

# Can We Be Sure The Animal Is Anaesthetized ?

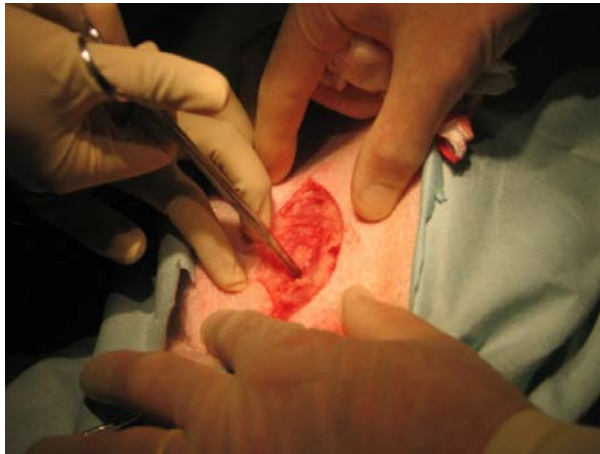
**R. Eddie Clutton**

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University of Edinburgh,  
Edinburgh,  
United Kingdom



is the animal anaesthetized ?

**Of course !**



- humans vs animals
- objectives

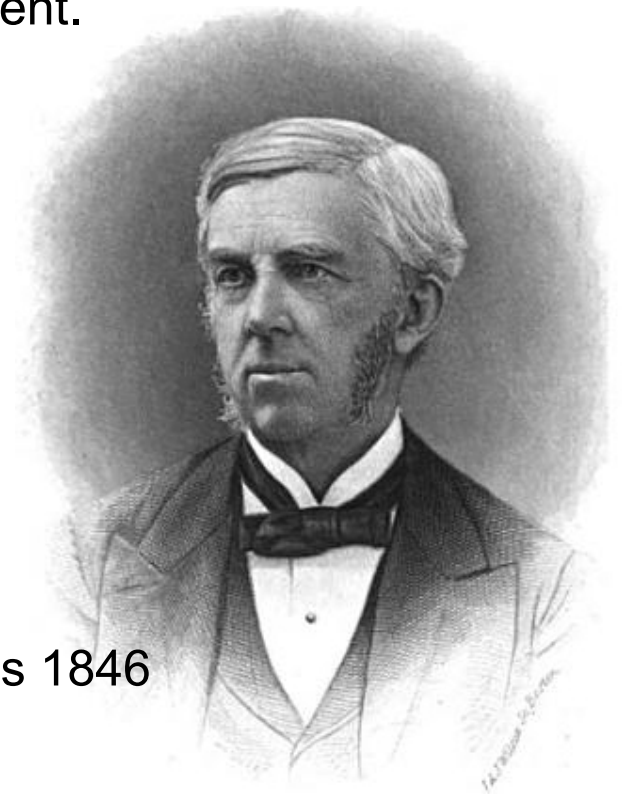
is the animal anaesthetized ?

## Anaesthesia; definitions

"Everybody wants to have a hand in a great discovery. All I will do is to give a hint or two as to names - or the name – to be applied to the state produced and the agent. The state should, I think, be called 'Anaesthesia'"

αν -αισθησις } without sensation  
an - aisthesis }

Oliver Wendell Holmes 1846

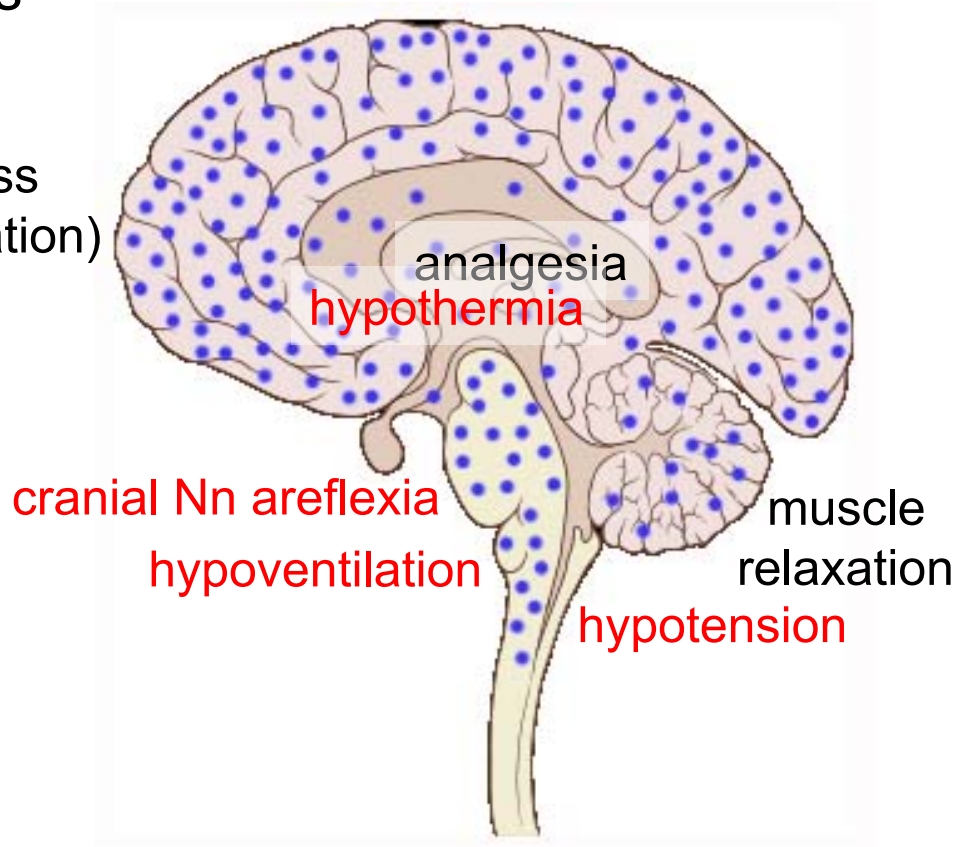


is the animal anaesthetized ?

## Anaesthesia; definitions

a state of controlled and reversible central nervous depression achieved with drugs

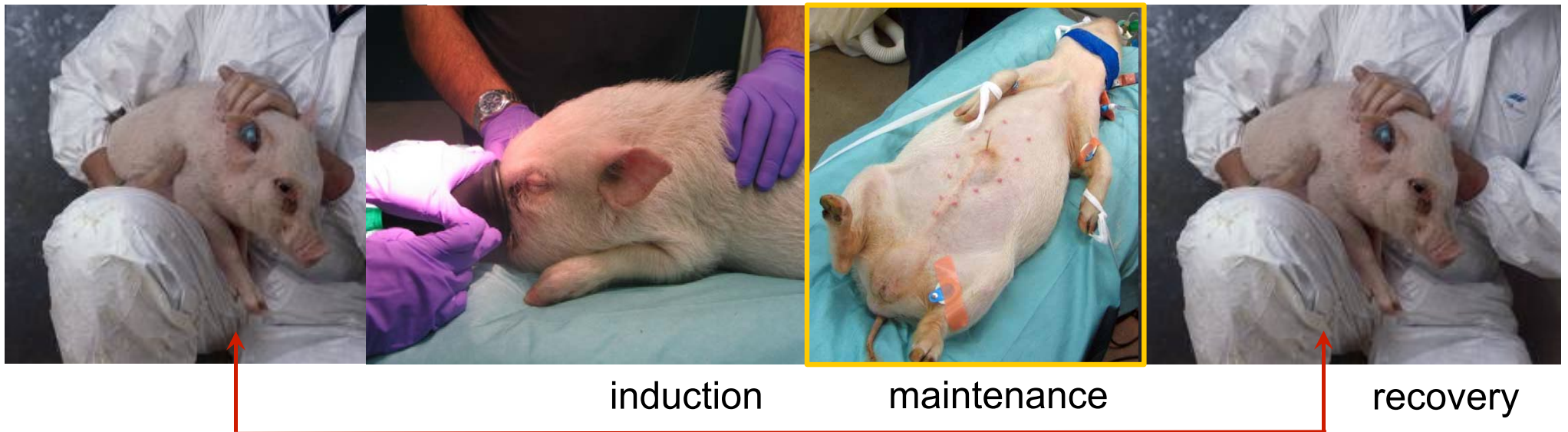
unconsciousness  
(absence of sensation)



is the animal anaesthetized ?

## Anaesthesia; definitions

a state of controlled and reversible central nervous depression achieved with drugs

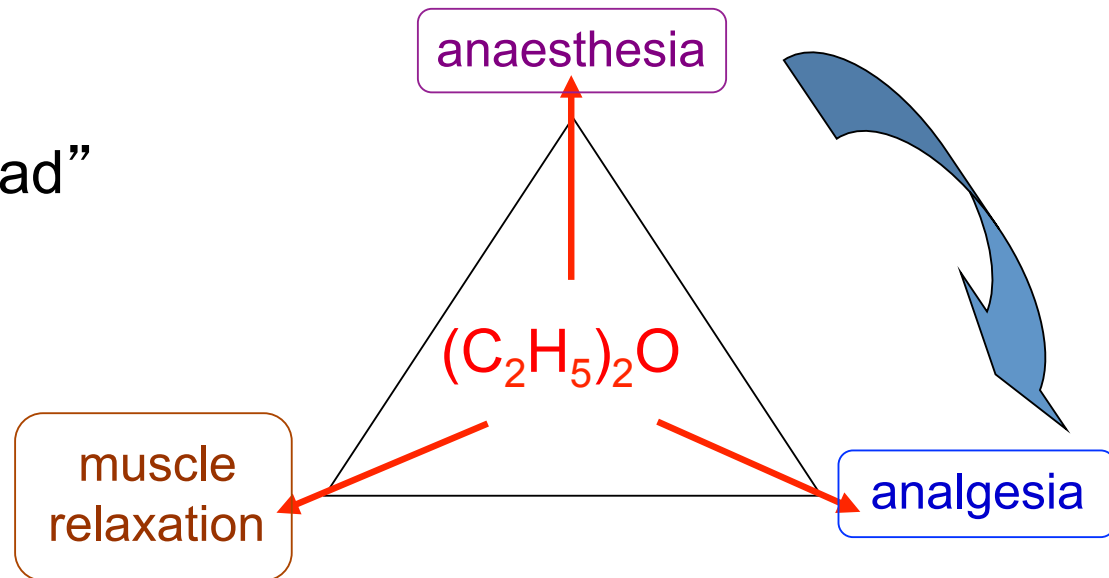


- no residual physiological effects
- no (unpleasant) memory

is the animal anaesthetized ?

