UTS UNIVERSITY OF TECHNOLOGY SYDNEY

Heart rate variability and neurocognitive performance in blue- and white-collar workers:

Implications for cardiac risks

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Declaration

I Ardalan Eslami declare that this thesis, is submitted in fulfilment of the requirements for the award of Doctor of Philosophy (Science), in the School of Life Sciences at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise reference or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

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List of Publications and Presentations

Publications

List of Publications

Eslami, A., Lal, S. 2021. Heart rate variability in teachers: The effect of stress on cardiac autonomic health. (Submitted, 7 June 2021, Work & Stress)

Under Preparation

Eslami, A., Nassif, N., Lal, S. 2021. Heart rate variability and neurocognitive performance in blue- and white-collar workers. (Industrial Health)

Eslami, A., Nassif, N., Lal, S., 2021. Differences in neurocognitive performance between high and low heart rate variability. (Biological Psychology)

Conference Abstracts

Eslami, A., Zaslawski, C., Nassif, N., & Lal, S. (2018, December). Cardiovascular changes during working memory and attention tasks: an assessment of blue-and white-collar workers. Psychophysiology (vol. 55, pp. S136-S136). USA: Wiley.

List of Presentations

National Conferences

ESLAMI, A., LAL, S. Heart Rate Variability in NSW Teachers: an exploratory study investigating implications for cardiac risks. Poster presentation: 32nd Combined Health Science Conference; New Horizons 2015, Sydney, Australia

ESLAMI, A., LAL, S. Heart Rate Variability in NSW Teachers: an exploratory study investigating implications for cardiac risks. Poster presentation: Inter-University Neuroscience & Mental Health Conference 2016, Sydney, Australia

International Conferences

ESLAMI, A., NASSIF, N., ZASLAWSKI, C., LAL, S. HRV changes in response to working memory and attention tasks in white-collar workers. Poster presentation: 27th Annual meeting of the Australasian Society for Psychophysiology 2017, Sydney, Australia

ESLAMI, A., NASSIF, N., ZASLAWSKI, C., LAL, S. Cardiovascular changes during working memory and attention tasks: assessment of blue- and white-collar workers. Poster presentation: 58th Annual meeting of the Society for Psychophysiological Research 2018, Quebec City, Canada.

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Abbreviations

ABS = Australian Bureau of Statistics

ACTH = Adrenocorticotropic Hormone

ADHD = Attention Deficit Hyperactivity Disorder

A/D Converter = Analog to Digital Converter

Ag = Silver

Ag/Cl = Silver Chloride

AIHW = Australian Institute of Health and Welfare

ANS = Autonomic Nervous System

AST = Attention Switching Task

BMI = Body Mass Index

BP = Blood Pressure

CANTAB = Cambridge Neuropsychological Test Automated Battery

CHD = Coronary Heart Disease

CHF = Chronic Heart Failure

cm = Centimetre

CPT = Continuous Performance Task

CR = Cardiac Reactivity

CRH = Corticotropin Releasing Hormone

CV = Cardiovascular

CVD = Cardiovascular Disease

df = Degrees of Freedom

ECG = Electrocardiogram

F = F Statistic

FFT = Fast Fourier Transform

fMRI = Functional Magnetic Resonance Imaging

GHQ = General Health Questionnaire

GP = Good Performance

HF = High Frequency

HPA = Hypothalamic Pituitary-Adrenal

HR = Heart Rate

HREC = Human Research Ethics Committee

HRV = Heart Rate Variability

Hz = Hertz

IMT = Intima-Media Thickness

LF = Low Frequency

LF/HF = Low Frequency to High Frequency Ratio (sympathovagal balance)

m = Minutes

MI = Myocardial Infarction

mm = Millimetres

mmHg = Millimetres of Mercury

MMSE = Mini-Mental State Examination

MRI = Magnetic Resonance Imaging

ms = Milliseconds

ms^2 = Milliseconds Squared

mV = Millivolts

n = Sample Size

NRU = Neuroscience Research unit

p = p Value

PFC = Prefrontal Cortex

pNN50 = Percentage of NN intervals >50ms apart

PNS = Peripheral Nervous System

PP = Poor Performance

RMSSD = Root Mean Square of Successive Differences

RSA = Respiratory Sinus Arrhythmia

RVP = Rapid Visual Processing

SD = Standard Deviation

SDANN = Standard Deviation of Averaged NN Interval

SDNN = Standard Deviation of NN Interval

SSP = Spatial Span

SWM = Spatial Working Memory

t = T Statistic

TP = Total Power

U = U Statistic

UTS = University of Technology Sydney

VLF = Very Low Frequency

VWM = Verbal Working Memory

WHO = World Health Organisation

WM = Working Memory

WMS = Weschler Memory Scale

WMT = Working Memory Task

Z = Z Score

↓ = Decrease

> = Greater Than

↑ = Increase

< = Less Than

± = Plus minus

* = Regression Analysis Performed

Abstract

The 21st century has seen a significant and ever-growing focus on performance and productivity within the workforce. The literature has shown that attenuated cognitive ability is not only associated with reductions in performance but also with increased risk of cardiovascular disease as indicated by heart rate variability (HRV) (Hansen et al., 2003, Forte et al., 2019). The present research investigated the links between HRV and neurocognitive performance in blue- and white-collar workers.

Data was obtained from n = 101 participants aged between 19-61 years comprising of n = 48 white-collar workers (male: n = 25, female: n = 23) and n = 53 blue-collar workers (male: n = 42, female: n = 11). The experimental protocol commenced with three blood pressure (BP) recordings, a questionnaire battery to obtain demographic and lifestyle data, as well as to determine eligibility of inclusion into the study, and the General Health Questionnaire (GHQ 60). HRV data was obtained using a 3-lead electrocardiogram (ECG) during baseline (10 minutes) and then during multiple neurocognitive tasks designed to assess working memory and attention function. These tasks are part of the Cambridge Neuropsychological Test Automated Battery (CANTAB) and included the following tasks: the spatial working memory (SWM), attention switching task (AST), rapid visual processing (RVP), and the spatial span (SSP). Three final post-study BP recordings were obtained to complete the experiment.

Higher parasympathetic activity was significantly associated to less errors made by the white-collar workers in the SWM task ($r = -0.30$, $p = 0.04$). The blue-collar workers also showed a relationship between higher parasympathetic activity and enhanced performance, namely, superior ability to detect sequences ($r = 0.28$, $p = 0.04$) during the RVP task. Interestingly, increased parasympathetic dominance was also linked to more errors made by the white-collar workers ($r = -0.31$, $p = 0.04$) during the AST. The blue-collar workers also showed increased parasympathetic dominance was correlated to a slower reaction time ($r = -0.28$, $p = 0.048$) during the RVP task. Moreover, blue-collar workers showed lower indices of HRV.

The initial findings of the present research indicate that white-collar workers perform better on neurocognitive tasks, however, higher LF HRV ($p = 0.02$) and lower HF HRV ($p = 0.03$) in white-collar workers indicates higher susceptibility to cardiovascular disease (CVD) as compared to blue-collar workers. These preliminary findings demonstrate the importance of considering the effect of occupation on both neurocognitive performance and cardiovascular disease.