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Assessing animal welfare at the farm level: do we care sufficiently about the individual?

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Abstract

Animal welfare is generally referred to as the quality of an animal's life as experienced by the individual animal. On-farm welfare assessment, however, usually relies on both individual and group measures. As regards the latter, individual animals are not identified (eg incidence of stereotypic behaviour in a pen) or features of the whole group (eg score obtained from qualitative behaviour assessment) are used. This raises the question whether our current approaches to on-farm assessment sufficiently consider the individual nature of animal welfare. Measures assessed at the group level bear the disadvantage that distribution across group members may be skewed and the most affected individuals are not necessarily identified. However, the importance of knowing about the welfare state of individual animals depends on the purpose of the assessment. If the primary aim is farm assurance, the individual animal is of lesser importance, but non-compliance with thresholds at herd/farm level or comparison with peer farms may induce change. Using individual measures in a sample of animals means that animals not sampled but requiring intervention, eg for treatment of lameness, would have to be identified subsequently. Measures truly taken at the group level make individual interventions difficult, but interventions implemented at the group level (eg reducing stocking density) do not necessarily require information on the individual animal. Automatic detection of welfare-relevant states has received increased attention and identifying individual animals with impaired welfare seems to be promising. Automated early detection of problems may also reduce the ethical dilemma that traditional assessments at the end of the production cycle, eg in broiler chickens, may identify welfare impairments but not directly benefit the affected animals. Reflection on individual and group measures and their consequences for animal welfare may help in interpreting the outcomes of the assessments and stimulate future developments in the field.

Keywords: *animal welfare, group measures, individual measures, on-farm assessment, purpose, welfare improvement*

Introduction

Independent of the views on animal welfare, ie the 'biological functioning', the 'affective states' or the 'naturalness' view (Fraser 2003), there is general consensus that animal welfare is a characteristic of the individual animal (Broom 2010). However, when assessing welfare on-farm, the measures may be recorded in (a sample of) individual animals, eg health-related indicators, such as lameness or skin lesions (eg Zuliani *et al* 2018), but in many cases they will be assessed at group level. The latter refers to, eg using behaviour sampling to record the occurrence of agonistic interactions in a group of animals during a certain period of time (eg Tremetsberger & Winckler 2012). Due to the often large number of animals present in a farm unit, for feasibility reasons the individual animals performing the behaviour in question are not identified (see, for example, the Welfare Quality® protocol for cattle in Table 1). It is therefore not possible to trace the outcomes back to individual animals. Another type of group measure uses aspects of the group as a whole without even distinguishing between animals. For example, the optical flow pattern of collective movements of broiler flocks has been suggested as a promising approach to assessing and managing broiler welfare (Dawkins *et al* 2012).

In fact, even if some of the information is obtained from individual animals, it is usually expressed as a group or farm/herd outcome, eg as prevalence (proportion of animals affected by a condition at a specific point in time) or incidence (number of cases/events within a specified period of time). One may therefore question whether we sufficiently consider the individual nature of animal welfare in our current approaches to on-farm welfare assessment and how reasonable it is to assess welfare at the group or farm level. In this paper, I will first challenge the extent to which both individual and group measures of welfare actually reflect the welfare state of the assessed animals. Considering the ultimate aim of welfare improvement, I will then discuss how important (and feasible) it is to know about the welfare state of the individual animal. Different purposes of on-farm welfare assessment, ie evaluation at

Table 1 Animal-based measures in the Welfare Quality® protocol for dairy cattle (Welfare Quality® 2009) including the level at which they are assessed and the level at which potential intervention measures are addressed.

Welfare principle	Welfare criterion	Welfare measures	Level at which assessed	Expressed as	Examples for potential interventions at individual and/or herd/group level
Good feeding	Absence of prolonged hunger	Body condition score	Individual*	Herd prevalence	Individual: adjustment of concentrate feeding; Herd/group: recalculation of feed ration, increase in feed push-up frequency
Good housing	Comfort around resting	Time needed to lie down, animals colliding with housing equipment during lying down movement, animals lying partly or completely outside lying area Cleanliness of udder, lower hind leg and upper hind leg	Individual*	Herd prevalence	Individual: - Herd/group: use of softer cubicle base, increased cleaning frequency of cubicles
Good health	Absence of injuries	Lameness, alterations of the integument (hairless spots or lesions/swellings)	Individual*	Herd prevalence	Individual: treatment of lame animals including analgesics Herd/group: routine claw-trimming, rubber flooring in alleys
	Absence of disease	Coughing, nasal discharge, ocular discharge, hampered respiration, diarrhoea, vulvar discharge, milk somatic cell count, mortality, dystocia, downer cows	Individual*	Herd prevalence/ incidence (coughing)	Individual: mastitis treatment Herd/group: hygiene measures at milking
Appropriate behaviour	Expression of social behaviours	Incidence of agonistic behaviours	Group	Herd incidence	Individual: removal of single animals from group Herd/group: reduction of stocking density
	Good human-animal relationship	Avoidance distance at the feed bunk	Individual*	Herd prevalence (in different categories)	Individual: - Herd/group: stockperson training
	Positive emotional state	Qualitative behaviour assessment	Group	Herd score	Individual: - Herd/group: variety of measures

