

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

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## 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.

This research is supported by an Australian Government Research Training Program.

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## List of Publications and Presentations

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# Table of Contents

Declaration.....	i
Acknowledgements.....	ii
List of Publications and Presentations .....	iii
<i>Publications</i> .....	iii
<i>List of Publications</i> .....	iii
<i>Under Preparation</i> .....	iii
<i>Conference Abstracts</i> .....	iii
<i>List of Presentations</i> .....	iii
<i>National Conferences</i> .....	iii
<i>International Conferences</i> .....	iv
Table of Contents.....	v
List of Tables .....	ix
List of Figures .....	xii
Abbreviations.....	xiii
Abstract.....	xv
Chapter 1 Introduction .....	1
1.1 <i>Australia’s Occupational Landscape</i> .....	1
1.1.1 <i>The White-Collar Employee</i> .....	1
1.1.2 <i>The Blue-Collar Employee</i> .....	2
1.2 <i>Cardiovascular Disease and Risk</i> .....	3
1.2.1 <i>Cardiovascular Risk and Occupational Health</i> .....	4
1.3 <i>Executive Cognitive Function</i> .....	7
1.3.1 <i>Memory</i> .....	8
1.3.2 <i>Working Memory</i> .....	10
1.3.3 <i>Attention</i> .....	12
1.4 <i>Executive Function and Cardiovascular Disease</i> .....	13
1.4.1 <i>Working Memory, Attention and Cardiovascular Disease</i> .....	14
1.5 <i>Heart Rate Variability</i> .....	16

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1.5.1 Frequency Domain HRV.....	16
1.5.2 Time Domain HRV .....	19
1.5.3 Heart Rate Variability, the Autonomic Nervous System, and Cardiovascular Risk ....	20
1.5.4 Heart Rate Variability, Working Memory, and Attention .....	23
1.6 Basis of Research .....	28
1.7 Aims .....	30
1.8 Hypotheses .....	30
Chapter 2 Materials and Methods.....	31
2.1 Participant Recruitment.....	31
2.2 Consent .....	31
2.3 Volunteer Eligibility.....	31
2.4 Research Protocol .....	33
2.4.1 Blood Pressure Measurement .....	33
2.4.2 Electrocardiogram .....	35
2.4.3 Active Neurocognitive Assessment Tasks.....	38
2.4.4 General Health Questionnaire.....	43
2.4.5 Final Blood Pressure Recording .....	43
2.4.6 Summary of Experimental Protocol.....	43
2.5 Derivation of Heart Rate Variability .....	45
2.5.1 Beat Detection and Pre-Processing .....	46
2.6 Statistical Analysis .....	46
2.7 Statistical Methods .....	47
2.7.1 Power Analysis.....	47
2.7.2 Dependent and Independent Sample t-tests.....	47
2.7.3 Partial Pearson's Correlation.....	48
2.7.4 Bonferroni Correction .....	49
2.7.5 Regression Analysis .....	49
Chapter 3 HRV and Neurocognitive Performance (White-Collar Workers).....	51
3.1 Results: White-Collar Workers.....	51
3.1.1 Demographics.....	52
3.1.2 Neurocognitive Performance Measures.....	53
3.1.3 Heart Rate Variability Parameters .....	56
3.1.4 Summary of Heart Rate Variability Findings .....	65
3.1.5 Correlations between Neurocognitive Performance and HRV .....	67

