The impact of Stress and Anxiety on the neurocognitive performance of Australian Nurses: An electroencephalographic and psychometric assessment

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BMedSci (Hons)

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Submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy (Science) at the University of Technology Sydney.
I certify that the work in this thesis has not been previously submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signature: ________________________ Date: ________________________

Ty Lees

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III. Publications and Presentations

Publications relevant to thesis

Journal Articles


Conference Abstracts


Invited Presentations

1. Lees, T., Stress and Cognitive Performance in Nurses: An example of research in the NRU. Oral Presentation: Warfighter Effectiveness Research Centre (WERC) United States Airforce Academy Brownbag 2015, Colorado Springs, USA.

Conference Presentations

Annual meeting of the Society for Psychophysiological Research 2018, Quebec City, Canada


Other Publications

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Reports


Invited Presentations


Conference Presentations


(EEG) and psychometric assessment: a comparative study. Oral presentation: 37th Annual Scientific Meeting of the Australasian Neuroscience Society 2017, Sydney, Australia


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<td>A – Auricular</td>
<td>IIR – Infinite Impulse Response</td>
</tr>
<tr>
<td>ACTH – Adrenocorticotropic hormone</td>
<td>LAQ – Lifestyle Appraisal Questionnaire</td>
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<td>AD – Alzheimer’s Disease</td>
<td>LASSO – Least Absolute Shrinkage Selection Operator</td>
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<tr>
<td>AIN – Assistant in Nursing</td>
<td>mmHg – Millimetres mercury</td>
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<tr>
<td>AUD – Australian Dollars</td>
<td>MCI – Mild Cognitive Impairment</td>
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<tr>
<td>AVP – Arginine vasopressin</td>
<td>MMSE – Mini-mental State Exam</td>
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<tr>
<td>BMI – Body Mass Index</td>
<td>MRI – Magnetic Resonance Imaging</td>
</tr>
<tr>
<td>BP – Blood pressure</td>
<td>NHP – Non-health Professional</td>
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<tr>
<td>C – Central</td>
<td>OCD – Obsessive Compulsive Disorder</td>
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<td>CRH – Corticotropin releasing hormone</td>
<td>O – Occipital</td>
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<tr>
<td>DASS – Depression, Anxiety, Stress, Scale</td>
<td>PCA – Principal Component Analysis</td>
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<tr>
<td>EEG – Electroencephalography</td>
<td>PD – Panic Disorder</td>
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<td>EN – Enrolled Nurse</td>
<td>RN – Registered Nurse</td>
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<tr>
<td>EOG - Electrooculogram</td>
<td>SNS – Sympathetic Nervous System</td>
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<tr>
<td>ERP – Event Related Potential</td>
<td>SSI – Standard Shiftwork Index</td>
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<tr>
<td>F – Frontal</td>
<td>T – Temporal</td>
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<tr>
<td>Fp – Frontal Pole</td>
<td>UTS – University of Technology</td>
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<td>GAD – Generalised Anxiety Disorder</td>
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<tr>
<td>HPA – Hypothalamic Pituitary Adrenal Axis</td>
<td>WCCL – Ways of Coping Checklist</td>
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<tr>
<td>HR – Heart Rate</td>
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<tr>
<td>HREC – Human research ethics committee</td>
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IX. Abstract

Stress and anxiety both have demonstrable impact, causing neuronal damage and death (Sapolsky, 1996, Conrad, 2006), functional connectivity changes (Bishop, 2009, Andreescu et al., 2014), and various cognitive impairments (de Quervain et al., 2000, Savage et al., 2000, Wetzel et al., 2006, Henderson et al., 2012, Nieuwenhuys et al., 2015). However, despite demonstrated quality of care reductions (Sveinsdóttir et al., 2006, Berland et al., 2008) and calls for further research (LeBlanc, 2009, Lees and Lal, 2017), a limited amount of research investigating the impact of stress and anxiety on the cognitive performance of health professionals has been conducted (LeBlanc, 2009). Therefore, the aim of the present study was to examine the relationships between stress, anxiety and cognitive performance in health professionals via comprehensive psychometric and electroencephalography (EEG) assessment; as well as assess the predictive capability of EEG in measuring cognitive performance.

Presently, this doctoral research reports on results obtained by analysing data from 118 nurses and 144 non-health professionals. The experimental protocol commenced by capturing participant demographic data, such as, blood pressure, heart rate, as well as hip and waist measurements, followed by the completion of pre-study questionnaires including the Lifestyle Appraisal questionnaire (Craig et al., 1996), the Depression, Anxiety, Stress scale (Lovibond and Lovibond, 1995b), and the Fatigue State Question (Lal and Craig, 2002). Following this, a two lead bipolar or 32 lead monopolar EEG was captured during a resting baseline and a Stroop test based active phase. After the electroencephalogram recording, psychometric cognitive performance was assessed by the Mini-Mental State Examination (Folstein et al., 1975) and the Cognistat (Mueller et al., 2007). Participants then completed the revised Ways of Coping Checklist (Vitaliano et al., 1985), and the Fatigue State Question, again for the latter. Nurse participants also
completed parts of the Standard Shiftwork Index (Barton et al., 1995). Lastly, participant’s blood pressure was again recorded and the experiment concluded.

The results indicate that both non-health professionals and nurses experience stress and anxiety. In both groups, a stress level within the normal range was significantly associated ($p < 0.05$) with increased memory performance and delta activity, while theta and beta activity increases were similarly implicated for the nurse group only. However, with an increase in stress levels, stress was associated with increased judgement performance and fronto-temporal and parietal gamma activity, as well as reduced fronto-temporal delta activity in non-health professionals. Additionally, impaired memory performance as well as fronto-central delta, fronto-temporal and parietal gamma, and fronto-central and temporal beta activity increases were associated with this increased stress in nurses.

With respect to anxiety, it was associated with increased lifestyle risk factors, impaired global, attention, and memory domain performance, as well as delta, alpha and gamma activity changes in non-health professionals. Comparatively, in nurses anxiety was associated with improved Stroop test performance, global cognitive performance and delta and gamma activity, as well as impaired memory performance. Lastly, it was found that global cognitive performance could be predicted by a combination of fast wave EEG activity variables ($R^2 \geq 0.440; p \leq 0.013$). Similarly, unique combinations of EEG variables from the 5 investigated frequency bands predicted, in varying degrees, attention ($R^2 \geq 0.204; p \leq 0.014$), memory ($R^2 \geq 0.443, p \leq 0.010$) and judgement ($R^2 \geq 0.407; p \leq 0.001$) domain performance.

Collectively, these findings provide an insight into the cognitive impact of stress and anxiety, and determine a unique impact profile of stress and anxiety for both non-health
professionals and nurses. Additionally, they demonstrate the multifaceted nature of the relationship between stress, anxiety and cognitive performance, where both improvements and impairments are observed. Further understanding the impact of stress and anxiety on cognitive performance may enable the development and implementation of management and intervention strategies to preserve the cognitive health of health professionals, and in turn, ensure quality of patient care and reduce adverse medical event incidence. Further, it may be possible to use EEG activity to predict early cognitive impairment, which has strong implications for developing diagnostic measures for cognitive impaired states such as dementia and Alzheimer’s disease.