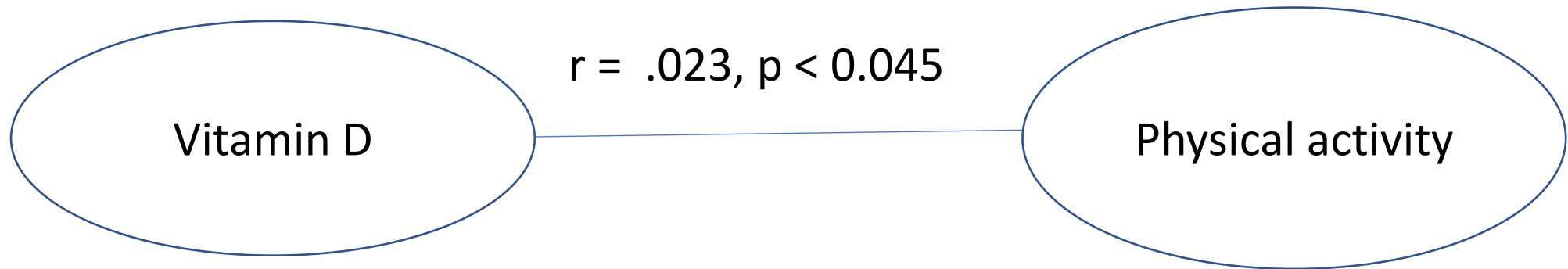
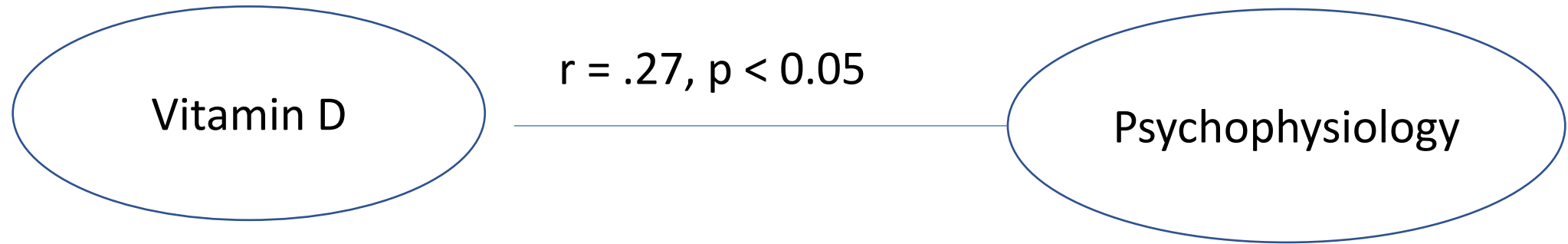
CG: 56 nmol/L

FG: 71 nmol/L

- No correlations between omega-3 and measures of mental health
 - No relationship between omega 3 and objective measures, e.g., psychophysiological variables
 - No relationship between omega 3 and self-report measures, e.g., anxiety, daily functioning

Week correlations between vitamin D status and other outcome measures





Vitamin D and stress resilience

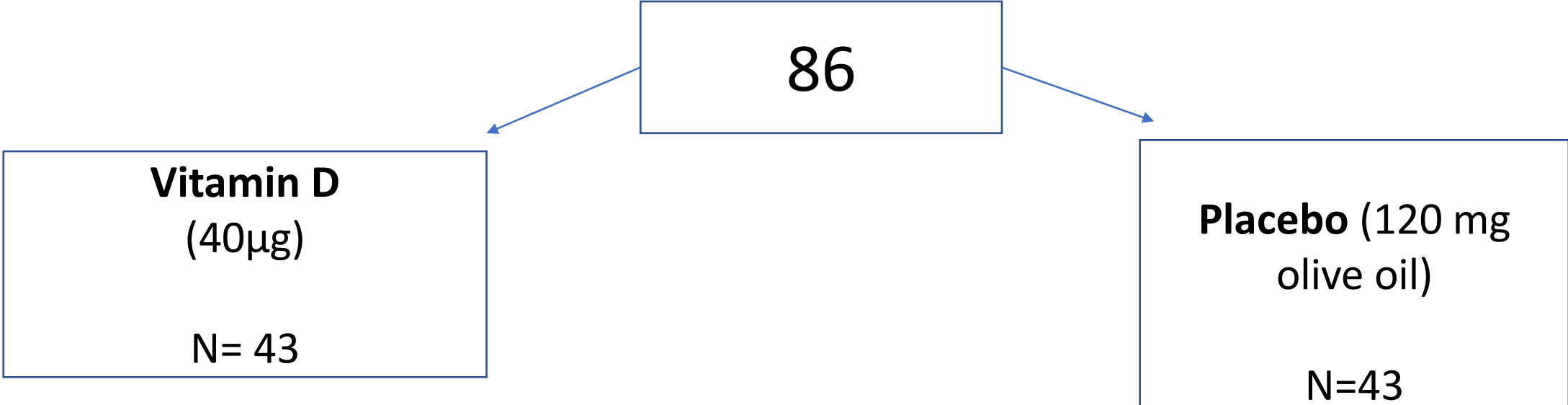
- The “Nutrition and mental health” project was carried out during wintertime
 - To better understand the role of vitamin D in relation to stress resilience a robust randomized controlled trial investigating the effects of vitamin D supplements is needed
- Aim:
 - Investigate the effects of vitamin D supplements in relation to an enhanced stress procedure during wintertime