* Assessed in a sample of animals, sample size depending on herd size.

farm level for farm assurance/certification or use as a decision support tool for the herd management, are considered. Finally, I will develop aims for future research on on-farm welfare assessment, taking into account the distinction between individual and group measures.

Individual or group level: do we measure what we are supposed to measure?

The validity of measures, ie the extent to which we are measuring what we are supposed to measure, is a key aspect in welfare assessment. Compared with resource-based measures, ie characteristics of the environment provided to the animals in terms of housing and management, such as floor type or feed quality, animal-based measures aim at directly reflecting how well animals cope with their environment. The degree to which animal-based measures currently used in on-farm welfare assessment have been validated is variable (Knierim & Winckler 2009). Measures usually possess face validity, ie experts agree on the meaningfulness of a measure to reflect welfare. However, criterion validity, ie the extent to which a measure correlates with other measures already held to be valid, and construct validity, referring to the degree to which a measure is actually able to measure a theoretical construct (Scott *et al* 2001), have been demonstrated to a lesser extent only.

Following the above-mentioned statement that welfare is a characteristic of the individual animal, preference should be given to valid individual measures of welfare. For example, local anaesthesia of the palmar digital nerves of cows with claw injuries resulted in improved gait scores thus providing evidence that gait alterations reflect pain and that gait-scoring may serve as a valid method to detect lameness in dairy cattle (Rushen *et al* 2007). Even if not associated with pain, lameness may also reduce mobility and thus impair access to resources, such as the feed bunk or, as shown by Borderas *et al* (2008), to an automatic milking system. Furthermore, negative associations with reproductive performance and longevity have been described (eg Huxley 2013). Scoring an individual cow as lame on a given day may thus tell us that the cow is currently experiencing pain and reduced mobility. This acute measure provides useful information if the focus is placed on the impact of a treatment, eg claw-trimming, or a management change.

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However, the overall welfare impairment may be described by multiplying the extent of poor welfare by its duration. Therefore, assuming that we know the severity of the lameness, for a proper assessment of the longer-term welfare state, we would need to know for how long the animal has been lame. Such information is not usually available. In this case the extent to which a spot assessment truly reflects the welfare state of the animal remains open to debate. The lameness may be due to a recent traumatic incident, eg a contusion resulting from a displacement by another cow which is likely to vanish within a short period of time, but it may also result from a chronic pathological state, such as white line disease or sole ulcer. Similar issues may apply to measures, such as soiling of animals or indicators of clinical disease, eg signs of diarrhoea. Thus, even focusing on an individual animal does not guarantee a full picture of its welfare state.

Measures assessed at the group level may suffer from the further problem that it is not clear whether the situation recorded applies equally to all group members or to single or a few animals only. For example, in the Welfare Quality® protocol for dairy as well as for beef cattle (Welfare Quality® 2009), the incidence of agonistic interactions is recorded using behaviour sampling in segments of the pen(s), and the single observation bouts are then averaged taking the number of animals present in the respective segments into account. For a given herd, the information obtained, ie the average number of agonistic interactions per animal and time unit, may only provide a reliable picture of the level of social disturbances if the interactions are performed more or less uniformly by all group members. However, the same average level of agonistic interactions may have resulted from one or a few animals displaying high levels of aggressive behaviour or, independent from the proportion of animals initiating the agonistic interactions, one or a few animals might have been target animals, thus suffering more than the other group members. Such aspects are rarely addressed or discussed when reporting results from group assessments (eg Kirchner *et al* 2014: application of the WQ system on European beef bull farms; Temple *et al* 2011: on-farm assessment of behavioural measures of welfare in pigs in intensive and extensive conditions). It might be assumed that all group members are similarly affected, but we may also need more debate regarding on-farm welfare assessment, whether we care about the group mean or the worst experience of any individual within the group. This may also raise the question whether it is worse for a few animals to have very poor welfare or for many animals to have only low welfare.