3.2 Discussion: White-Collar Workers.....	70
3.2.1 White-Collar Heart Rate Variability during the Neurocognitive Tasks.....	70
3.2.2 Associations between Heart Rate Variability and Neurocognitive Performance in White-Collar Workers.....	73
3.3 Conclusions: HRV and Neurocognitive Performance in White-Collar Workers.....	75
Chapter 4 HRV and Neurocognitive Performance (Blue-Collar Workers) .....	77
4.1 Results: Blue-Collar Workers.....	77
4.1.1 Demographics.....	78
4.1.2 Neurocognitive Performance Measures.....	79
4.1.3 Heart Rate Variability Parameters .....	82
4.1.4 Summary of Heart Rate Variability Findings .....	89
4.1.5 Correlations between Neurocognitive Performance and HRV .....	90
4.2 Discussion: Blue-Collar Workers .....	93
4.2.1 Blue-Collar Heart Rate Variability during the Neurocognitive Tasks .....	93
4.2.2 Associations between Heart Rate Variability and Neurocognitive Performance in Blue-Collar Workers.....	95
4.3 Conclusions: HRV and Neurocognitive Performance in Blue-Collar Workers .....	97
Chapter 5 HRV and Neurocognitive Performance: Comparison of White- and Blue-Collar Workers .....	99
5.1 Results: White-Collar versus Blue-Collar Workers .....	99
5.1.1 Demographics: White-Collar and Blue-Collar Workers .....	99
5.1.2 Differences in Neurocognitive Performance between White-Collar and Blue-Collar Workers .....	99
5.1.3 Differences in HRV Parameters between the White-Collar and Blue-Collar Workers .....	102
5.2 Discussion: Comparison of White-Collar and Blue-Collar Workers.....	105
5.2.1 Differences in Heart Rate Variability Parameters between the White-Collar and Blue-Collar Workers during the Neurocognitive Tasks .....	106
5.2.2 Comparison of Neurocognitive Performance between the White-Collar and Blue-Collar workers.....	111
5.3 Conclusion: Comparison of HRV and Neurocognitive Performance Measures in White-Collar Workers and Blue-Collar Workers .....	114
Chapter 6 Comparison of High HRV and Low HRV Groups within the Blue-Collar and White-Collar Cohorts.....	116



6.1 Median Split.....	116
6.2 Results: Comparison of High HRV versus Low HRV in White-Collar Workers.....	119
6.2.1 Differences in Neurocognitive Performance between High and Low HRV (White-Collar Workers).....	119
6.2.2 Correlations between HRV and Neurocognitive Performance Measures in the High and Low HRV (White-Collar Workers).....	121
6.3 Results: Comparison of High HRV versus Low HRV in Blue-Collar Workers.....	128
6.3.1 Differences in Neurocognitive Performance between the High and Low HRV (Blue-Collar Workers).....	128
6.3.2 Correlations between HRV and Neurocognitive Performance Measures in the High and Low HRV (Blue-Collar Workers).....	130
6.4 Discussion: High HRV versus Low HRV in White- and Blue-Collar Workers.....	135
6.4.1 White-Collar Workers: Differences in Neurocognitive Performance between the High HRV and Low HRV Sub-Groups.....	135
6.4.2 White-Collar Workers: Neurocognitive Performance Correlations in the High HRV and Low HRV Sub-Groups.....	136
6.4.3 Blue-Collar Workers: Differences in Neurocognitive Performance between the High and Low HRV Sub-Groups.....	139
6.4.4 Blue-Collar: Neurocognitive Performance Correlations in the High and Low HRV Sub-Groups.....	140
6.5 Conclusions: Comparison of High HRV and Low HRV Sub-Groups of the White-Collar and Blue-Collar Workers.....	142
Chapter 7 Conclusions and Future Directions.....	143
7.1 Limitations and Future Directions.....	143
7.2 Conclusions: HRV and Neurocognitive Performance in Blue-Collar and White-Collar Workers.....	146
Chapter 8 Appendices.....	149
8.1 Consent Form.....	149
8.2 Study Summary Sheet.....	150
8.3 Neuroscience Research Unit Lifestyle Questionnaire (modified from the lifestyle appraisal questionnaire (Craig et al., 1996)).....	151
References.....	154