Participants:

- 86 male forensic inpatients
- Recruited from a high secure facility in the US
 - Most of the patients have severe mental health problems
 - Personality disorders
 - Anxiety
 - Depression
 - Substance use disorder



Study design – double blinded randomized control trial



Outcome measures pre and post intervention:

- **Fasting blood samples**
 - Vitamin D status
 - Serotonin
- **Saliva samples**
 - Cortisol responses
- **Psychophysiological activity (Actiheart system)**
 - Heart rate (HR)
 - Heart rate variability (HRV)
 - Measure of the continuous interplay between sympathetic and parasympathetic influences on heart rate



- **HRV – physiological index of both physical and mental health**

- **High HRV during rest:**

- Good physical and mental health
- Adaptability to novel situations – resilience to stress

High HRV associated with ***low heart rate***

- **Low HRV during rest:**

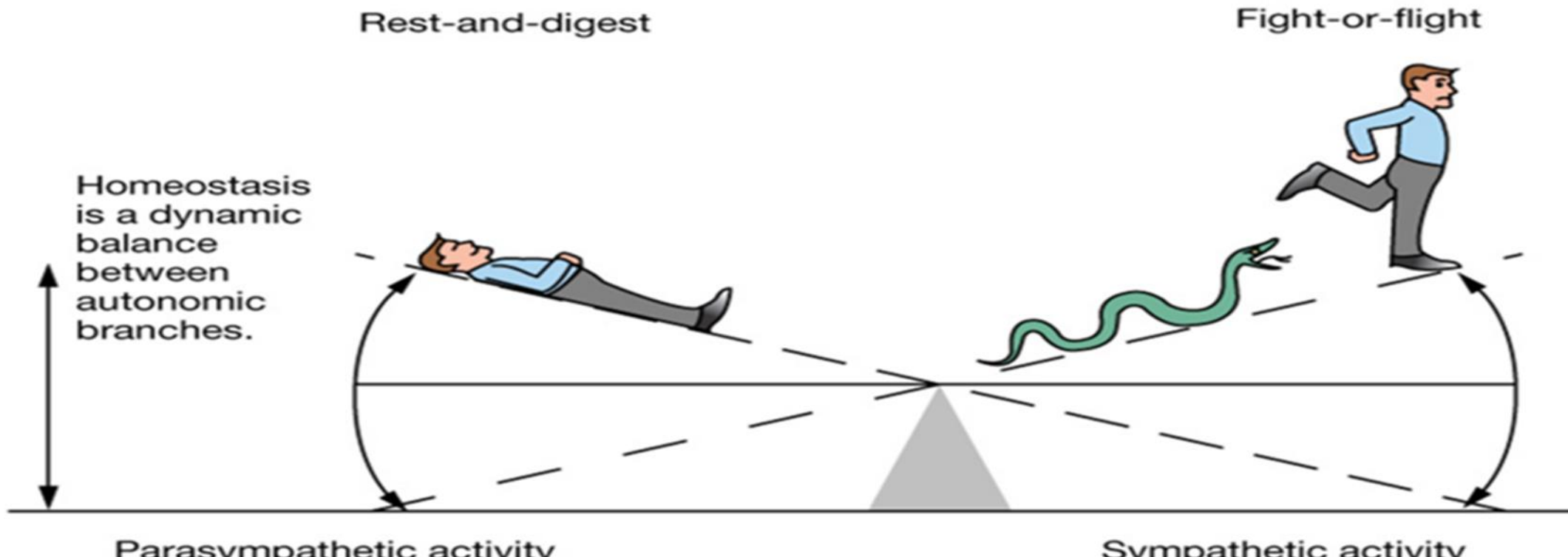
- Psychiatric conditions
 - e.g., anxiety, depression, low resilience to stress
- Risk factor for cardiovascular diseases

