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The Sensory Amplification of Pain: The Adrenaline Model of Headache Causation

**A thesis presented in fulfilment of the requirements for the degree of
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Abstract

Current models of headache causation including vasodilatation and myofascial models are inconsistent with many headache phenomena. In recent decades the pathophysiology of headache disorders has been thought to involve peripheral and central sensitisation but the cause of this sensitisation has been elusive. The significant aim of this thesis was to develop a model to explain headache disorders which has resulted in the development of the Adrenaline Model of Headache Causation, a model which explains the origin of both peripheral and central sensitisation and is consistent with the headache phenomena found in the literature.

This model proposes that activation of the stress pathways of the body, in particular the hypothalamic-pituitary-adrenal (HPA) pathway and sympathetic nervous system (SNS), results in the secretion of several neurotransmitters including histamine, serotonin, noradrenaline and adrenaline in the brain and the secretion of adrenaline and noradrenaline into the blood stream, all of which results in subsequent activation of second messenger cascades, opening of ion channels and lowering of action potential threshold in the pathways of nociception resulting in central and peripheral sensitisation. Furthermore an acute stress response from a headache trigger can create episodes of headache as the same neurotransmitters and hormones produce action potentials in the pathways of nociception in the presence of central and peripheral sensitisation.

The model proposes that a sustained elevation of SNS and HPA activity leads to sensitisation of central nervous system pathways (e.g. noradrenaline, adrenaline, serotonin, histamine) that lower the pain threshold by acting on the thalamus and dorsal horn. Adrenaline and noradrenaline released from the adrenal medulla may also bind to peripheral nociceptors reducing their threshold of firing. Triggers including psychological stress, poor sleep, hypoglycaemia and changes in temperature activate the HPA and SNS pathways increasing the likelihood of action potential generation in the pathways of nociception in people with sensitisation leading to episodes of headache. In people without sensitisation of the neuronal pathways of nociception these stimuli will not usually lead to headache symptoms as the threshold for generation of action potentials in the pathways of nociception is not normally reached. Essentially the

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threshold for transmission of action potentials in the pathways of nociception is set by the tone of the SNS and HPA pathways.

The Adrenaline Model of Headache Causation is consistent with the literature on chronic tension-type headache (CTTH) including headache medication effects, headache triggers, pathophysiological experiments and epidemiological findings. This model gives an insight into treatment strategies aimed at the causation of headache disorders including regular exercise, heat, relaxation therapies and improving sleep.

The Adrenaline Model of Headache Causation predicts that heat may be beneficial for headache disorders. The Wellington Education and Self Treatment (WEST) headache study, a single blind, randomised control trial was performed using heat in the form of sauna for people with CTTH. Thirty seven participants completed the study with 20 in the control group who performed soft tissue massage and 17 in the sauna group who also performed soft tissue massage and attended the sauna for 20 minutes three times a week. A baseline one month daily diary of headache intensity and duration was followed by a two month daily headache diary. Questionnaires were completed measuring depression, sleep disturbance and headache disability before and after the trial. The study showed a statistically significant improvement in the primary outcome of headache intensity of 44% in the intervention group. Seventy nine percent of participants in the sauna group had over 50% reduction of headache index. Heat in the form of sauna is a simple, cheap and self directed treatment that is effective and can be added to the arsenal of treatments available to health practitioners treating headache disorders.

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