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Automated video analysis of pig activity at pen level highly correlates to human observations of behavioural activities

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ABSTRACT

Automated collection of continuous activity data of pigs can be performed easily using video analysis. In welfare and health research, this technique can be economically advantageous over manual observations. However, the relationship between activity measures by automated video analysis and manually scored behavioural activity has never been established. We correlated automated activity measures through video analysis to ethological scores of pig activity, using off-line video recordings of four pens with grower pigs. Human observations (HO) of different behavioural activities were carried out by 2-min scan sampling during four 30-min sessions on 6 observation days. HO of pig activity was expressed as a mean proportion per session. Automated observations (AO) of pig activity were calculated by the relative number of moving pixels between two consecutive image frames (1 frame/s) and expressed as a mean image activity index per session. The overall correlation between pig activity data from AO and HO was strong and positive ($R_s = 0.92$, $P < 0.0001$). When comparing AO and HO data at session level, the correlation coefficients for the two afternoon sessions were lower. Both static activities and activities involving locomotion had a significant effect on the activity index of AO ($P < 0.05$), but activities that included locomotion had a three times higher effect than static activities. Further validation research is necessary, but it can be concluded that automated video analysis is a promising technique to continuously monitor behavioural activity level of pigs at pen level.

1. Introduction

Recording animal behaviour is a non-intrusive method in welfare assessment and in the near future, it is expected that technologies such as automated video-analysis will play a major role in welfare monitoring (Dawkins, 2004). One of the advantages of automated monitoring systems is that they can collect data continuously, do not disturb the animals and are neither subject to (inter)-observer reliability nor other sources of observer bias. Because these

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systems can operate in real time, they would be able to detect behavioural changes timely and therefore have the potential to be a valuable tool for detection of inadequacies in management, unrest or diseases (Frost et al., 1997). One simple parameter that can be easily measured automatically is the activity level of animals. In ethological research, changes in the activity level were found to be related to welfare and health problems. For instance, significant differences in activity were found after infection (Escobar et al., 2007; Reiner et al., 2009), outbreaks of tail biting (Statham et al., 2009) and after stress induction (Salak-Johnson et al., 2004). Activity can be measured automatically by e.g., attaching accelerometers to individual animals, as was shown in validation research for measuring activity types in sows (Cornou and Lundbye-Christensen, 2008). However, to measure the activity level in groups of fattening pigs, automated video analysis might be more cost-effective. Automated video analysis is based on subtraction algorithms to extract the animals in the image from the background based on the contrast (Lind et al., 2005). This technique has been applied for instance for tracking animals, and for registering movements, or resting and drinking behaviour (Kashiha et al., 2013a; Lind et al., 2005; Shao and Xin, 2008; Spink et al., 2001). Although automated video analysis is not a new technique, it has not been validated for group-housed pigs. If this technique proves to be a valid method to measure the activity level of a group of pigs, it would save considerable amounts of man hours and moreover can provide continuous data in real time. Therefore, the main purpose of this study was to investigate the correlation between data on pig behavioural activity obtained by human labelling versus automated video analysis. In addition, the relative contribution of different subtypes of activity to the automated activity score was examined.

2. Material and methods

2.1. Animals and housing

Pigs were housed at the pig husbandry site of Biocentrum Agri-vet of Ghent University in Merelbeke, Belgium. Ten days prior to the start of the video recordings, forty pigs (average weight 27.0 ± 4.0 kg (mean ± SD), Rattlerow Seghers × Piétrain Plus (Hypor KI), were selected from the battery pens and assigned in groups of 10 to 4 fully slatted pens (2.25 m × 3.60 m). The groups were balanced for sex, live weight and former litter and battery mates. Each pen was equipped with a double feeder space and one drinker nipple and animals had ad libitum access to food (commercial grower diet) and water. Pens were separated from each other by solid walls so pigs could hear pigs from adjacent pens, but could not make visual or physical contact. The barn in which the pens were located had a timer-controlled 12 h light period from 7h00 to 19h00, with an average light intensity of 70 lx. The barn climate was controlled by a system of Hotraco (Horst, The Netherlands). During the video recordings the mean barn temperature was 22.5 °C ± 1.24 (mean ± SD).

2.2. Video recordings

Video images were recorded daily during the light period for 12 days in 3 successive weeks. Only daytime recordings were done, as literature and preliminary observations indicated that pigs show very low night-time activity (Gonyou et al., 1992; Robert et al., 1987). Four digital cameras (Panasonic 1/3″ CCD Digital Signal Processing B/W WV-BP330, Noldus, Wageningen, The Netherlands) with wide angle lenses (adjustable lens TG3Z2910FCS, 2.9–8.2 mm) were placed above the centre of each pen to produce a top view image. Video images were captured in MPEG-1 format, with a frame rate of 25 frames per second (frame size 720 × 576 pixels) and data rate of 64 kbps using the software MPEG Recorder 2.1 (Noldus, Wageningen, The Netherlands).

2.3. Human observations of pig activity

Human observations (HO) of pig activity were performed off-line using 2-min instantaneous scan-sampling in four 30-min sessions on 6 recorded days (day 1, 4, 8, 11, 15 and 18). The four 30-min sessions (session 1: 9h30–10h00; session 2: 11h00–11h30; session 3: 16h00–16h30; session 4: 17h30–18h00) were selected based on preliminary observations that showed pigs to have relatively low activity in the morning and a relatively high activity in the late afternoon. Behavioural observations were performed using the software The Observer XT 10.2 (Noldus, Wageningen, The Netherlands). At each scan sample, each individual pig of a pen was either scored for the behaviour category inactive or general active. The general active category was further divided into three activity subtypes: (1) locomotion; (2) static activity; (3) locomotion + activity (Table 1). This sub-division in general active behaviour was made to test if activities that involve locomotion are better registered by the automated system compared to activities that are performed when being in a static posture. The occurrence of each behaviour was calculated as a proportion of the total number of scans per session (15 scans). Per

Table 1
Classification and description of the behaviour categories and the activity subtypes scored by the human observations (HO).

Behaviour category	Activity subtype	Description
General active	Locomotion	Only locomotion (walking or running) is performed but not performing an "activity" in conjunction
	Static activity	Only an activity is performed (feeding, drinking, exploring, pen directed or pen mate directed behaviour, agonistic behaviour, playing, comfort behaviour) in a static posture (lying, sitting or standing)
	Locomotion + activity	Locomotion and activity are performed simultaneously
Inactive		Absence of locomotion and activity