Low HRV associated with ***high heart rate***

e.g., Thayer et al., 2009, Thayer et al., 2012

- Low resting HRV and a higher HR means that the **body is constantly working overtime** → a risk factor for mortality and morbidity

→ variations in HR and HRV from a resting or safe condition to a stressful and challenging condition are a healthy, normal physiological response





Experimental stress procedure pre and post intervention



Cognitive tasks:

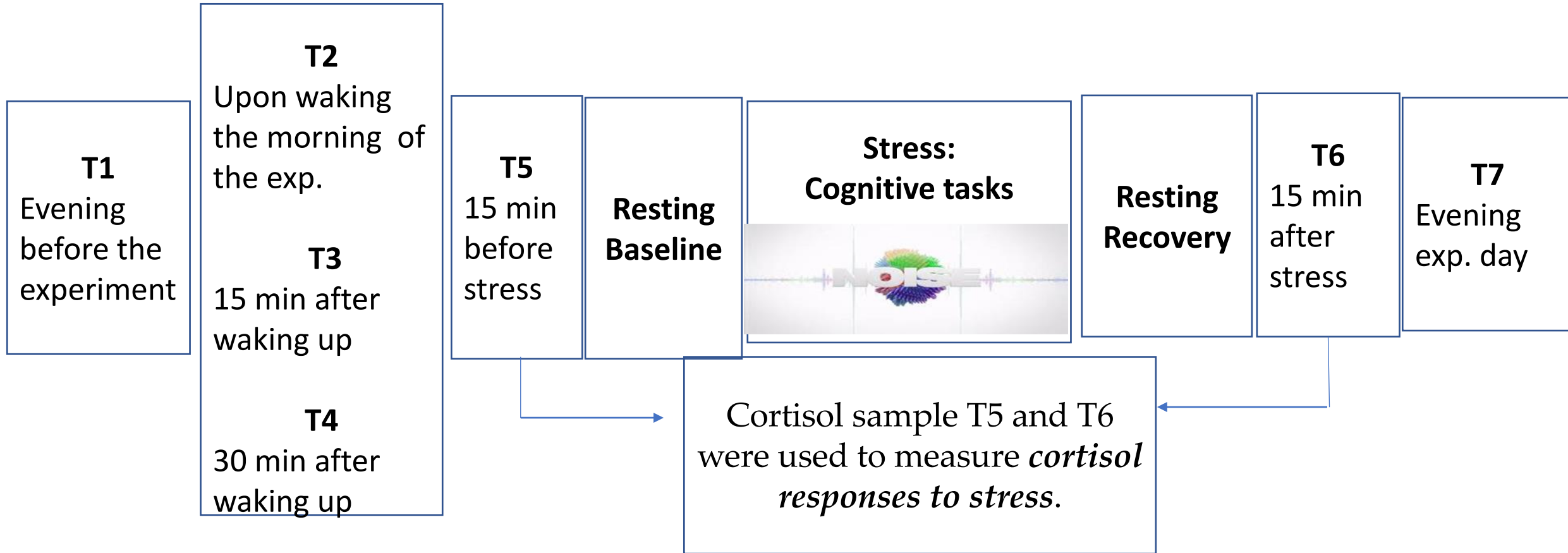
N-back – Tower of Hanoi –
Tower of London – Iowa
Gambling task

Resting baseline

**Resting recovery =
post stress measure**

Psychophysiological activity was measured throughout the whole procedure, i.e., from resting baseline – resting recovery

Cortisol responses



Cortisol samples T1, T2, T3, T4 and T7 were used to measure *diurnal cortisol patterns*, including the *cortisol awakening response (CAR; T2, T3 and T4)*.

- **Pre-test**

- November - December

- **Intervention period**

- January – May

- **Post-test**

- April – May
- Post-intervention testing took place while the participants were still taking supplements.