The importance of knowing about the welfare state of individual animals depends on the purpose of the assessment

Protocols used in certification/farm assurance often contain measures recorded both at the individual (eg measures of the physical appearance and health assessed in a sample of animals) and at the group level (eg incidence of agonistic social interactions) (Welfare Quality® 2009; AWIN; Assurewel; see also Table 1). The main purpose of these assessments is to gather information on the welfare situation at herd level in terms of prevalences/incidences and implies that the individual animal is not of primary importance. Instead, outcomes are either benchmarked across peer farms aiming at inducing change in the farms through a continuous improvement-based approach (Main *et al* 2014; Mullan *et al* 2016) or thresholds at herd level are defined. For example, the latter approach has been taken in the US National Dairy FARM Animal Care Program, in which for a limited number of selected animal-based measures (cleanliness, lameness, hock and carpal joint lesions and body condition) maximum acceptable prevalences have been defined (eg maximum 5% severely lame cows; National Milk Producers Federation 2016). Similarly, the German Animal Welfare Association (Deutscher Tierschutzbund 2018) has defined thresholds for a number of animal-based measures for different farm animal species, which apart from complying with housing and management standards have to be met if the welfare label 'Für mehr Tierschutz' is used.

With the ultimate aim of welfare improvement, results obtained from assessments related to certification/farm assurance are usually reported to the farm manager to encourage actions. When originating from the assessment of (a sample of) individual animals, the information may be immediately translated into action, eg through the treatment of animals requiring interventions. The number of animals sampled/assessed usually depends on the required reliability of the data obtained (Mullan *et al* 2009; van Os *et al* 2018) and the availability of resources (Sørensen *et al* 2007). Regarding the limited availability of (time) resources, in most cases examining all animals is not feasible. This is especially true for large herd or flock sizes. Thus, while representative information on the welfare situation at the farm level may be obtained, the individual animal's welfare state will be known for a limited number of animals only. As a consequence, the animals not assessed but requiring intervention would have to be subsequently identified. For example, since all lame animals in a dairy herd should benefit from measures, such as claw-trimming and other treatments, the farmer or a stockperson would have to score the gait of the whole herd for targeted interventions.

In some types of farm animals, the animals which have been assessed will, however, not benefit from actions taken due to the outcomes of the assessment. For example, broiler chickens or turkeys, for which on-farm assessments usually take place towards the end of the fattening period as welfare often deteriorates during the last days of the production cycle (Marchewka *et al* 2013, 2015), are not likely to benefit from implementing any improvement measures. Effects may only then be expected in the following batches, thereby losing completely the focus on the individual animal's welfare state at the time of the assessment.

Measures truly taken at the group level (eg group observations) bear the disadvantage that animals are usually not individually identified, thus rendering individual interventions difficult or requiring further assessments to identify which animals are involved. This is especially problematic if an effective intervention would consist of, eg removing single animals which cause the majority of agonistic interactions or perform injurious behaviours (eg in the case of tail- or penis-biting in pigs), or of removing the animals which suffer most from, eg aggression. However, assuming that the group measures are meaningful for all or at least the majority of the group members, ie the group mean does reflect the average situation, interventions aimed at improvements (eg reducing stocking to reduce aggressive interactions or modifying handling procedures to improve human-animal relationship) are often also implemented at the group and not the individual level. Therefore, they do not require information at the level of the individual animal for targeted actions.

The potential of automated welfare assessments

On-farm assessments in the course of certification or farm assurance usually take place once a year or at even longer time intervals, thus providing spot information only. This may be overcome by continuously monitoring the welfare state and using the obtained information for decision support in farm management. With increasing herd sizes, this becomes impractical for the farm personnel, even in dairy herds or piglet production. In recent years, automatic detection of relevant welfare states has therefore received increased attention. Imaging and sensor approaches are able to individually recognise animals and measure parameters from an individual animal (Rutten *et al* 2013; Nasirahmadi *et al* 2017). The automatic identification of individual animals with impaired welfare has been, however, so far largely restricted to dairy cattle. Examples are the automatic detection of lameness (eg Pastell *et al* 2010; Viazzi *et al* 2013), mastitis (eg Jensen *et al* 2016; Khatun *et al* 2017) and poor body condition (eg Spoliansky *et al* 2016). Also, in pigs, the identification of individual animals with welfare problems is possible, eg using radio-frequency identification (RFID) stations to detect feeding behaviour changes before tail-biting occurrences (Wallenbeck & Keeling 2013) but seems to be less well developed. Automated approaches may develop, in future, into personalised welfare management systems. For example, individual weaning strategies for artificially reared dairy calves based on continuous monitoring of individual concentrate intake are promising in reducing prolonged hunger during the weaning process (Patt *et al* 2017). As regards indicators of positive welfare, brush use may be an interesting indicator (Mandel *et al* 2016), although RFID-based registration of brush use has been less successful so far (Toaff-Rosenstein *et al* 2017).