## Anaesthesia; definitions

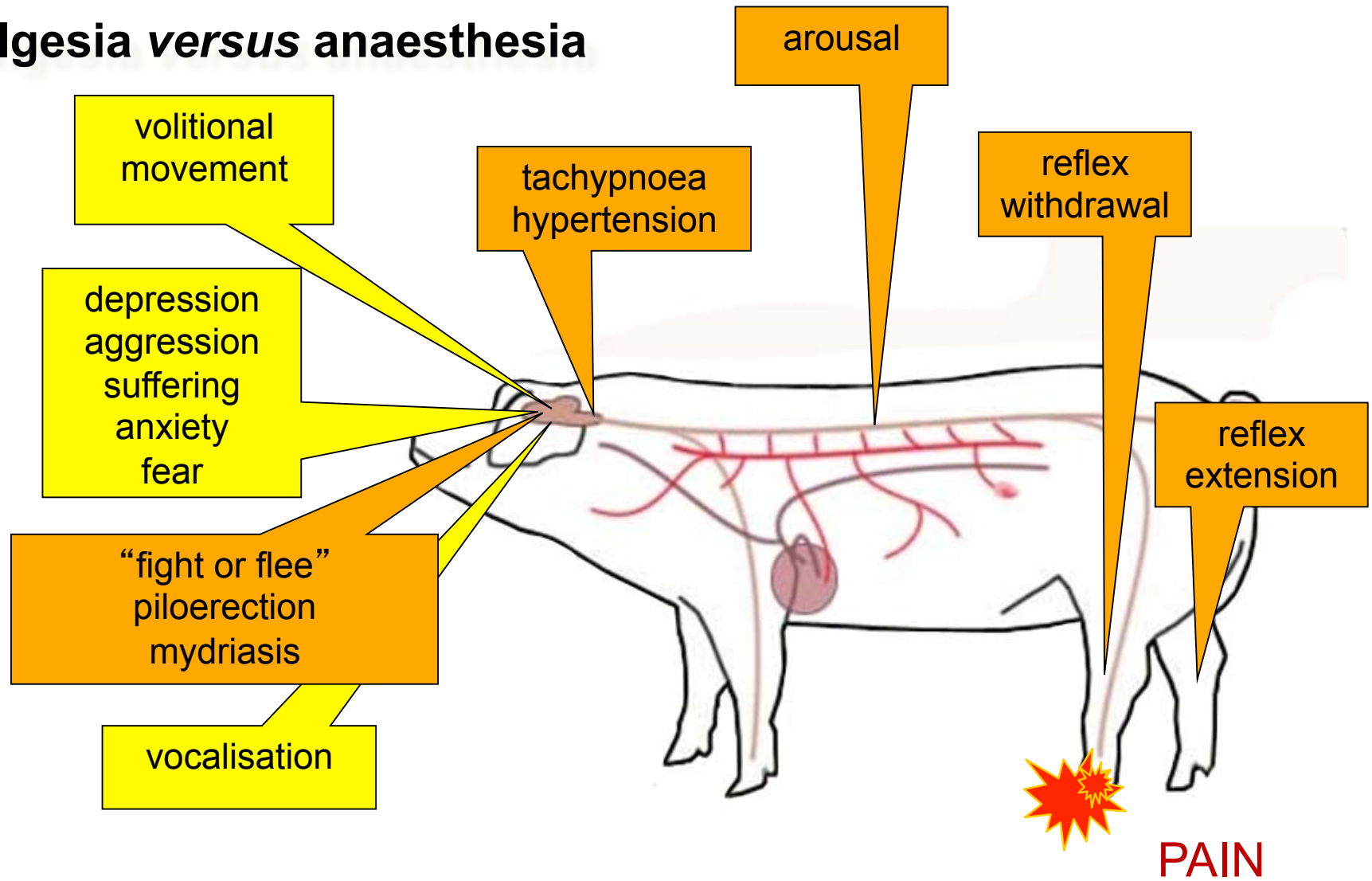
surgical anaesthesia  
= the anaesthesia “triad”



- improved operating conditions
- increased subject comfort
- increased subject safety

is the animal anaesthetized ?

## Analgesia versus anaesthesia

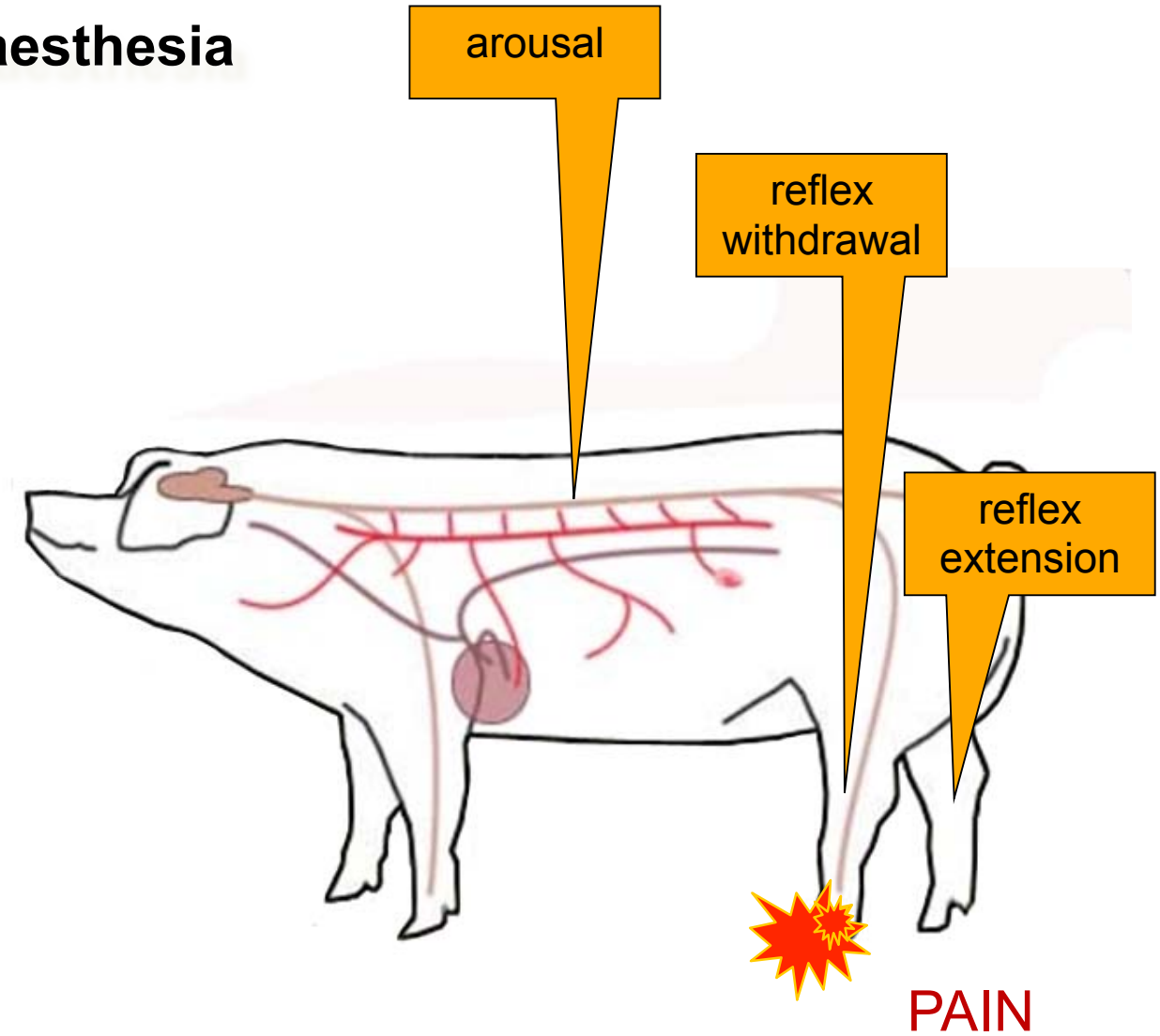


is the animal anaesthetized ?