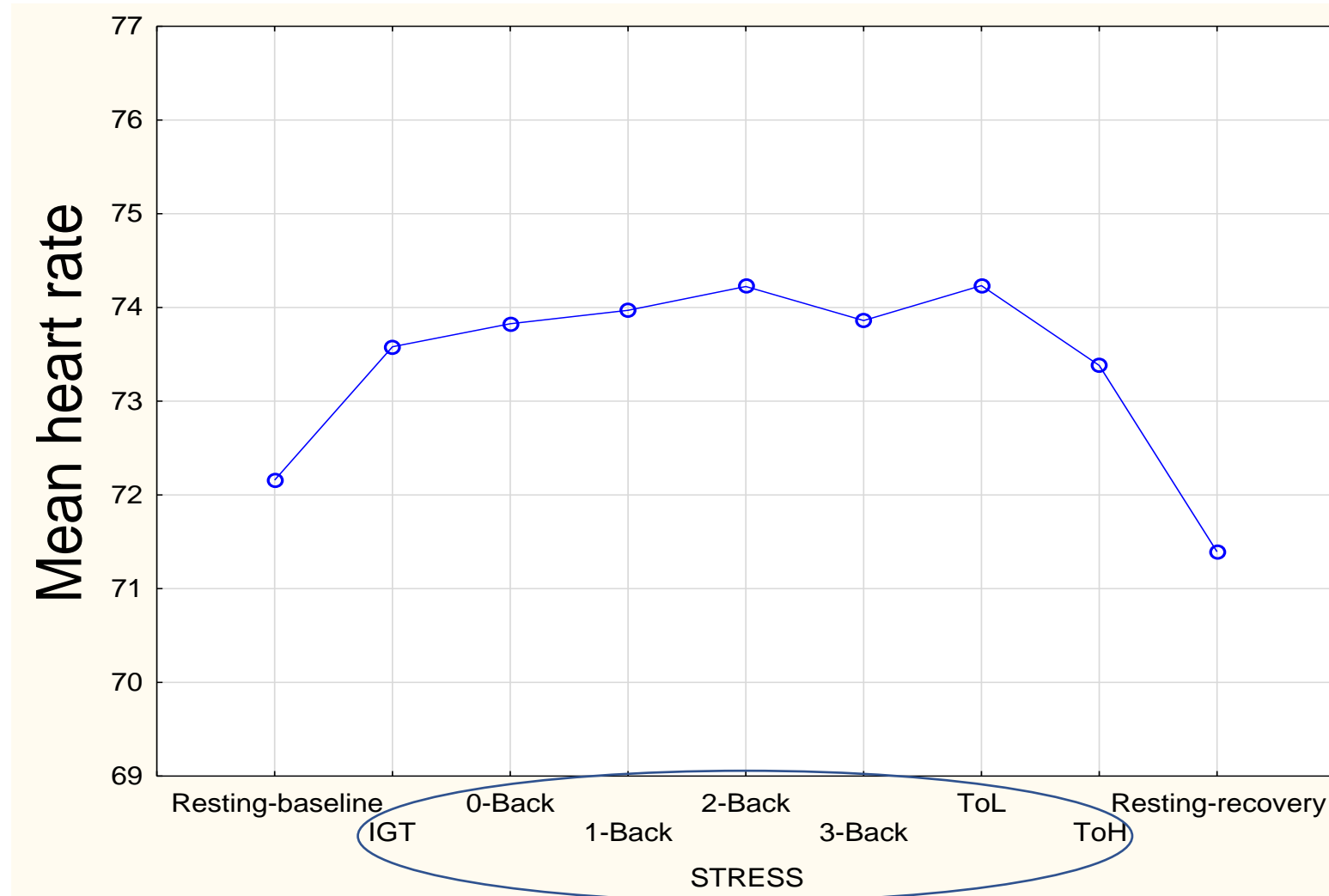


Manipulation check

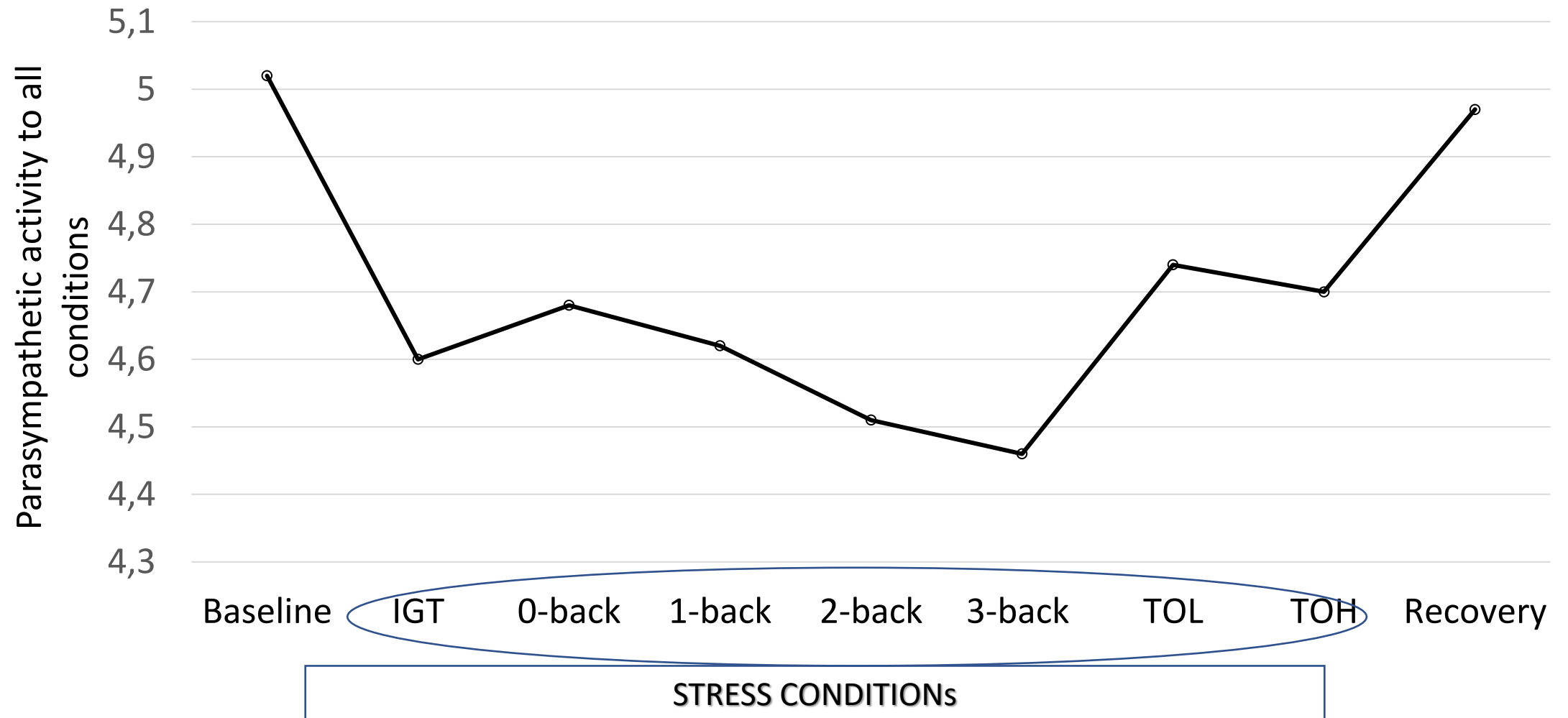
- Was the experimental stress procedure stressful for the participants?
- What was the effect of vitamin D supplementation on vitamin D status?