## List of Tables

Table 1.1 Time Domain Heart Rate Variability Parameters .....	20
Table 1.2 Frequency Domains of Heart Rate Variability .....	22
Table 1.3 Summary of Research Investigating HRV in Cardiovascular Health .....	23
Table 1.4 Supporting Evidence Linking HRV and Executive Function.....	25
Table 2.1 Blood Pressure Classification in Adults .....	32
Table 2.2 Time Domain HRV Parameters .....	45
Table 3.1 Mean Demographics for the White-collar Worker Sample Population (n = 48) .....	53
Table 3.2 Mean Neurocognitive Performance Measures for the White-collar Worker Group (n = 48) .....	55
Table 3.3 Mean Baseline HRV Parameters White-collar Group (n = 48) .....	57
Table 3.4 Mean HRV during the Spatial Working Memory Task in the White-collar Worker Group (n = 48).....	59
Table 3.5 Mean HRV during the Attention Switching Task for the White-collar Worker Group (n = 48) .....	60
Table 3.6 Mean HRV during the Rapid Visual Processing Task for the White-collar Worker Group (n = 48).....	62
Table 3.7 Mean HRV during the Spatial Span Task for the White-collar Worker Group (n = 48).....	64
Table 3.8 Dependent Sample t-test between Baseline and Active HRV in the White- collar Worker Group (n = 48).....	66
Table 3.9 Partial Pearson's Correlation between HRV and Neurocognitive Performance in the White-collar Worker Group (n = 48) .....	67
Table 4.1 Mean Demographics for the Blue-collar Worker Population (n = 53).....	78
Table 4.2 Mean Neurocognitive Performance Measures for the Blue-collar Workers (n = 53).....	81
Table 4.3 Mean Baseline HRV Parameters for the Blue-collar Workers (n = 53) .....	83
Table 4.4 Mean HRV during the Spatial Working Memory Task for the Blue-collar Workers (n = 53).....	85

<b>Table 4.5 Mean HRV during the Attention Switching Task for the Blue-collar Workers (n = 53) .....</b>	<b>86</b>
<b>Table 4.6 Mean HRV during the Rapid Visual Processing Task for the Blue-collar Workers (n = 53) .....</b>	<b>87</b>
<b>Table 4.7 Mean HRV during the Spatial Span Task for the Blue-collar Workers (n = 53) .....</b>	<b>88</b>
<b>Table 4.8 Dependent Sample t-test between Baseline and Active HRV in the Blue-collar Workers (n = 53) .....</b>	<b>89</b>
<b>Table 4.9 Partial Pearson’s Correlation between HRV and Neurocognitive Performance in the Blue-collar Workers (n = 53) .....</b>	<b>90</b>
<b>Table 5.1 Independent Sample t-test Comparing Neurocognitive Performance Measures between the Blue- (n = 53) and White-collar (n = 48) Worker Groups ....</b>	<b>101</b>
<b>Table 5.2 Independent Sample t-test of HRV between the White- (n = 48) and Blue-collar (n = 53) Worker Sample .....</b>	<b>104</b>
<b>Table 6.1 Medians for HRV Split of the White-collar Worker Group into High and Low HRV Sub-Groups .....</b>	<b>117</b>
<b>Table 6.2 Medians for HRV Split of the Blue-collar Worker Group into High and Low HRV Sub-Groups .....</b>	<b>118</b>
<b>Table 6.3 Mann-Whitney U Test Comparing Neurocognitive Performance between the High and Low HRV Sub-Groups Within the White-collar Group (n = 48) .....</b>	<b>120</b>
<b>Table 6.4 Spearman’s Correlation between HRV and Neurocognitive Performance Measures in the High and Low Log RMSSD Groups (White-collar Workers) .....</b>	<b>122</b>
<b>Table 6.5 Spearman’s Correlation between HRV and Neurocognitive Performance Measures in the High and Low Log HF Groups (White-collar Workers) .....</b>	<b>124</b>
<b>Table 6.6 Spearman’s Correlation between HRV and Neurocognitive Performance Measures in the High and Low Log LF/HF Sub-Groups (White-collar Workers) .....</b>	<b>126</b>
<b>Table 6.7 Multiple Regression between Log LF/HF (White-collar low HRV group) and Neurocognitive Performance Measures (n = 24) .....</b>	<b>127</b>
<b>Table 6.8 Mann-Whitney U Test Comparing Neurocognitive Performance between the High and Low HRV Sub-Groups of the Blue-collar Worker Group (n = 53) .....</b>	<b>129</b>
<b>Table 6.9 Spearman’s Correlations between HRV and Neurocognitive Performance Measures in High and Low Log RMSSD Sub-Groups (Blue-collar Workers) .....</b>	<b>131</b>

**Table 6.10 Spearman’s Correlations between HRV and Neurocognitive Performance Measures in the High and Low Log HF Sub-Groups (Blue-collar Workers)..... 133**