## Analgesia versus anaesthesia

reflex movement

- precludes microsurgery
- compromises asepsis
- prolongs surgery
- risk of injury



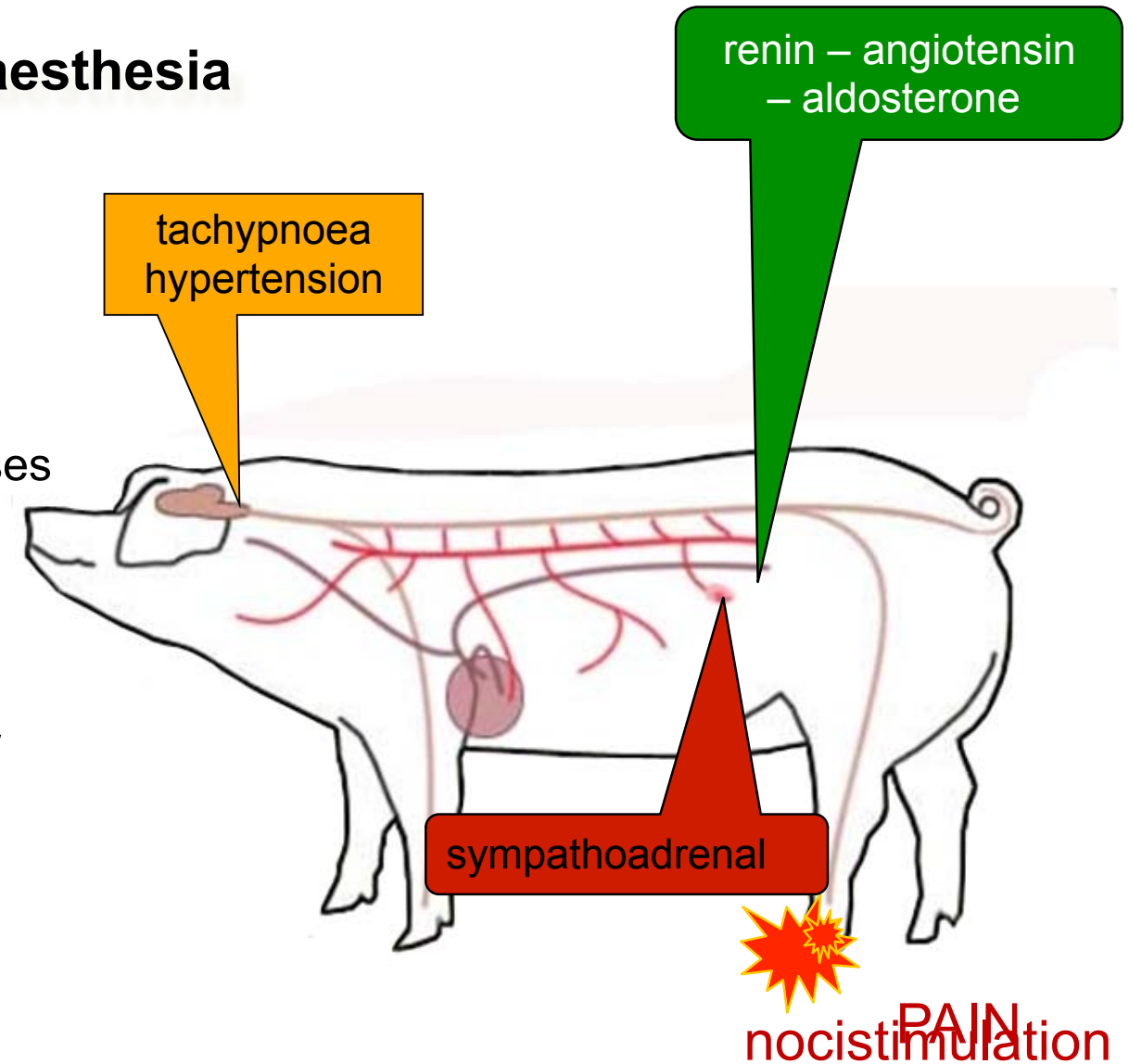


is the animal anaesthetized ?

## Analgesia versus anaesthesia

sympathetic nervous responses

- -ve m(D-V)O<sub>2</sub>
- increased haemorrhage
- reduced renal blood flow
- reduced hepatic blood flow
- ileus

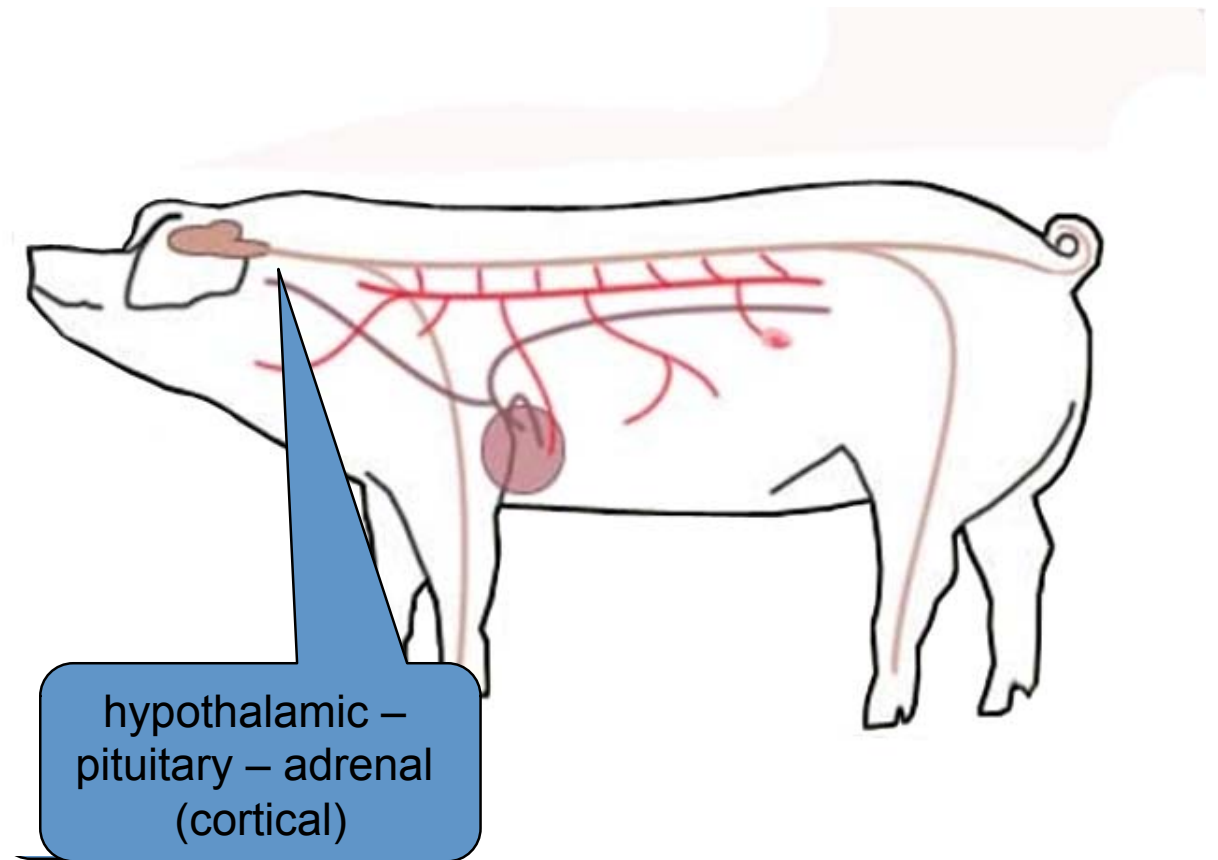


is the animal anaesthetized ?

## Analgesia versus anaesthesia

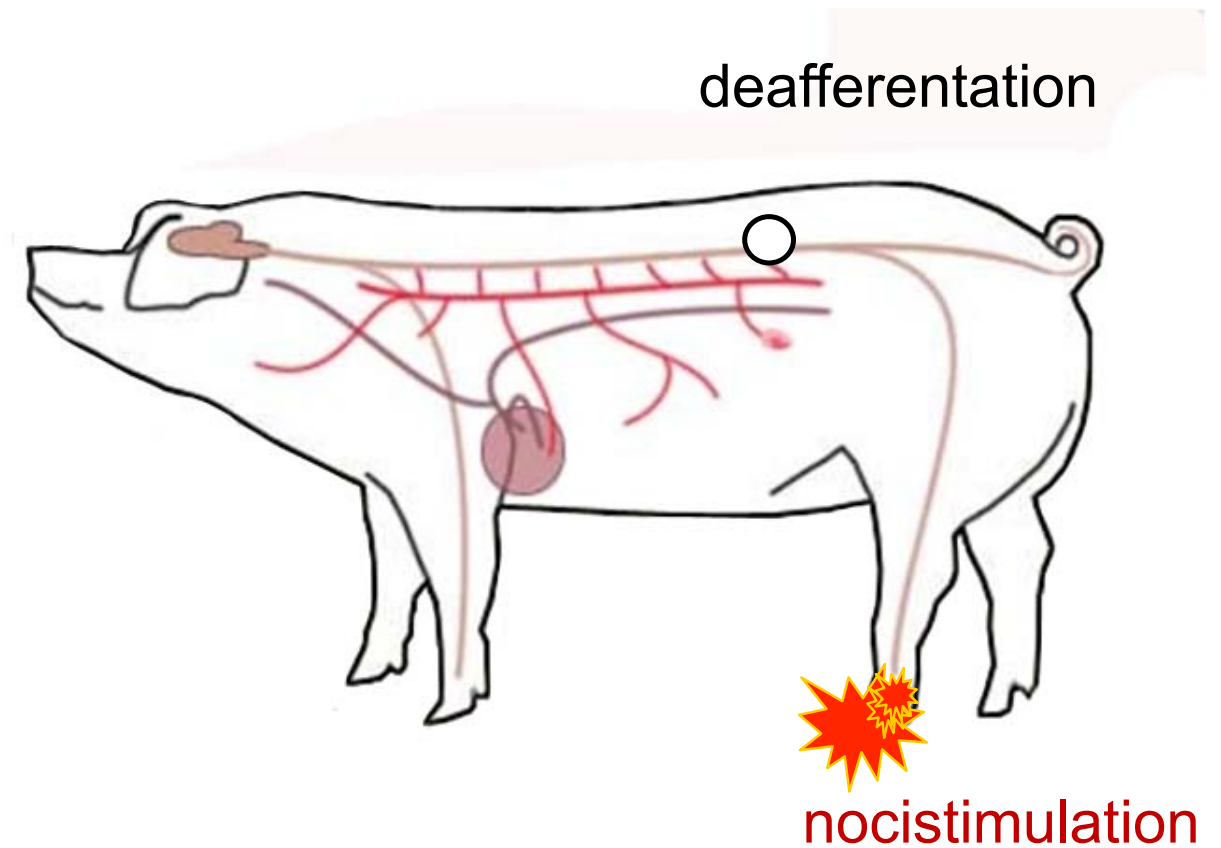
CRF  
ACTH  
cortisol  
glucagon  
PRL  
AVP  
T4  
 $\beta$  endorphin

- catabolism
- anabolism
- -ve N<sub>2</sub> & E balance
- impaired healing



is the animal anaesthetized ?