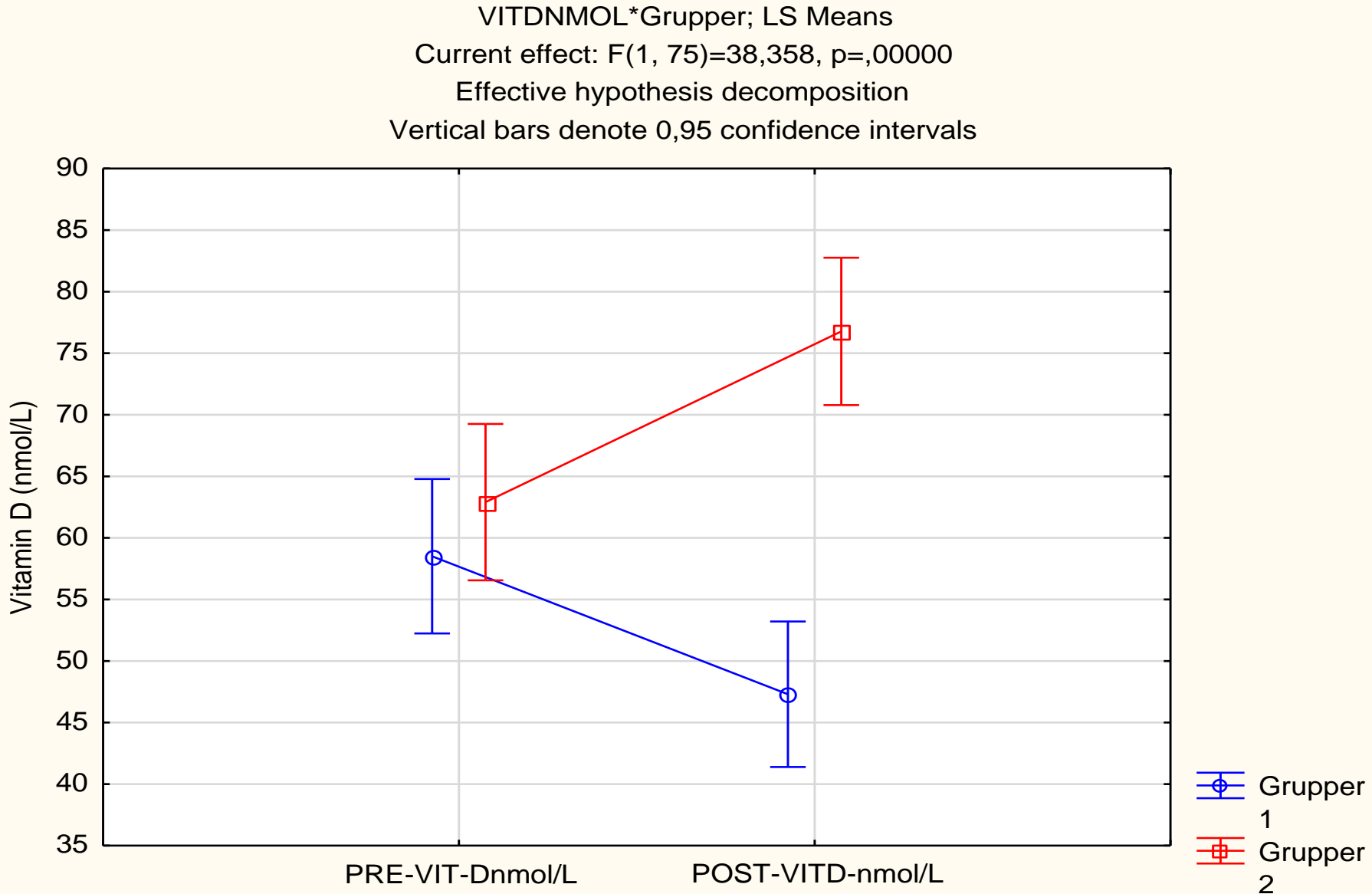
Stress-test: Heart rate



Stress-test: Heart rate variability



Vitamin D status



Vitamin D supplementation during winter prevented a nadir in vitamin D level during spring.

