Electroencephalographic responses of calves to the noxious sensory input of slaughter by ventral neck incision and its modulation with non-penetrative captive bolt stunning

A thesis presented in partial fulfilment of the requirements of the degree of:

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Troy John Gibson
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- All the ethical requirements applicable to the study have been complied with as required by Massey University and relevant legislation.

Animal Ethical Authorisation codes: Protocol no. 04/86 and 06/61.

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ABSTRACT

Slaughter by ventral neck incision (VNI) is performed on some animals without prior stunning in New Zealand and other countries. A single incision with a razor sharp blade is made in the ventral aspect of the neck, sectioning both carotid arteries and jugular veins, though, not the vertebral arteries. There are a number of potential welfare concerns surrounding slaughter by VNI including pain due to the incision, which may lead to distress during the time before loss of consciousness. The aims of this thesis were to identify cortical responses indicative of noxious stimulation due to slaughter by VNI using analysis of the electroencephalogram (EEG) power spectrum and to investigate the effects of non-penetrative captive bolt (NPCB) stunning on these cortical responses.

The studies utilised adaptations of a minimal anaesthesia model, which has been validated in a range of mammalian species. Surgical dehorning was used as a validation technique for this methodology in cattle and demonstrated a 'typical' EEG response to noxious stimulation. Cattle slaughtered by VNI without prior stunning produced specific responses in the EEG that strongly indicated responses to noxious stimulation. Causation was investigated in cattle where blood flow through the brain remained intact during neck tissue incision (NTI) or the major blood vessels of the neck were isolated and transected independently of other neck tissues (BVT). The response to neck incision in intact animals was principally due to the noxious sensory input due to incision of neck tissues and not mainly as a result of loss of blood flow through the brain. NPCB stunning produced states of cortical activity that were incompatible with the maintenance of sensibility and pain perception. Experimental examination of the time to onset of undoubted insensibility was attempted in cattle subsequent to a pilot study in sheep. The generation of somatosensory-evoked potentials was problematic in cattle.

The conclusions of this thesis are that incision of neck tissues during slaughter without prior stunning constitutes a substantial noxious stimulus. Were an animal conscious, this stimulus would be perceived as painful until the onset of hypoxia-induced insensibility. This would represent a significant compromise to animal welfare.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS AND ACRONYMS

AEP	Auditory evoked potentials
ANOVA	Analysis of variance
bpm	beats per minute
BSE	Bovine spongiform encephalopathy
BVT	Major neck blood vessel transection
CJD	Creutzfeldt-jakob disease
CNS	Central nervous system
CI	Confidence interval
DH	Dehorned only
DH+LA	Dehorned plus lidocaine ring block
ECG	Electrocardiogram/electrocardiographic
ECoG	Electrocorticogram
EEG	Electroencephalogram/electroencephalographic
EMG	Electromyogram / electromyographic
EP	Evoked potential
F50	Median frequency
F95	95% Spectral edge frequency
FFT	Fast Fourier Transformation
F_E'HAL	End-tidal halothane partial pressure
fMRI	Functional magnetic resonance imaging
HALF	High amplitude low frequency
HAHF	High amplitude high frequency
H&E	Hematoxylin and Eosin
HPA	Hypothalamic-pituitary adrenocortical axis
I.M	Intramuscular
NPCB	Non-penetrative captive bolt
NTI	Neck tissue incision with intact blood circulation through the brain
PET	Positron emission tomography
Ptot	Total power of the electroencephalogram
SAM	Sympathetic adrenomedullary system

SD	Standard deviation
SEM	Standard error of the mean
SEP	Somatosensory evoked potentials
SI	Sham incision
TBI	Traumatic brain injury
VAS	Visual analogue scale
VEP	Visual evoked potentials
VNI	Ventral neck incision