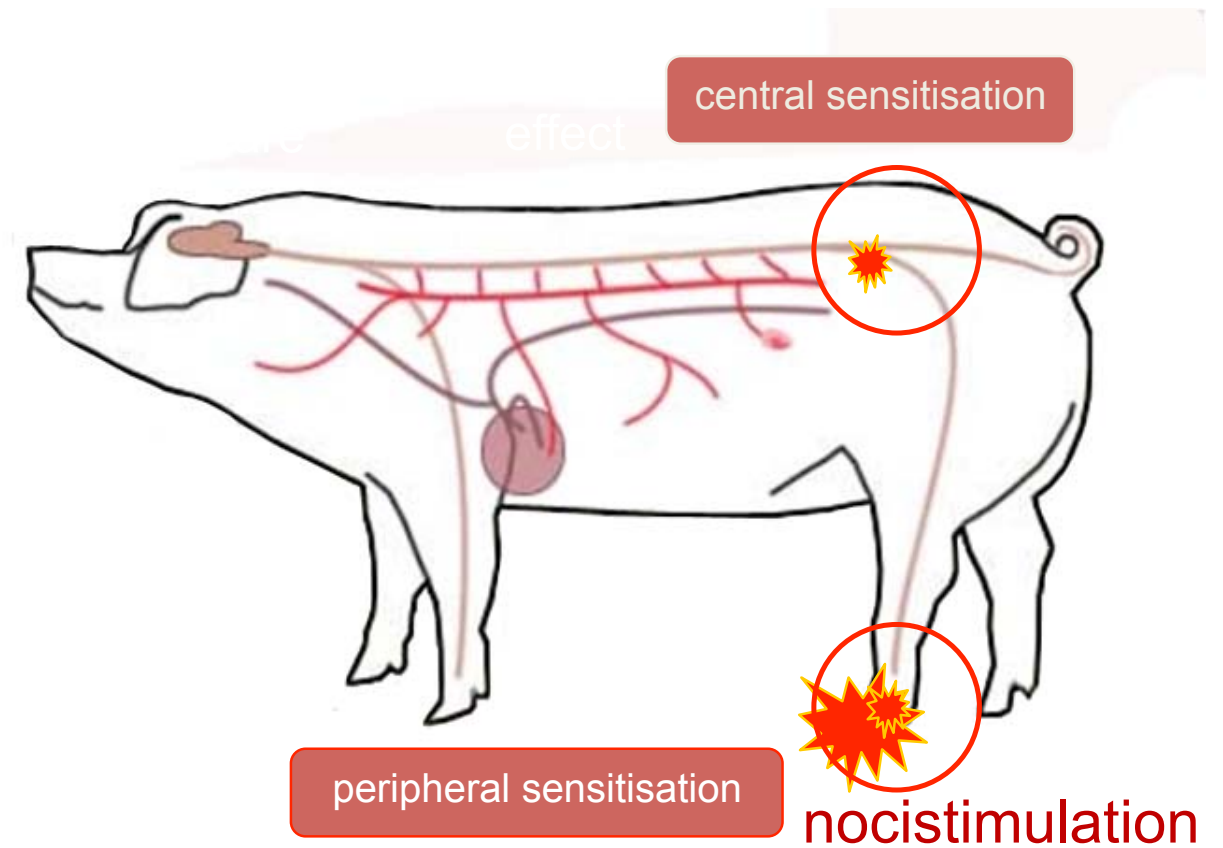
## **Analgesia versus anaesthesia**



is the animal anaesthetized ?

## Analgesia versus anaesthesia

Pain sensitization



is the animal anaesthetized ?

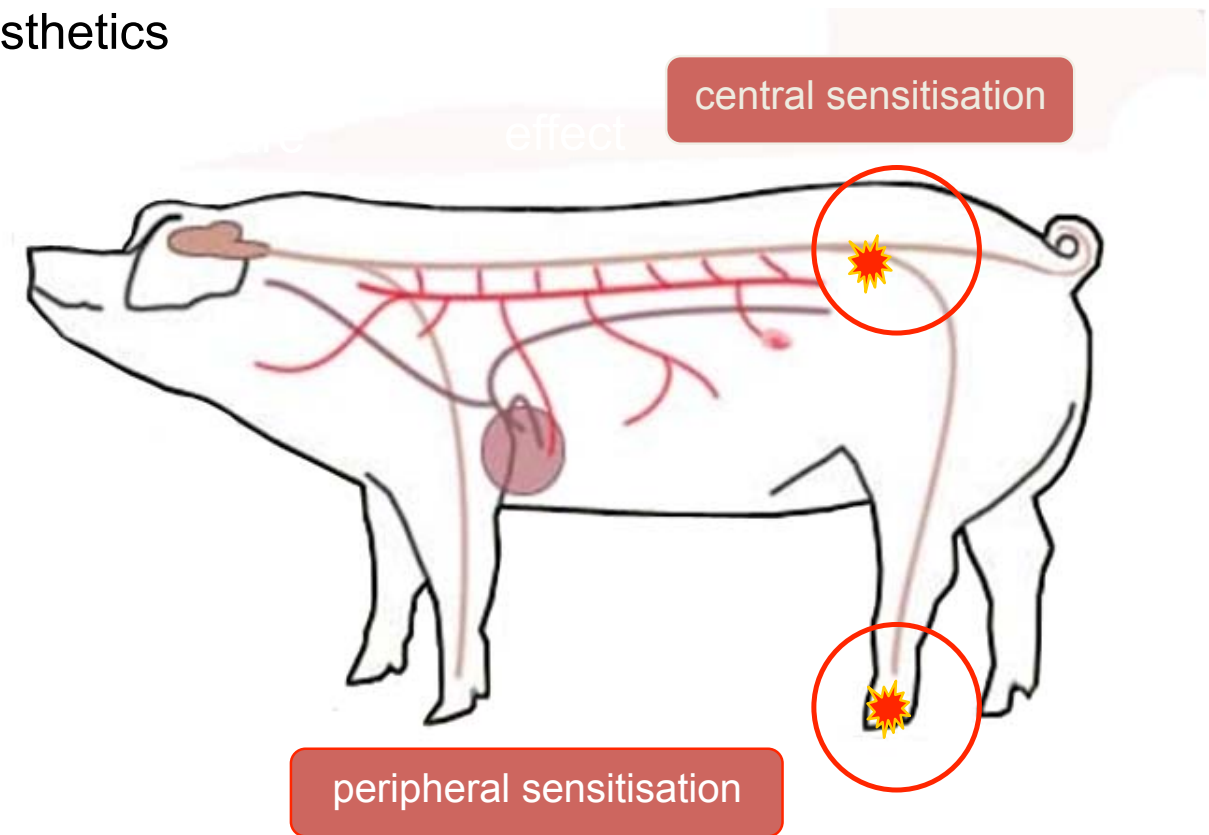
## **Analgesia versus anaesthesia**

start on injury

unaffected by general anaesthetics

explains

- postoperative pain
- hyperalgesia
- allodynia
- neuropathic states



is the animal anaesthetized ?