Vitamin D and biological markers of stress resilience

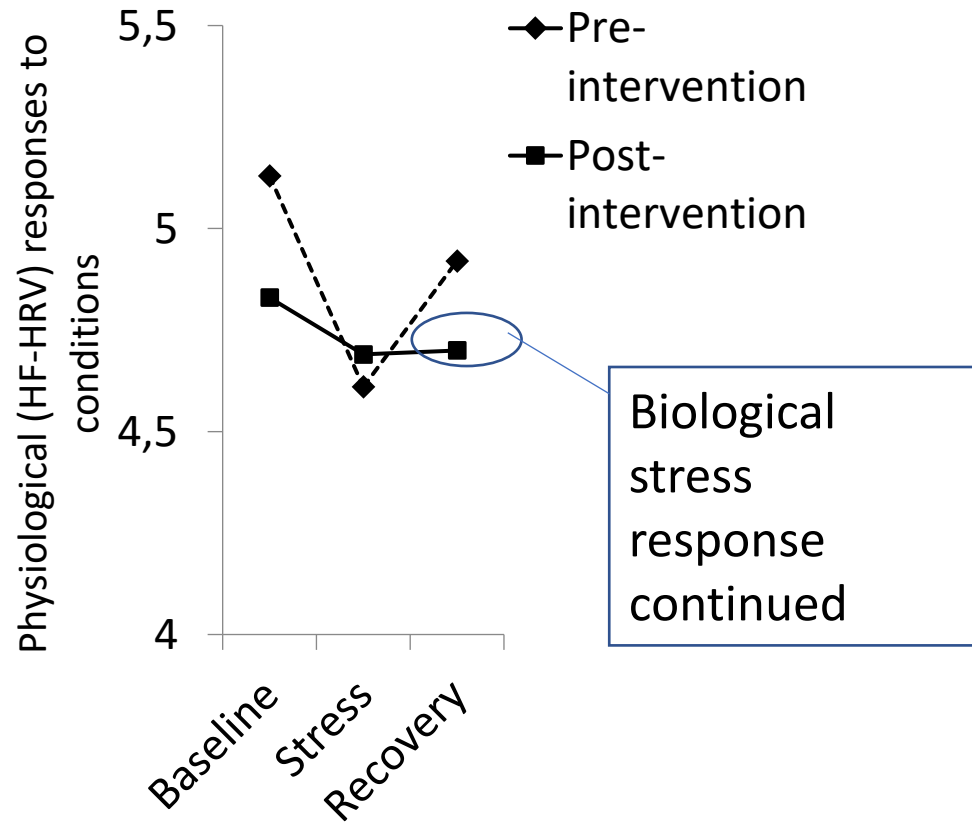
- **Cortisol**

- No effects of vitamin D on cortisol responses

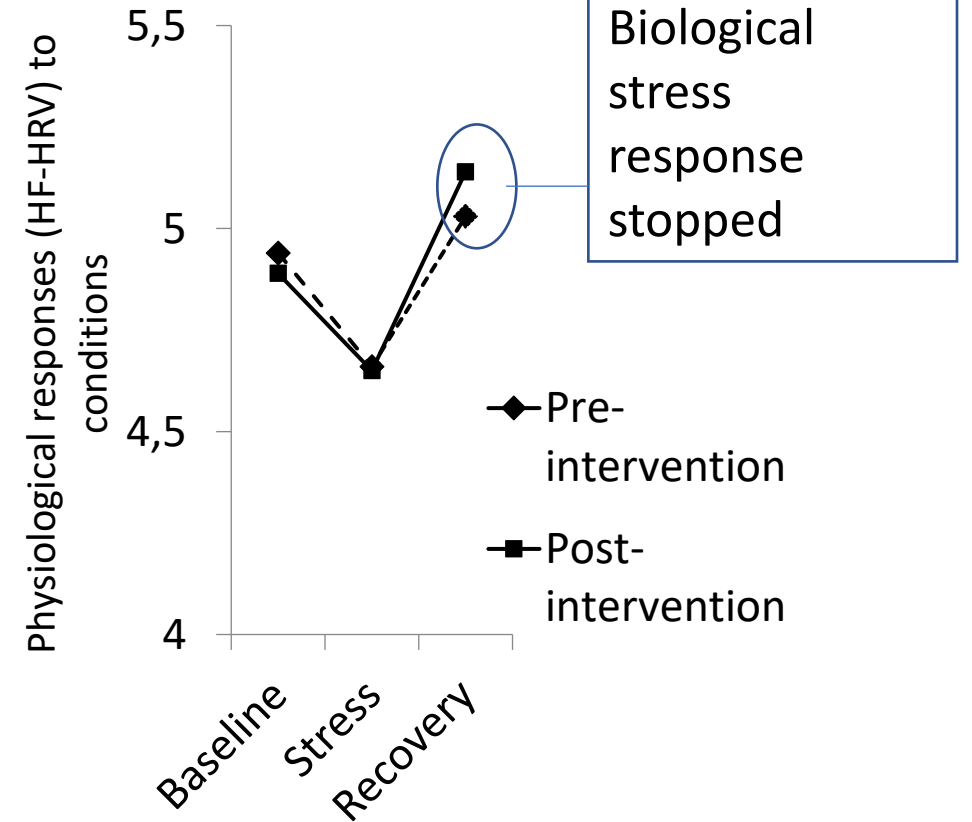
- **Serotonin:**

- No effects of vitamin D on serotonin
- Both groups showed a significant decrease in serotonin.
- In line with other studies showing seasonal variation in serotonin (e.g., Callaway et al., 2005)

