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Affective-autonomic states of domestic pigs in the context of coping and animal welfare

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Objectives of research

Gaining better insight into affective states of (farm) animals is increasingly important in terms of understanding and improving animal welfare. One important step in this direction is to establish valid and accurate proxy measures to objectively assess an organism's affective state. Evaluating the activity of the autonomic nervous system (ANS) and the balance of its two branches (parasympathetic and sympathetic branch) is a promising approach, as they are viewed as a major component of the affective state in many theories of emotion. Common studies in this field evaluate cardiac activity by the use of external systems providing reliable parameters indicative for parasympathetic (vagal) activity, whereas there does not appear to be any valid index that adequately reflects sympathetic modulation. Due to advances in technology it is now possible to detect both branches of the ANS by the additional assessment of blood pressure (BP), which complements information about subtle changes in ANS activity. The objective assessment of these underlying neurophysiological mechanisms makes it possible to draw conclusions about how affective states may vary both in terms of valence (pleasantness/unpleasantness) and arousal, which are viewed as the core dimensions of affective states.

Moreover, affective states may vary between individuals and it has to be considered that individuals differ in their general adaptive response to challenges. This comprises individual behavioural reaction patterns, such as coping styles (proactive vs. reactive). However, only little is known about the possible link between affective states and coping styles. This thesis combines a methodological and an experimental approach by using an implantable telemetric system to investigate affective-autonomic states in free-moving domestic pigs in the context of coping and animal welfare. Two major aims were addressed:

(1) The establishment of a telemetric method for measuring both branches of the ANS in order to provide a valid tool for the objective evaluation of affective-autonomic states in free-moving pigs. This included (a) the development of a reliable surgical procedure for the implantation of a telemetric device for the continuous recording of ECG and BP and (b) the functional assessment of recorded parameters to ensure reliability of the acquired data.

(2) The assessment of affective-autonomic responses of pigs in different housing-relevant situations and the relationship to their individual coping characteristics within the two-dimensional model of affective states.

Main findings

In the context of the establishment of the telemetric method the following key findings were published in *The Veterinary Journal* 207, 140–146 (2016) and in *Frontiers in Veterinary Science* 2, 52 (2015).

- ✓ A detailed surgical protocol for the implantation of a telemetric device for the continuous recording of electrocardiogram (ECG) and BP in free-moving pigs was developed. For the generation of valid signals it has proven advisable to place electrodes in muscle tissue (the negative electrode lateral to the sternum and the positive electrode lateral to the scapula), to insert the BP catheter in the external carotid artery, and to place the telemetric device subcutaneously at the left side of the neck of the animal.

- ✓ Technical and surgical issues concerning catheterization and detachment of ECG leads impeded data transmission in four (out of 11) pigs and a list of recommendations for future implantation studies was generated.
- ✓ Detection performance decreased with elevated behavioural level comparing resting to feeding conditions, but manual correction was able to reliably eliminate errors.
- ✓ Blood pressure signal was more stable and less susceptable to movement artefacts compared to electrocardiogram.
- ✓ Cardiovascular parameters during baseline (resting) conditions indicated high vagal and low sympathetic activity.
- ✓ Cardiovascular parameters during behavioural activity in the context of food consumption indicated decreased vagal and increased sympathetic activity.
- ✓ BP signal was reliable in calculating HR values, but may not be used for the determination of HRV due to systematic overestimation of the values in comparison to calculations derived from ECG (gold standard).

The investigation of affective-autonomic responses of pigs in different housing-relevant situations and the relationship to their individual coping style yielded the following findings which were published in *Frontiers in Behavioral Neuroscience 11, 103 (*2017):

- ✓ The respective coping style was related to significant context-related differences in their general autonomic state.
- ✓ The two coping styles differed in their behavioural and affective-autonomic response over the time course of the experiment in the context of a repeated handling situation indicating individual differences in their affective appraisal.
- ✓ Proactive pigs developed an anticipatory ANS response in the context of feeding faster than reactive pigs, whereas pigs of both coping styles did not clearly anticipate the handling situation. Instead, a vagally mediated orienting response was shown.

Conclusions

This thesis presents a valid tool for the objective evaluation of affective-autonomic states in free-moving pigs. This provides insight into the neurophysiological processes underlying affective responses and situational appraisal. The link between context-specific affective-autonomic states and individual coping characteristics indicates that coping may play a more pivotal role than suggested so far and highlights the importance of both, as mediators of the relationship between the animal and its environment. Understanding affective states and appraisal processes is of elemental interest in the context of animal welfare. Gaining better knowledge of the complexity of affective states regarding their underlying mechanisms and their individual perception and processing is important to reveal new perspectives to both current and future animal welfare studies. This will (hopefully) direct our perception of domestic pigs from being a production species more to being complex individuals with each having their own individual characteristics, emotions and needs. This would be a significant step in the direction of improving farm animal husbandry and welfare.