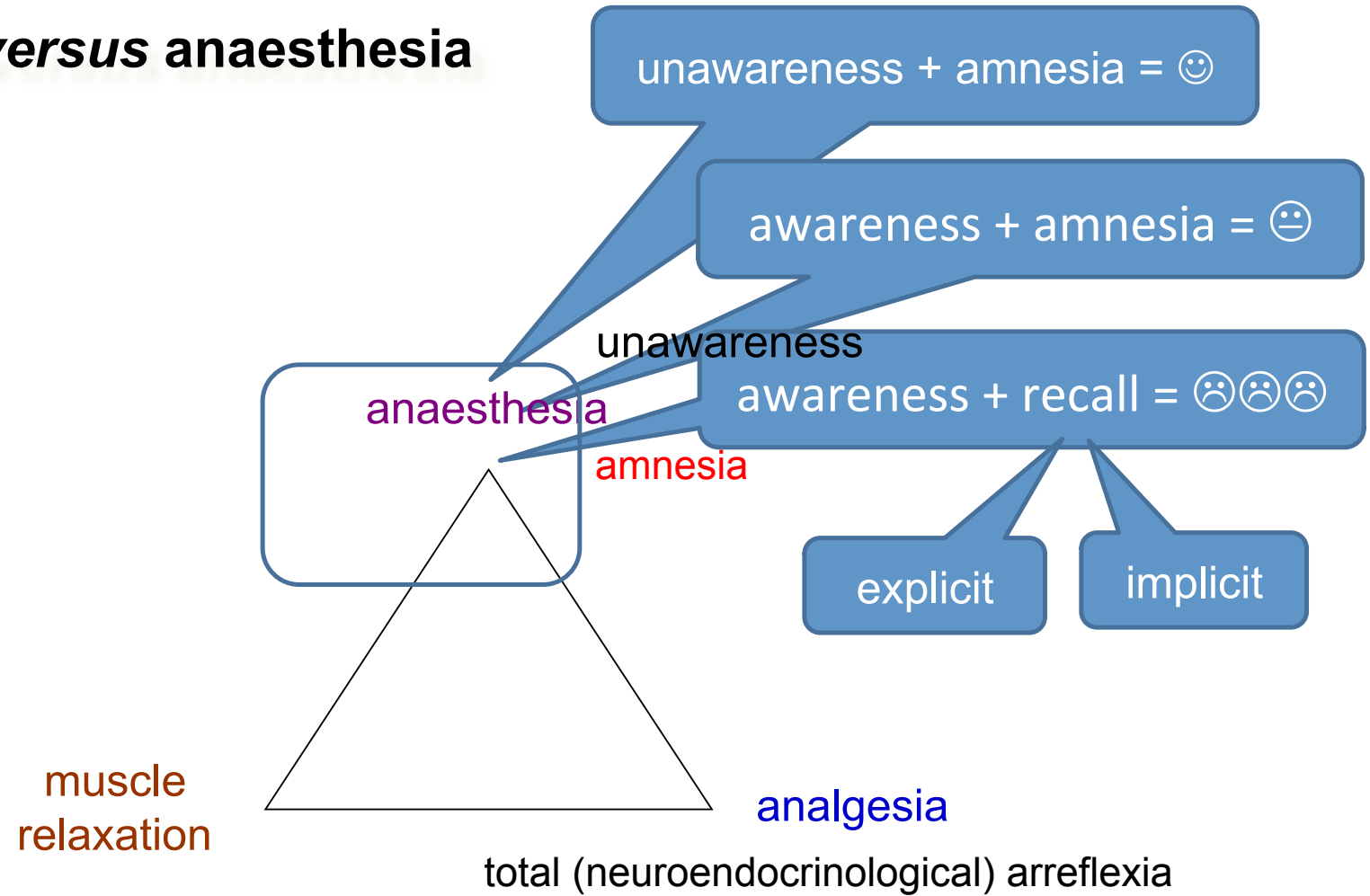
## **Analgesia *versus* anaesthesia**

### Analgesics

- contribute to narcosis
- ↓ anaesthetic requirement (preserve function)
- ↓ undesirable nocifensive responses
- ↓ post-operative pain

is the animal anaesthetized ?

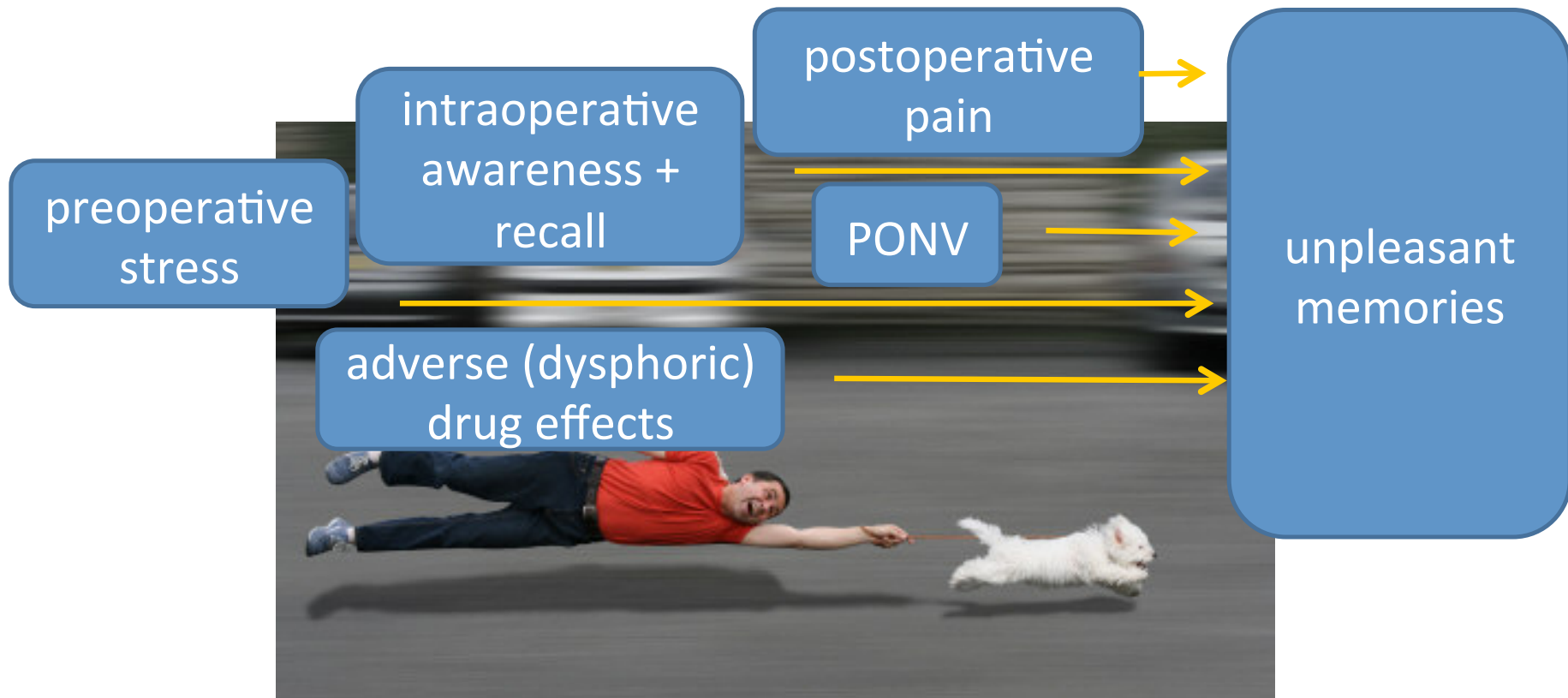
## Analgesia versus anaesthesia



is the animal anaesthetized ?

## Anaesthesia; re-definition

animal relevance ?





is the animal anaesthetized ?

## Is the animal anaesthetized?

do animals remember perioperative events ?

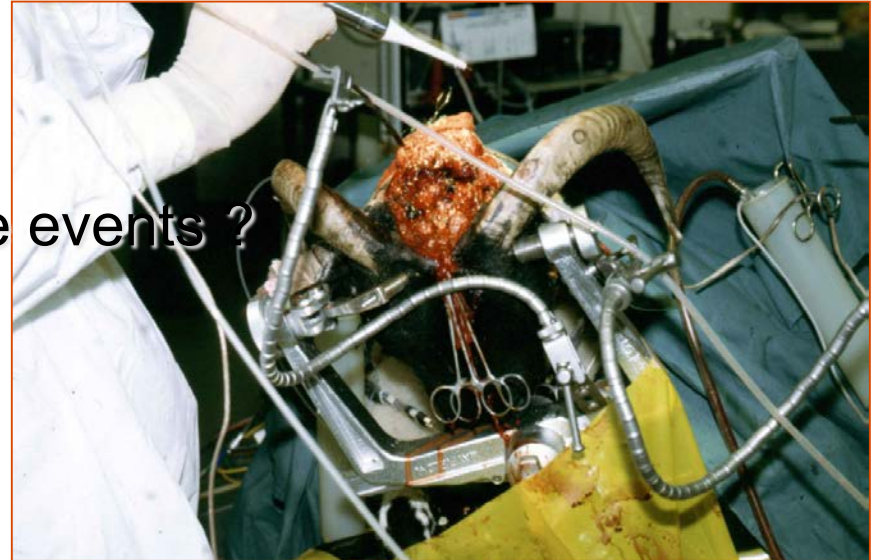


Pascoe PJ. (1986) Humaneness of an electroimmobilization unit for cattle. *American Journal of Veterinary Research* 47 (10): 2252-2256.

is the animal anaesthetized ?

**Is the animal anaesthetized?**

do animals remember perioperative events ?



Repair of the Facial Nerve in the Cerebellopontine Angle Using Freeze -Thawed Skeletal Muscle Autografts. An Experimental Surgical Study In Sheep. M.A. Glasby, R.E. Clutton, S.J. Drew, M.G.J. O'Sullivan and I.R. Whittle. (1994) Acta Neurochirurgica, 136: 151 - 159

is the animal anaesthetized ?

## Is the animal anaesthetized?

do animals remember perioperative events ?

Aversive effects of halothane anesthesia in the rat, using extinction of tasks by positive reinforcement.

C R Acad Sci Hebd Seances Acad Sci D. 1977 Oct 17;285(9):985-8



is the animal anaesthetized ?

## Is the animal anaesthetized?

do animals remember perioperative events ?

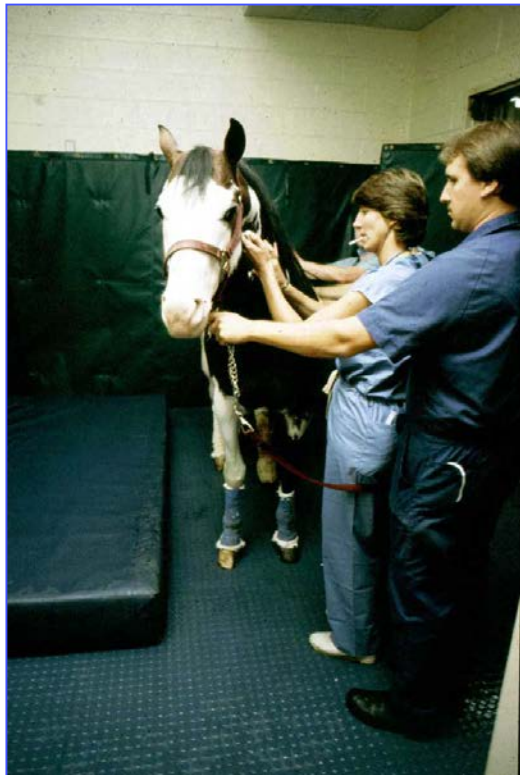


'Repeated Anaesthesia in the Vervet (*Cercopithecus aethiops*)'. Clutton, R.E. and Richards, D.L.S. (1983) *Proceeds of the Association of Veterinary Anaesthetists of Great Britain and Ireland* No. 11, p. 145-153.

is the animal anaesthetized ?

**Is the animal anaesthetized?**

do animals remember perioperative events ?