Effects of vitamin D and psychophysiological activity during wintertime



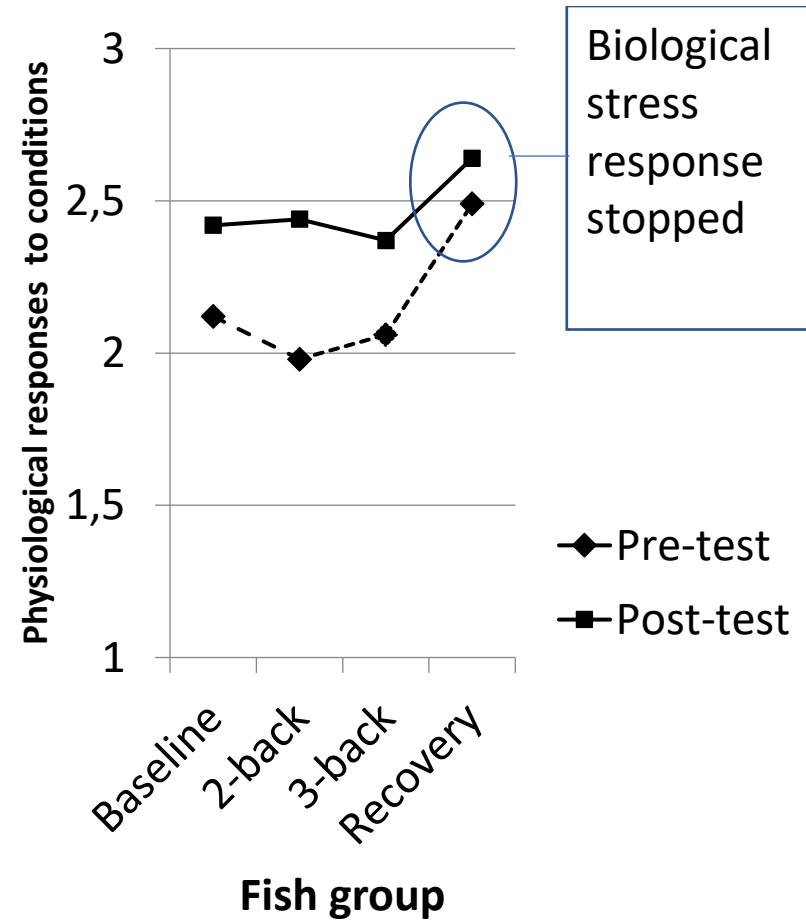
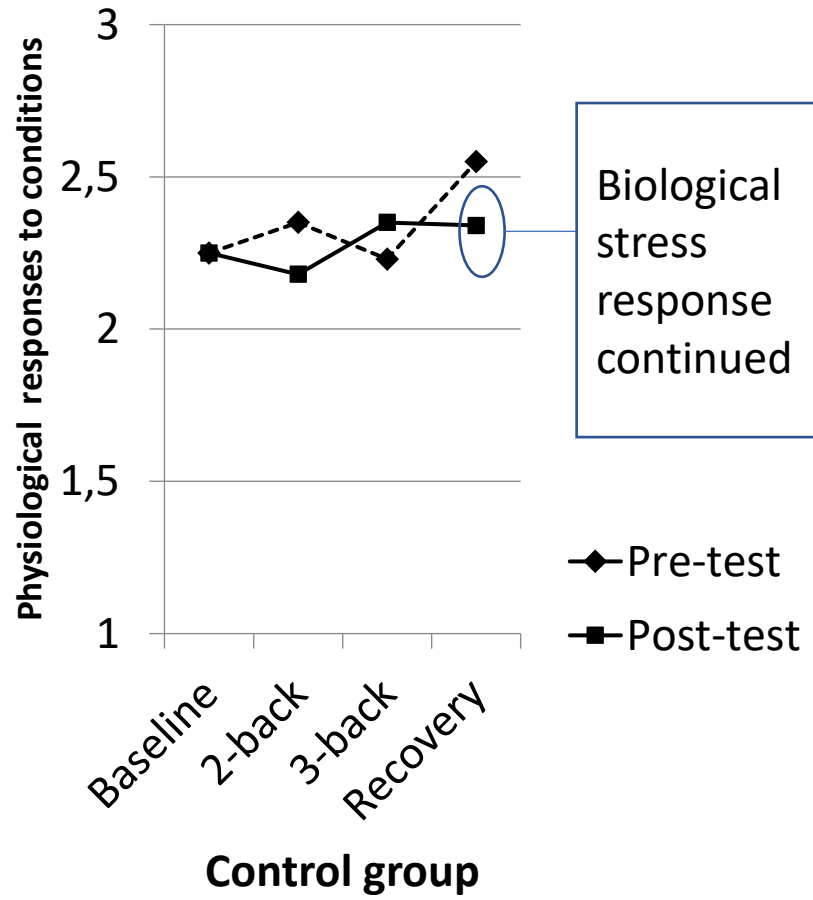
(a) Control group



(b) Intervention group

Stress = average score

Fatty fish consumption and psychophysiological responses to *mild cognitive stress (no noise)*



Thanks!

Anita.hansen@uib.no