Often, however, the focus on automatic detection of health and welfare compromises lies on group assessments. For example, in pigs, the detection of changes in diurnal drinking and feeding behaviour, monitoring coughs and vocalisations as well as thermal comfort has been demonstrated using multiple sensors (Hillmann *et al* 2004; Matthews *et al* 2016). However, in most cases, these changes have to be actively identified by the staff, whereas fully automated detection of welfare compromises has rarely been successful (eg Madsen & Kristensen 2005: monitoring deviations in water intake leading to diarrhoea outbreaks). In poultry production, monitoring each animal appears not to be feasible (eg loggers/sensors fitted to the birds may not be retrieved at slaughter and therefore end up in the foodchain; Dawkins *et al* 2012). Instead, optical flow patterns may be a promising and feasible approach as they correlate with key welfare parameters, such as mortality, hockburn and gait aberrations in broiler chickens and, already at the age of 15–20 days, provide information on which flocks will suffer from increased mortality until slaughter (Dawkins *et al* 2012). Another promising type of measure applied at the group level focuses on the inter-individual variation in a certain trait. For example, weight data automatically gathered through computerised weighing scales (Turner *et al* 1984) or digital image analysis (Mollah *et al* 2010; Kashiha *et al* 2014) from single, but not individually identified animals do not only provide information on the weight development but also the uniformity of the group or flock. Such approaches use individual measures (eg weight information of single animals) which are then translated into a measure of the group (eg variation in weight in a given group). Exceeding previously determined thresholds for indicators of variation may indicate maladaptation or health problems and trigger further attention and action. Particularly in poultry production, early detection of welfare problems through such approaches may also solve the ethical dilemma that with more traditional welfare assessment at the end of the production cycle, the flocks for which welfare impairments have been identified will not benefit from any improvement measures taken.

While the automation of individual livestock monitoring seems to be promising for welfare assessment, there are major practical challenges before such systems can be implemented on a broader scale in commercial farming (Nasirahmadi *et al* 2017). Apart from further elaboration of techniques, which detect problems and decide on alarms, the economic value of automatic detection systems needs to be considered. Although rarely investigated, tools to guide economic value estimation have recently been developed, eg regarding lameness detection (van de Gucht *et al* 2018). However, concerns about precision livestock farming also relate to a loss of observation skills, a potential deterioration of human-animal relationship, increased mental workload due to the complexity of information provided and a loss of identity of farmers (Hostiou *et al* 2017; Werkheiser 2018).

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Future (research) needs

There are trade-offs between feasibility and accuracy of welfare assessment, eg in terms of prevalence estimates, but also our knowledge of the reliability of sampling strategies for measures taken at the individual level is limited. Further studies on the reliability of such measures are therefore needed. Regarding group measures, ie mostly incidences of welfare-relevant behaviours, more fundamental studies should be carried out which focus on the distribution of behavioural incidences across group members under practical conditions. Attributing single behaviour incidences from group observations to individually identified animals would allow a picture on the level of skewness across groups/farms to be obtained. For example, on-farm observations of agonistic interactions in dairy cattle could be carried out under different husbandry conditions recording the individual animals exerting as well as receiving interactions. Depending on the distribution of the incidences across the animals, this would provide information on the bias introduced when assuming equal involvement of all group members. Epidemiological analyses might even help in identifying factors that are associated with skewed distribution and which could be taken into account when interpreting outcomes for group measures.

The automated detection of welfare-related measures is rapidly advancing. It should focus on the early detection of problems both at individual and at group level. Furthermore, interfaces between automated data collection and welfare assessment protocols for farm assurance as well as for decision support at the farm level may improve longitudinal monitoring of welfare and thus allow for a more complete picture of the overall welfare state of the animals.

Animal welfare implications

On-farm welfare assessment is of huge importance to safeguard animal welfare. It not only forms the basis for farm assurance but also forms part of farmers' management routines concerning continuous welfare monitoring and improvement. The choice of measures is paramount for an assessment, which aims at reflecting the actual welfare state of the affected animals. However, some of the commonly used measures do not directly address the individual animal. For example, behavioural measures on group level do not allow identifying individual animals performing a certain behaviour. Likewise, measures which describe dynamics of the group as a whole, such as optical flow patterns of flock movements, do not assess the welfare of the individual animal. Whereas information from group measures allows triggering improvement for individuals by interventions addressing the whole group, herd or flock, the potentials and limitations of both individual and group measures require increased awareness to ensure the correct interpretation of the outcomes of assessments. Such an increased awareness may also stimulate further developments in the field towards a more 'individualised' approach of assessing and improving animal welfare in the future.

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