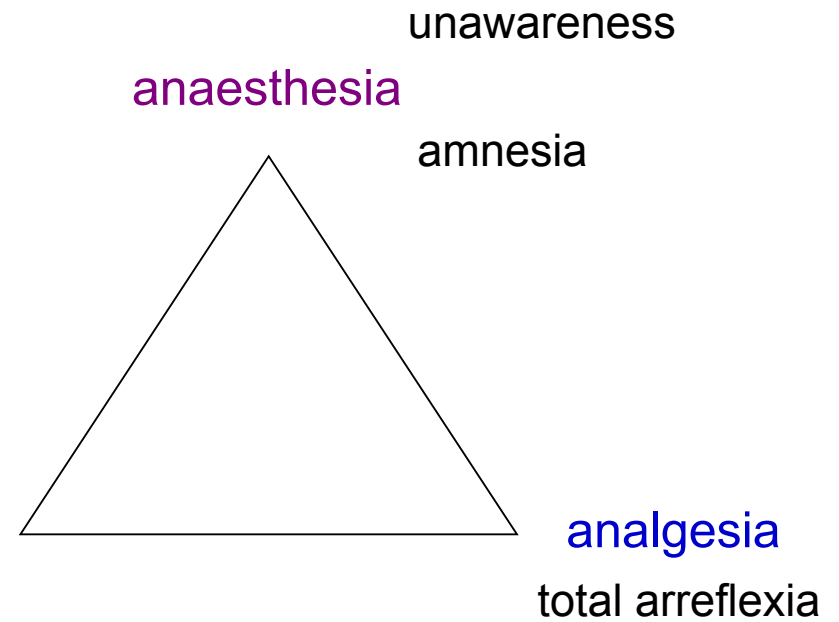
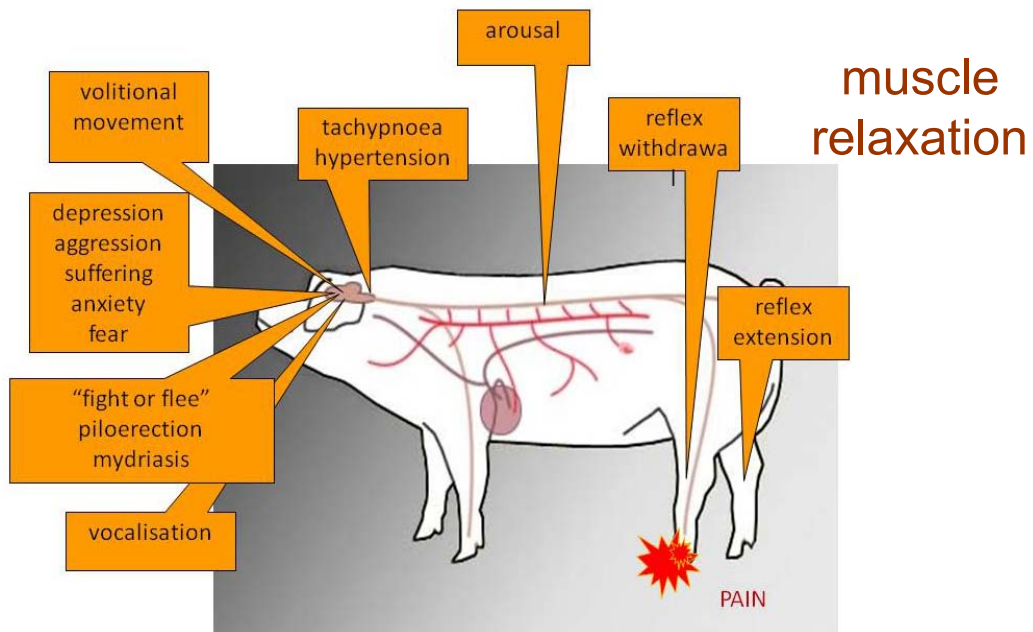


Valverde, A et al., (2013), *Vet Anaesth Analg* 40: 3–12

is the animal anaesthetized ?

## Is the animal anaesthetized?

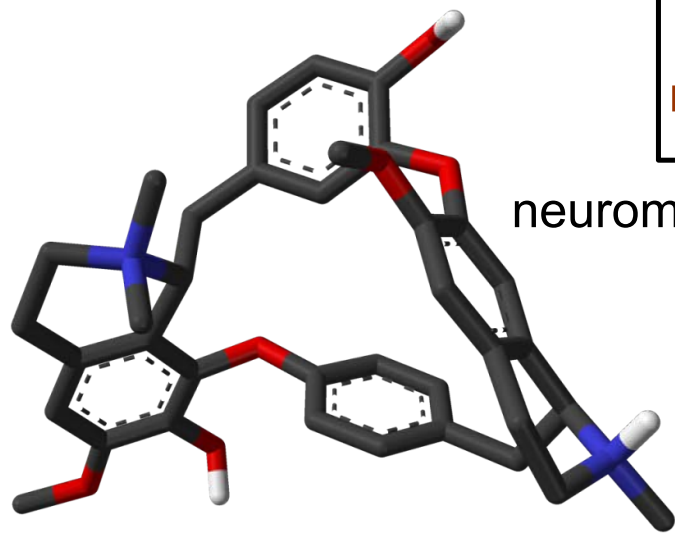
normally yes



is the animal anaesthetized ?

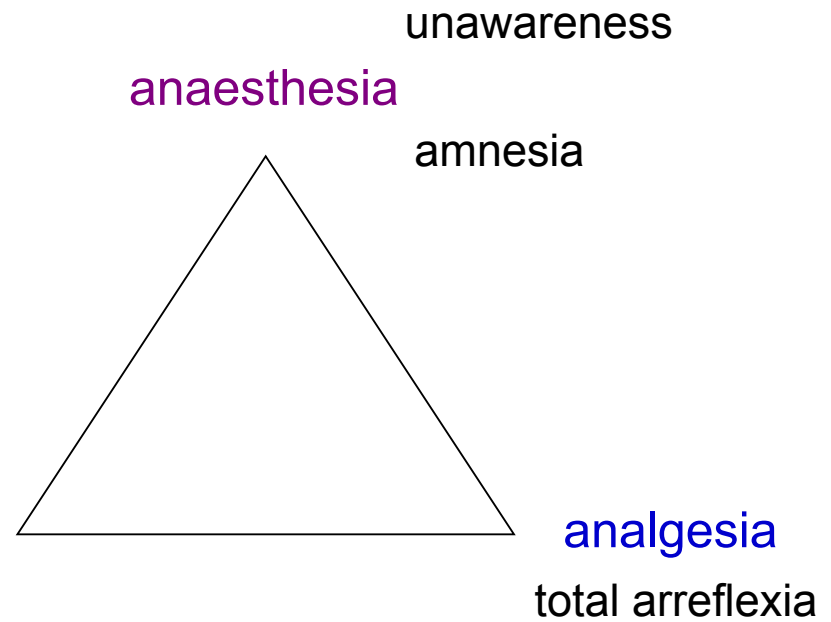
## Is the animal anaesthetized?

normally yes



neuromuscular blockade

muscle  
relaxation



- prevent reflex motor responses
- complicate “depth” monitoring
- eliminate breathing (pattern)

is the animal anaesthetized ?

## Is the animal anaesthetized?

Intra-operative awareness: neuromuscular blockade

- Editorial. Curare in anesthesia. *Lancet* 1945: **ii**: 81-82.
- 0.3 – 0.5% (0.8% children)
- worst cases - irreversible PTSD
- medicolegal (2%)
- difficult to recognize

271 cases (1950 - 2005)

20% tachycardia & hypertension

80% no signs

### Awareness During Anesthesia: Risk Factors, Causes and Sequelae: A Review of Reported Cases in the Literature

Mohamed M. Ghoneim, MD

Robert I. Block, PhD

Mary Haffarnan, CRNA

Maya J. Mathews, CRNA

**BACKGROUND:** Awareness during anesthesia is uncommon. The number of cases that are found in one single study are insufficient to identify and estimate the risks, causal factors and sequelae. One method of studying a large number of cases is to analyze reports of cases of awareness that have been published in scientific journals.

**METHODS:** We conducted an electronic search of the literature in the National Library of Medicine's PubMed database for case reports on "Awareness" and "Anesthesia" for the time period between 1950 through August, 2005. We also manually searched references cited in these reports and in other articles on awareness. We used two surgical control groups for comparative purposes. The first group in a study by Sebel et al. consisted of patients who did not experience awareness. The second group, from the 1996 data from the National Survey of



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Intra-operative awareness: neuromuscular blockade

- Editorial. Curare in anesthesia. *Lancet* 1945: **ii**: 81-82.
- 0.3 – 0.5% (0.8% children)
- worst cases - irreversible PTSD
- medicolegal (2%)
- difficult to recognize

79 cases

15% had hypertension

7% tachycardia.

Anesthesiology  
1999, 90:1053-61  
© 1999 American Society of Anesthesiologists, Inc.  
Lippincott Williams & Wilkins, Inc.

### *Awareness during Anesthesia*

*A Closed Claims Analysis*

Karen B. Domino, M.D., M.P.H.,\* Karen L. Posner, Ph.D.,† Robert A. Caplan, M.D.,‡  
Frederick W. Cheney, M.D.§

is the animal anaesthetized ?

