8. Summary

Short and long term changes in heart rate variability and heart rate in response to changes in the social environment (grouping and grooming-simulation) of domestic pigs

In the present study, the usefulness of heart rate variability (HRV) and heart rate (HR) for documenting short and long term effects of two different changes in the social environment (grouping and grooming simulations) of pigs was examined relative to the following aspects:

- It is commonly accepted that HR gives little information about the long term effects of housing on animals. Therefore, the role of HR and HRV was reconsidered in the context of long term effects.
- Cardiac vagal tone is considered as an index of stress and stress vulnerability. Some parameters of HRV are better suited for the assessment of the vagal activity than HR. It was tested whether HRV better reflects the reaction of pigs to changes in the social environment than HR.
- Objective physiological parameters are relevant for the interpretation of stress in animals. The suitability of HR and HRV for the interpretation of the nature of a stimulus (positive or negative) was investigated in this study.

A quantitative Lorenz plot analysis was used to calculate two HRV-parameters: (1) the SD1, which correlates to vagal tone and (2) SD2, depending on overall activity of all components which control heartbeat. In order to minimise influence of motor activity on SD1, SD2 and HR, only those valid 5-minute-periods of non-invasive telemetric measurements of succeeding beat-to-beat intervals were taken into account, in which pigs remained in recumbency.

Grouping is known as a stressful event for pigs, because a new group hierarchy has to be established. In a housing experiment, sixteen single housed pigs were grouped into 4 groups of 4 pigs at the age of 22 wk (GROUP-pigs). In pens of 2 groups, objects for manipulation (straw in a rack, tyre, stone) were available. In weekly intervals from wk 20 to 25, individual medians of HR, SD1 and SD2 from all valid 5-minute-periods per week (i.e. for basic resting values) of GROUP-pigs were compared to those of eight pigs that remained in single housing (SINGLE-pigs, control). After grouping, HR increased and SD1 decreased compared to wk 21 in GROUP-pigs (p < 0.05). From wk 22 to 24, HR of GROUP-pigs was higher and SD1 was lower compared to SINGLE-pigs (p < 0.05). In wk 25, no differences were found between GROUP- and SINGLE-pigs. SD2 was not affected by grouping and objects for manipulation did not influence grouping effects on HR and SD1. The results indicate a grouping induced long term decrease in parasympathetic activity (i.e. SD1 is an index for vagal tone), which can be explained as a long lasting stress effect (i.e. a low vagal tone is an indication for stress in mammals). Since the parasympathetic activity returned to normal (control) conditions after three weeks, the long term effect of grouping was reversible. Therefore, grouping but not group-housing of pigs should be considered as the real stressor for pigs.

Grooming is a behaviour typically seen in many social living animals. Pigs are grooming each other with their snout (massaging and nibbling) and the behaviour of the recipient (e.g. moving into a recumbent position, accompanied by general muscle relaxation, closed eyes and short grunts) indicates a state of relaxation. In a grooming experiment, HR, SD1 and SD2 were measured in 8 single housed pigs during 5-minute-periods of grooming-simulation (massaging
the pigs along head and belly with fingers by the experimental handler) and compared with undisturbed periods immediately before and after the experiment (3 simulations per pig/day on 4 days per wk during wk 26 and 27). Experimental grooming increased HR while SD1 decreased (p < 0.05), but had no effect on SD2. Similar results were found in ‘natural’ grooming between pigs (some events during telemetric measurements from group-housed pigs). The physiological results are pointing to a state of tension (i.e. decreased parasympathetic activity), which appear contradictory to the behavioural reaction suggesting relaxation. However, this particular reaction to grooming can be interpreted as a response best described as ‘positive strain’. Long-term effects of grooming were investigated by calculating the individual medians of HR, SD1 and SD2 from all valid 5-minute-periods per week. Contrary to the short-term effects of grooming, the periodical grooming-simulations caused an increase of both HRV-parameters (SD1 and SD2) and a decrease of HR in the second week (wk 27) of the experiment (p < 0.05). The results indicate a pronounced increase of parasympathetic activity as a long term effect of the grooming-simulations. This is an indication that group housing should be the preferred housing system for pigs, because grooming could contribute to the well-being of pigs.

Conclusions:

- HR and HRV can provide valid information about the long term effects of housing (or other changes in the social environment) on pigs, when using medians of HR and HRV-parameters from several measurements (e.g. all valid 5-minute-periods per week) under the same behavioural state (e.g. lying in recumbency).
- Summarising all results, changes in SD1 were more obvious than changes in HR, while effects on SD2 were only obvious when alterations in parasympathetic activity were strong. The following order of significance can be postulated: SD1 > HR >>> SD2. This order might be determined by the magnitude of internal control components which mainly influence these parameters: SD1 is dominated by vagal tone, HR is normally controlled by parasympathetic and sympathetic activity and SD2 depends on overall activity of all components that control heartbeat.
- The results indicate, that the direction of long term changes in the parasympathetic activity, especially seen in the changes of the SD1, correspond to the nature of a stimulus: a negative stimulus (grouping) causes a decrease and a positive stimulus (regular grooming) induces an increase in parasympathetic activity. Short term changes in HRV and HR appear to indicate a more general physiological activation, regardless whether the stimulus is positive or negative. Therefore, short term changes in HRV and HR should be interpreted together with behaviour and other physiological factors.
- The application of HRV, especially those HRV-parameters which reflect the vagal tone like SD1, can be a sensitive tool to address problems in applied animal research. For example, by optimising housing conditions based on the information of a higher parasympathetic activity of pigs as an indicator of reduced stress, for rearing pigs with high parasympathetic activity which have a better stress resistance to management procedures or for studies where pigs are used as a model for research in human medicine.