Physiological Aspects of Humane Killing in Animals

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Seminar at the Animal Welfare Science Centre

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Pathophysiology application of knowledge of normal structure and function to an understanding of disease and injury

Sir William Osler

Chris Pallis 1923-2005
a.k.a. ‘Maurice Brinton’

Arthur Guyton 1919-2003

Eric Kandel
Nobel Prize 2000

Bruce McEwen

Jaak Panksepp

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Cardiocentric consciousness

Aristotle, 384-322 BCE
Galen, 129-216
Ibn Sina (Avicenna), 980-1037
Ibn Rushd (Averöess), 1126-1198

Galen’s depiction of the animal, natural and vital spirits
Prominent people

Galvani (1737-1798)
Lavoisier (1743-1794)
Carnot (1796-1832)
Liebig (1803-1873)
Descartes (1596-1650)
Oxidative phosphorylation

O₂  Fuel

ADP + Pᵢ → Respiration → ATP

CO₂ + H₂O

ATP

Biosynthesis
Mechanical work
Transport work
Emergence of Affective Consciousness in Evolution - deference to Jaak Panksepp

Timeline of evolution

Degree of awareness

- Reflexive behaviour
- Affective awareness
- Cognitive awareness
- Self awareness
- Awareness of awareness

Other vertebrates
Lissencephalic mammals
Gyrencephalic mammals?
Primates
Great apes
Humans
Birds?
Cephalopods?
Consciousness - selective attention

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.
Consciousness: Intentionality
Consciousness and unconsciousness

• Aspect 1: The waking or aware state
• Aspect 2: The content of consciousness

Cerebral cortex and brainstem

A. frontal lobe
B. parietal lobe
C. occipital lobe
D. lateral ventricle
E. thalamus
F. pineal gland
Interaction between the different parts of the brain involved in consciousness.

BRAINSTEM

Reticular formation

Respiratory control centres

Respiratory system

Cerebral cortex:
座 of consciousness

Clinical signs attributable to the cerebral cortex diagnose consciousness

No function of cerebral cortex, no consciousness
Death

• As opposed to pain and distress, death itself, or the Óstate of being deadÓ is no longer harmful to the animal, which at that point has no physical existenceÓ (World Association of Zoos and Aquaria)
• Death refers to the ending of an animal as an integrated whole and not to the death of every single cell in all tissues of an animal
Role of the brainstem in sustaining respiration as the ultimate vital function in the transition from life to death
The unitary process of death

Irreversible cessation of brainstem function

Death of the organism as a whole

Irreversible cessation of respiratory function then circulatory function

Death of all parts of the organism

Cardiac death OR blood loss leads to

Brainstem death leads to
Pain

- Pain is an unpleasant sensory and emotional experience associated with potential or actual tissue damage. It may elicit protective actions, result in learned avoidance and distress and may modify species-specific traits of behaviour, including social behaviour.
Classification of Pain

**Nerves and noxious stimulus - nociception**

1. **Phasic:** Tissue damage or threat of tissue damage.  
   - Short lived response in spinal cord and brain.
   - Brief and wanning

2. **Tonic:** Inflammatory response and continuing discharge of nociceptors.  
   - Increased excitability of cells in spinal cord (dorsal horn).
   - Persistent

3. **Neuropathic:** Nerve damage leads to spontaneous discharge.  
   - Modified behaviour of nerve cells in spinal cord (dorsal horn) allows access of non-pain nerve impulses to pain system.
   - Abnormal: Non-noxious stimuli can cause pain (alodynia) and extreme sensitivity to painful stimuli (hyperalgesia).
Emotions

- Fear, anxiety, rage and anger will have physiological aspects and will be expressed in behaviour.

- Emotions depend upon the structure and function of the body. Emotions arise from the processing of external stimuli by the brain.

- Emotions are accompanied by bodily responses such as arousal in the nervous system and changes in the cardiovascular system.

- The expressed behaviours associated with emotion include facial expressions and sound-based communication like bleating in sheep and mooing in cattle.
Conceptual diagram of the processing of fear or rage-related stimuli in animals and the consequent response

Stimulus for FEAR or RAGE

- Genetic endowment
- Developmental environment
- Maintenance and preparation environment

Process by the brain

- Previous experiences

Threat perceived

- Uncertain-vigilance

No threat perceived

- Arousal
- Stress reaction
- Emotion

Response to threat

- Welfare
- Comfort ➔ Discomfort ➔ Distress
Emotion: Rewards and Punishers

Negative reinforcer acts
- Terror
- Fear
- Apprehension

Threshold
- Pleasure
- Elation
- Ecstasy

Positive reinforcer acts

Omission or termination of a positive reinforcer
- Rage
- Anger
- Grief
- Frustration
- Sadness

Threshold
- Relief

Omission or termination of a negative reinforcer
Sickness behaviour - emotion, motivational state?

- Mediated by substances produced by the immune system
- What is the state of current knowledge?
- How can sickness behaviour be managed during euthanasia?
Expression of Emotion
“Soft eyes, relaxed muzzle”*

Acknowledgements

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