## Is the animal anaesthetized?

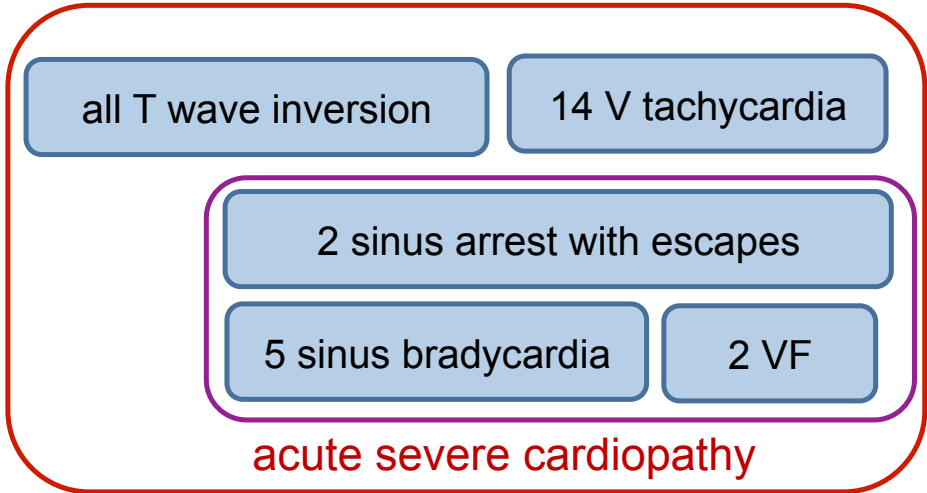
Intra-operative awareness: neuromuscular blockade



23 + n pigs  
"restrained"  
with  
succinylcholine

5 – 6 electric  
shocks in 20  
minutes

no treatment



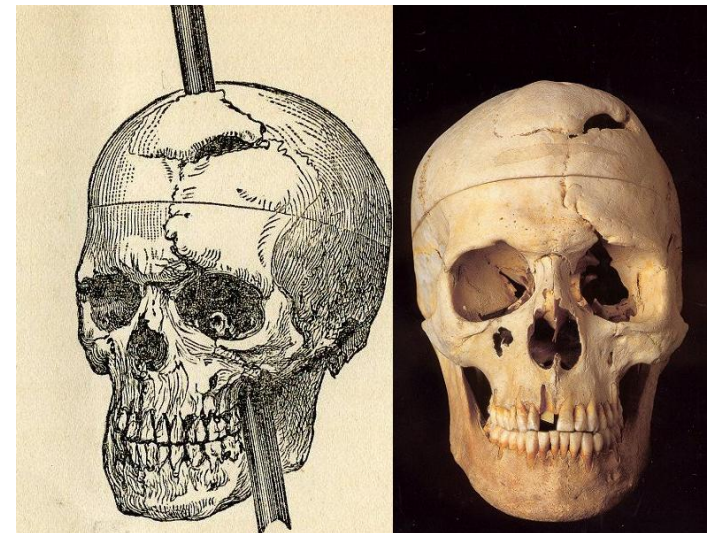
Blomgren L, Lannek N, Blomgren L, Lindberg P, Poupa O  
Am Heart J.1974 Apr;87(4):451-7.  
no cardiopathy

is the animal anaesthetized ?

## Is the animal anaesthetized?

Intra-operative awareness: acute resistance to anaesthetics

- Phineas Gage



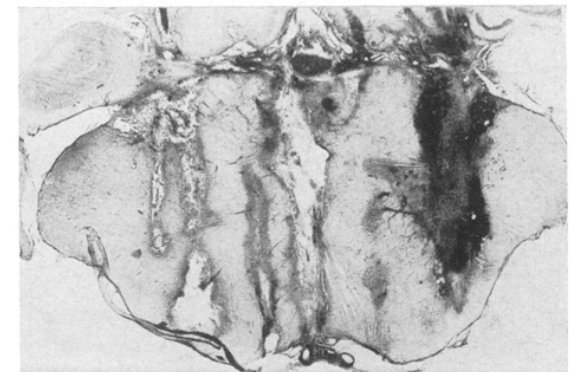
is the animal anaesthetized ?

## Is the animal anaesthetized?

Intra-operative awareness: acute resistance to anaesthetics

- Phineas Gage
- brain lesioning studies

FIG. 5. Cat 60. Eight lesions were placed in a row across the reticular substance at A-f-4. Two lesions were placed at the 1st procedure and one each at succeeding weekly procedures. The animal regained awareness of surroundings, and ability to walk and feed itself after each of the stages. Photograph was taken on 4th postoperative day after placement of the 8th lesion and the animal was killed ~ days later, months after the initial lesion had been placed.



### RATE OF RECOVERY OF FUNCTIONING IN CATS WITH ROSTRAL RETICULAR LESIONS

AN EXPERIMENTAL STUDY\*

JOHN H. ADAMETZ, M.D.†

*Divisions of Neurology and Neurosurgery, and the Beaumont-May Institute of Neurology,  
Washington University School of Medicine, St. Louis, Missouri*

(Received for publication April 25, 1958)

is the animal anaesthetized ?



**Is the animal anaesthetized?**

Intra-operative awareness: acute resistance to anaesthetics  $\text{H}^+$

•Le Chatelier' s principle



is the animal anaesthetized ?

## **Is the animal anaesthetized?**

Intra-operative awareness: acute resistance to anaesthetics

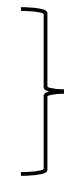
- Le Chatelier' s principle
- acute tolerance
- up- & down-regulation
- autonomic nervous recovery
- “shivering” sheep
- myoclonic pigs

is the animal anaesthetized ?

## Is the animal anaesthetized?

aware but paralysed

CNS unresponsiveness to anaesthetics



“fight-or-flight”  
(ergotropic) signs ?

“conservation – withdrawal” (trophotropic) responses



is the animal anaesthetized ?

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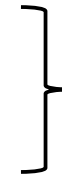


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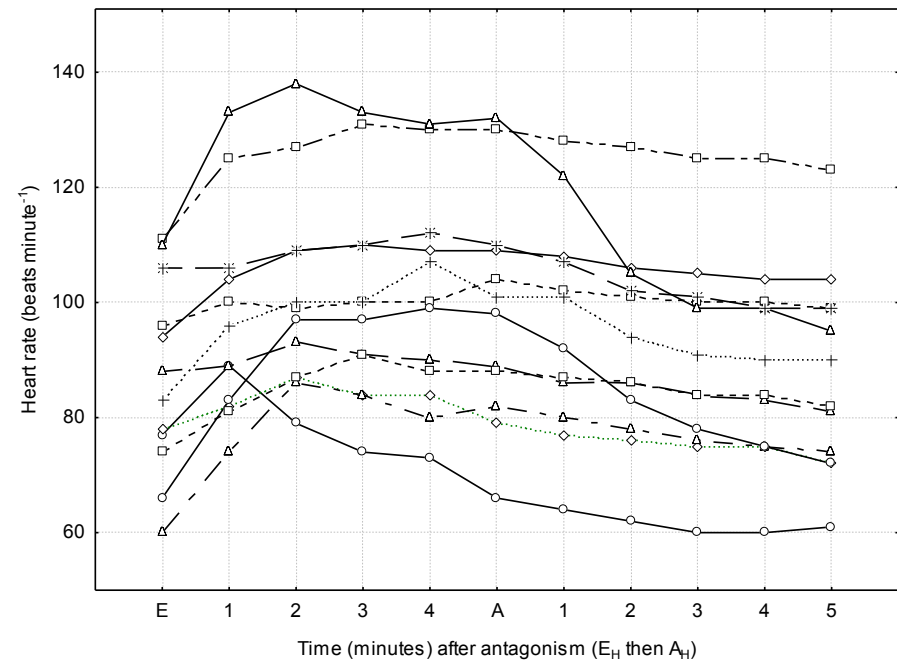
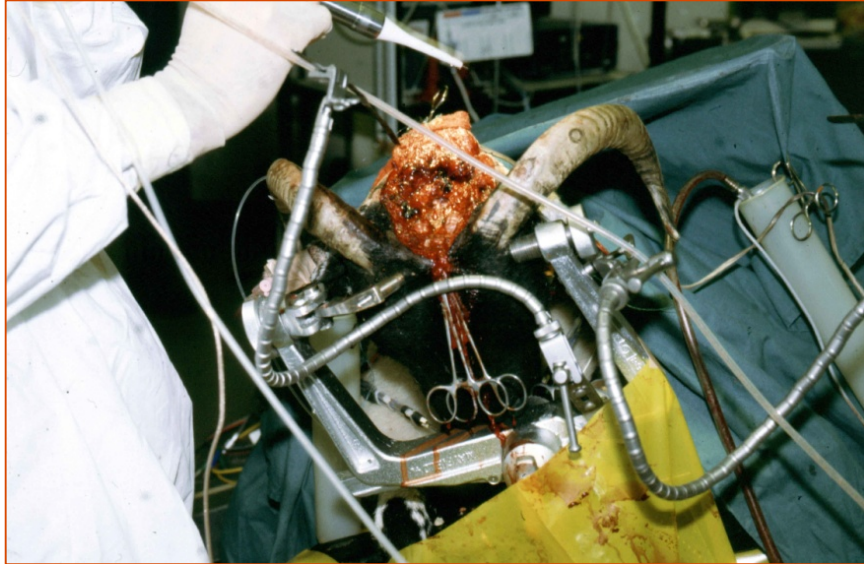
“conservation – withdrawal” (trophotropic) responses



is the animal anaesthetized ?

