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Review

Consciousness, unconsciousness and death in the context of slaughter. Part II. Evaluation methods

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ABSTRACT

This second review describes indicators of consciousness and unconsciousness that can be used in the abattoir. These indicators evaluate different aspects of cerebral functioning, but only indirectly. It is therefore necessary to monitor several indicators. Animals are considered unconscious if signs of consciousness are absent, and signs of unconsciousness are present. Given that the unconscious state may be reversible it is further necessary to monitor these indicators until the end of bleeding. The techniques used to diagnose brain death in humans cannot be used in the slaughterhouse. Under field conditions, at the end of bleeding, the absence of breathing and of brainstem reflexes and the adequacy of the exsanguination are verified. If these three aspects are confirmed, in the context of the slaughterhouse and at this stage of the slaughter process the loss of vital functions is irreversible and the animal can be considered dead.

Contents

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1. Introduction

Our first review presented the current state of scientific knowledge on brain functioning in the context of unconsciousness and the process of death at slaughter (Terlouw, Bourguet & Deiss, 2016). Loss of consciousness is the result of a reversible or irreversible dysfunction of certain brain structures: the reticular formation, the ascending reticular activating system or the cerebral hemispheres globally. The death of an individual is defined in terms of brain death. This implies the irreversible cessation of brain structures responsible for vital functions like breathing and thermal and cardiovascular regulation that are in the brainstem (Laureys, 2005). This second review aims to contribute to the reflection on the use and interpretation of indicators of consciousness and unconsciousness. The difficulty of assessing brain death in the context of slaughter is also addressed. The synthesis concerns the major food species consumed in Europe, with the exception of fish.

2. Indicators of consciousness and unconsciousness

Following stunning, to avoid unnecessary stress or pain, the unconscious state should be ensured before shackling and hoisting of cattle, pigs and sheep (Grandin, 2013). A number of indicators are used to assess the state of consciousness or unconsciousness of the animal (EFSA, 2004, 2013). These clinical signs are indirectly associated with brain functions involved in consciousness, particularly the reticular formation and/or the cerebral cortex. Some of these indicators indicate almost certainly a conscious and others an unconscious state (Table 1). To ensure unconsciousness, indicators of consciousness must be absent and indicators of unconsciousness must be present. The absence or presence of these indicators must be checked after stunning and during bleeding, for both conventional and religious slaughter. Other indicators have a lower discriminating power and can be used as complementary information (Gregory, Lee, & Widdicombe, 2007). The relationships between the different indicators and brain functioning, including consciousness and unconsciousness, are discussed below.

Table 1
Indicators of consciousness and unconsciousness[a]. Other indicators may be used but their discriminatory power is lower. As the indicators are only indirectly related to the state of consciousness, it is necessary to check several. The animal is unconscious when the signs of consciousness are absent and signs of unconsciousness are present.

Indicator	Sign of
Standing posture	Consciousness
Head or body righting reflex	
Voluntary vocalizations	
Spontaneous blinking	
Eye pursuit	
Response to the threat test	
Absence of corneal reflex	Unconsciousness or death
Absence of eyelash reflex	
Absence of rhythmic breathing	

[a] Some indicators are explicitly mentioned in the memorandum of the French Ministry of Agriculture DGAL/SDSSA/N2012-8250 of 05 December 2012, based on Council Regulation No. 1099/2009: Operators must carry out systematic checks to ensure that animals do not show any sign of life before undergoing dressing or scalding.
According to this memorandum, the clinical signs to check are:- Lack of pupillary reflex;- Absence of corneal reflex;- Absence of spontaneous breathing.

2.1. Indicators of consciousness

2.1.1. Standing posture

In the slaughter context, the standing posture is an indicator of consciousness (Table 1). Therefore, the immediate and permanent loss of the standing posture is used as an indicator of the potential loss of consciousness. Immediate collapse following application of the stun is a main indicator because it is relatively visible; it allows assessing the quality of the stun or of bleeding in non-stunned animals that are bled in the standing posture. This indicator should be interpreted with caution, however, because collapse can be caused by an inability to stand, for example, when the stun gun is placed in the neck and severs the upper spinal cord only paralysing the animal without damaging the brain. Moreover, the collapse cannot be evaluated in animals maintained in a box which restrains the head or body, in a V-shaped restrainer, or animals suspended on a rail (poultry).

Following an effective mechanical stunning the animal collapses immediately. This collapse can be explained by damage to the reticular formation, involved in the control of the standing posture (Purves et al., 2001; Schepens & Drew, 2004). Electrical stunning also causes immediate collapse, due to the seizure spreading through the cerebral hemispheres and subcortical structures, particularly the reticular formation (Tatum, 2010). Gas stunning and bleeding without stunning gradually induce a loss of capacity to maintain the standing posture probably due to a global progressive dysfunction of cortical and subcortical structures including the reticular formation.

Widespread anoxia in the brain following bleeding of non-stunned animals results also in a global progressive dysfunction of cortical and subcortical structures explaining the progressive loss of the capacity to stand upright. It was suggested that the first loss of posture may be only a sign of the early stages of onset of unconsciousness (Gibson, Dadios, & Gregory, 2015; Gregory, Fielding, von Wenzlawowicz, & von Holleben, 2010). This may explain why in some cases, during religious slaughter some cattle can regain the standing posture briefly, probably due to transient physiological adjustments partly restoring neurological function, before the final collapse (Bourguet, Deiss, Tannugi, & Terlouw, 2011; Gregory et al., 2010).

2.1.2. Righting reflex of the head and/or body

An animal on the floor that is conscious following an unsuccessful stun may attempt to lift the head and/or body, or at least to position them in the usual angle (head/body axis perpendicular to the axis of the earth; Anil, 1991). After an effective stun, as long as the animal is unconscious, it does not attempt to recover its normal posture. Recovery movements are oriented but sometimes difficult to distinguish from other movements which are automatic or reflex movements (see below: paddling and other movements).

2.1.3. Vocalizations

When unrelated to social communication, vocalization expresses most often pain (Grandin, 2013). It was found that 99% of the vocalizations of cattle and pigs during slaughter were preceded by aversive situations, such as the use of an electric prod, a fall, a failed stun or excessive pressure during restraint (Grandin, 1998; Warriss, Brown, Adams, & Corlett, 1994; Watts & Stookey, 2000; White et al., 1995). As pain can only be perceived if the animal is conscious, intentional vocalizations occurring after a stun are indicative of consciousness (Grandin, 2013). Some guttural sounds are reflex-like that should not be confounded with vocalizations (see below: gasping).