**Table 6.11 Spearman’s Correlations between HRV and Neurocognitive Performance Measures in the High and Low Log LF/HF Sub-Groups (Blue-collar Workers)..... 134**

## List of Figures

Figure 1.1 Healthcare Expenditure by Disease Group in Australia, 2015-16 .....	4
Figure 1.2 The Hypothalamic-Pituitary-Adrenal Axis.....	6
Figure 1.3 The Major Qualitative Classification of Human Memory .....	9
Figure 1.4 Temporal Classification of Human Memory.....	10
Figure 1.5 The Multi-Component Model of Working Memory.....	12
Figure 1.6 Derivation of Heart Rate Variability .....	18
Figure 2.1 The OMRON IA2 Automatic Blood Pressure Monitor .....	34
Figure 2.2 Instructions for the Use of the Automated Blood Pressure Monitor.....	34
Figure 2.3 Equipment for Electrocardiogram Recording and Display .....	36
Figure 2.4 Arrangement of Electrocardiogram Electrodes .....	37
Figure 2.5 Electrocardiogram Example .....	38
Figure 2.6 Spatial Working Memory Task .....	39
Figure 2.7 Spatial Span Task .....	40
Figure 2.8 Attention Switching Task .....	41
Figure 2.9 Rapid Visual Processing Task.....	42
Figure 2.10 Present Study Experimental Protocol .....	44
Figure 3.1 White-Collar Sample Distribution by Position and Field (n = 48) .....	52
Figure 3.2 Correlation between Log LF/HF and Errors for the White-Collar Workers (n = 48).....	68
Figure 3.3 Correlation between Log RMSSD and Total Errors for the White-Collar Workers (n = 48).....	69
Figure 4.1 Blue-Collar Worker Sample Distribution by Position (n = 53) .....	77
Figure 4.2 Correlation Graphs between Log RMSSD and Signal Detection for Blue-Collar Workers (n = 53). .....	91
Figure 4.3 Correlation Graph between Log LF and Signal Detection for the Blue-Collar Workers (n = 53).....	92

## Abbreviations

ABS = Australian Bureau of Statistics	FFT = Fast Fourier Transform
ACTH = Adrenocorticotrophic Hormone	fMRI = Functional Magnetic Resonance Imaging
ADHD = Attention Deficit Hyperactivity Disorder	GHQ = General Health Questionnaire
A/D Converter = Analog to Digital Converter	GP = Good Performance
Ag = Silver	HF = High Frequency
Ag/Cl = Silver Chloride	HPA = Hypothalamic Pituitary-Adrenal
AIHW = Australian Institute of Health and Welfare	HR = Heart Rate
ANS = Autonomic Nervous System	HREC = Human Research Ethics Committee
AST = Attention Switching Task	HRV = Heart Rate Variability
BMI = Body Mass Index	Hz = Hertz
BP = Blood Pressure	IMT = Intima-Media Thickness
CANTAB = Cambridge Neuropsychological Test Automated Battery	LF = Low Frequency
CHD = Coronary Heart Disease	LF/HF = Low Frequency to High Frequency Ratio (sympathovagal balance)
CHF = Chronic Heart Failure	m = Minutes
cm = Centimetre	MI = Myocardial Infarction
CPT = Continuous Performance Task	mm = Millimetres
CR = Cardiac Reactivity	mmHg = Millimetres of Mercury
CRH = Corticotropin Releasing Hormone	MMSE = Mini-Mental State Examination
CV = Cardiovascular	MRI = Magnetic Resonance Imaging
CVD = Cardiovascular Disease	ms = Milliseconds
df = Degrees of Freedom	ms <sup>2</sup> = Milliseconds Squared
ECG = Electrocardiogram	mV = Millivolts
F = F Statistic	n = Sample Size
	NRU = Neuroscience Research unit

p = p Value	↑ = Increase
PFC = Prefrontal Cortex	< = Less Than
pNN50 = Percentage of NN intervals >50ms apart	± = Plus minus
PNS = Peripheral Nervous System	* = Regression Analysis Performed
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	

## Abstract

The 21<sup>st</sup> 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.