## Is the animal anaesthetized?

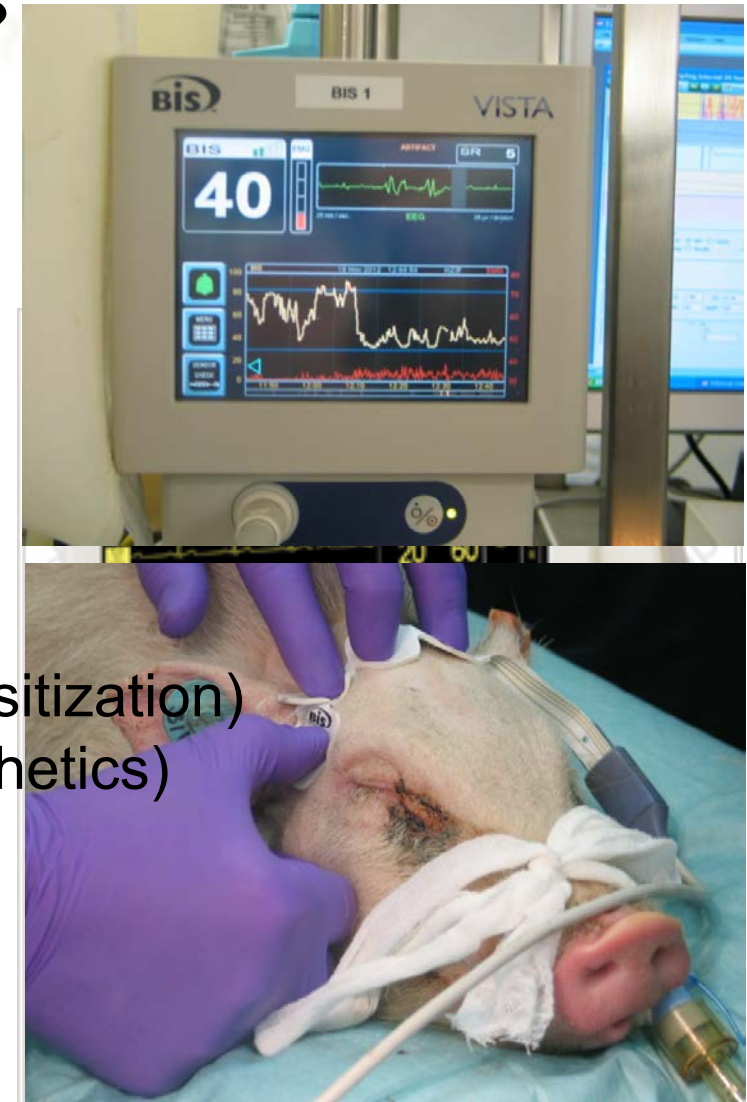
“conservation – withdrawal” (trophotropic) responses



is the animal anaesthetized ?

## Ensuring the animal is anaesthetized?

- medical history
- physical examination
- adequate doses
- do not paralyse
- E/ inhalation agent monitoring
- monitor or quantify “depth”
- recognize paradoxical ANS effects
- prevent nocistimulation (arousal & sensitization)
- consider de-afferentation (local anaesthetics)



is the animal anaesthetized ?

## Ensuring the animal is anaesthetized?

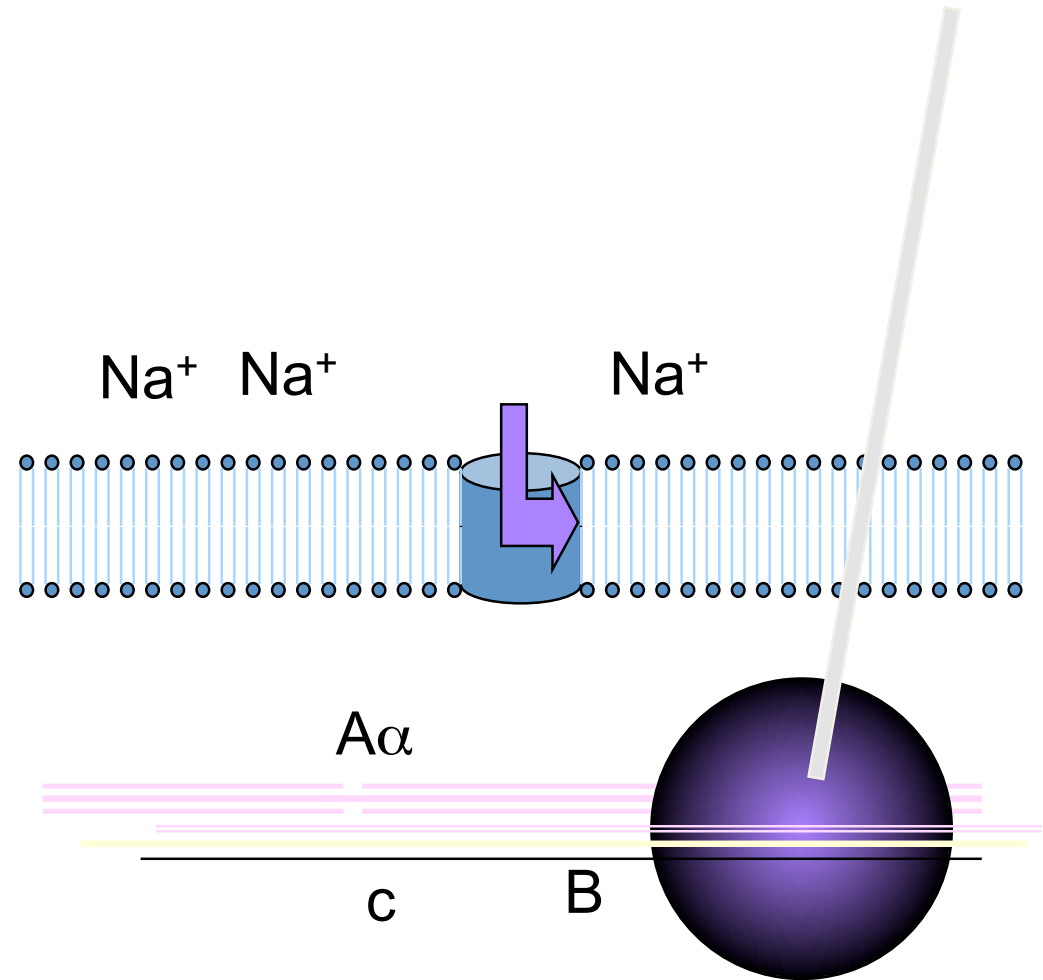
"It may be an unpleasant thought that although our patient is unconscious from general anaesthesia, the nerve impulses inaugurated by operative injury of the nerves *reach the brain*, making a reactive opposition to the surgeon, an attempt to get off the table and escape from the injuries the surgeon is inflicting."

George W. Crile (1864 – 1943)



is the animal anaesthetized ?

## Ensuring the animal is anaesthetized?



is the animal anaesthetized ?

## Ensuring the animal is anaesthetized?



is the animal anaesthetized ?

## Ensuring the animal is anaesthetized?

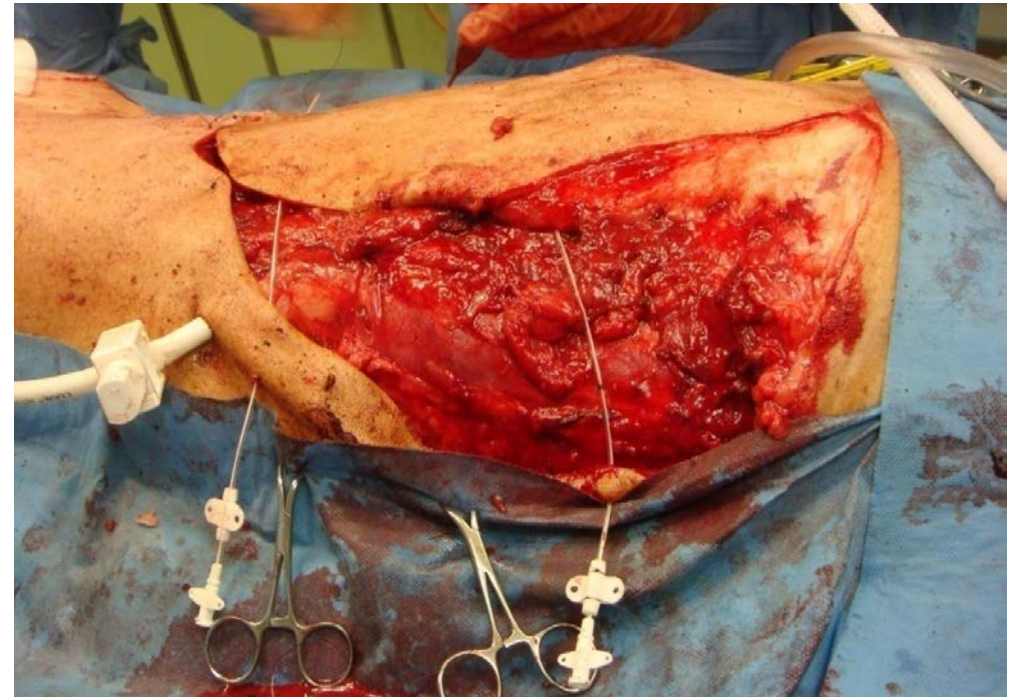
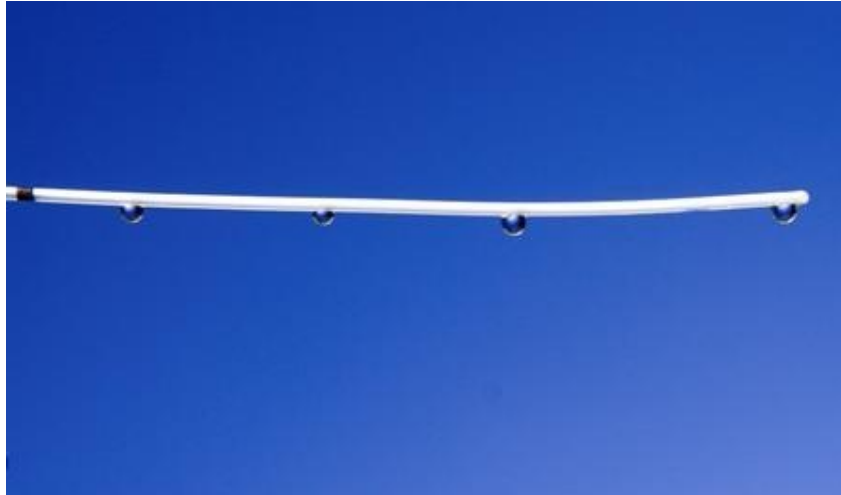


light general anaesthesia  
+  
analgesia  
+  
local anaesthesia



is the animal anaesthetized ?

## Ensuring the animal is anaesthetized?





is the animal anaesthetized ?

## Ensuring the animal is anaesthetized?

