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Overall animal welfare reviewed. Part 3: Welfare assessment based on needs and supported by expert opinion

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Abstract

Welfare concerns what matters to animals from their point of view. What matters to animals is their state of need. Satisfaction and frustration of needs are associated with emotional states, the subjective experience of which directly determines the welfare status of an animal. Because emotional states are difficult to assess, overall welfare assessment (OWA) is best approached as an assessment of needs.

For actual OWA a list of needs must be formulated. Different authors have formulated different lists. From these lists a concept need-list was constructed. For validation the needs-based approach for OWA was discussed in interviews with experts (n = 21) in the field of ethology and other welfare related sciences. These experts generally used mental terminology to define welfare, but when asked to classify their definition of welfare, many preferred a definition in terms of measurable parameters or a combination of both mental terms (feelings) and measurables. Most experts believed that welfare can be assessed objectively and that the problem of OWA is indeed best approached through an assessment of needs. Experts differ as to the exact composition of the list of needs. A list of needs is formulated which we intend to use for OWA in the case of sows.

Keywords: interviews, expert, animal welfare assessment model, pigs.

Introduction

This paper is the third and last of a series on the topic of overall farm-animal welfare assessment (OWA). These papers highlight three areas of concern.

The first paper (Bracke *et al.*, Part 1) dealt with the methodological question whether OWA is possible in principle. We defined welfare as what matters to animals from their point of view. This means that the welfare status of an animal is fully determined by the quality of its emotional states, including their sign (positive or

negative), intensity and duration. A major problem is how the private minds of animals can be assessed by scientific methods (Nagel, 1974; Dawkins, 1993, 1998; Mason & Mendl, 1993). We suggested to regard OWA as the attempt to make the best possible assessment based on what is known scientifically. Accordingly, OWA is conceived as the descriptive activity that involves multi-criteria decision making with fuzzy information. Based on these considerations we believe that OWA is possible, but the question remains how it should be done in a systematic and explicit way.

The second paper (Bracke *et al.,* Part 2) reviewed assessment tables and schemes that have been published to find useful recommendations as to how OWA may be performed. The basic format for OWA was identified as a table in which housing systems (in columns) are compared and evaluated using a list of criteria (welfare relevant attributes, in rows). This assessment table must be linked with other (supporting) tables to make OWA fully explicit.

The present paper deals with the problem of how OWA can be performed on a scientific basis. The suggestion is that overall welfare can be assessed from an assessment of needs. We have applied this idea and constructed a prototype decision support system, which is a computer-based information system that was designed to examine the feasibility of performing OWA in a systematic way (Bracke *et al.,*1999). Because performing OWA on the basis of an assessment of needs is a very basic assumption, we conducted interviews to examine the degree of consensus for this assumption. The results of these interviews will be presented in this paper. The aims of this paper are to specify how overall welfare assessment (OWA) can be performed on the basis of biological needs, to examine the degree of consensus among experts for such a needs-based approach and to specify a list of needs that may be used for actual OWA in pigs.

A biological basis for welfare

Biological organisms are regulated by homeostatic control mechanisms which support survival and reproduction in the environment of evolutionary adaptation (EEA). The higher vertebrates are goal-directed (Toates, 1986). They have a number of more or less distinct motivational systems. These systems, which we call needs, can be thought of as intervening variables which have functionally related sets of behaviours or physiological responses that can be activated by a certain class of stimuli and deactivated by a specific event or behaviour. Classical examples of motivational systems are hunger, thirst, sex and thermoregulation. Each motivational system serves a proximate goal (reference point, set point or Sollwert). These goals have been formed in the course of evolution and are, therefore, strongly similar for individuals of the same species (Wiepkema, 1987). In order for responses to be functional in achieving the goal the animal surveys its environment and compares Sollwert (the goal) and Istwert (the actual state of the world). Discrepancies between Istwert and Sollwert cause activation of behavioural and physiological responses with the aim of reducing the discrepancy and restoring homeostasis. The degree of the dis-

crepancy may vary (i.e. the animal may be more or less hungry, thirsty etc.), and changes in this 'central motivational state' (Toates, 1986), which we call 'state of need', give rise to observable changes in behaviour and physiology (e.g. when more hungry the animal may run faster toward food).

Higher vertebrates show certain flexibility in the way they achieve their goals, i.e. they can take different courses of action to obtain a certain goal. This flexibility also requires that animals must monitor the effectiveness of their responses. Emotions, such as pleasure and fear, are functional elements in this monitoring process, in that they strengthen (when positive) or weaken (when negative) the use of a particular behavioural or physiological response (Fraser & Duncan, 1998). Emotions are causally related to behaviour (e.g. Dawkins, 1993; Broom, 1998). They function as signals in the brain to coordinate the responsiveness in a certain direction. These signals produce a coordinated state which is generally appropriate for coping with categories of challenges (e.g. danger). Such a state is recognised by the animal. For example, the higher vertebrates are able to recognise these internal emotional states as is shown by their ability for so-called drug-discrimination learning, which is a much used technique to investigate the subjective effects of drugs on the control of behaviour (Overton, 1991).

Positive reward occurs in cases where discrepancies between Istwert and Sollwert are reduced or minimised. Animals are attracted to objects and events associated with positive reward (positive emotions). Events or stimuli that are rewarding act as reinforcers, in the sense that they tend to strengthen a response. Conversely, negative emotions (aversions) occur when discrepancies between Istwert and Sollwert increase in magnitude or continue to exist. Animals will attempt to avoid such situations, which they find aversive. Especially negative is stress, i.e. '(a) a protracted failure of the animal to maintain alignment between its reference values and the actual state of the world and (b) the absence of an assessment of near-future realignment' (Toates, 1995, p. 31).

Because animals have different needs and because they often cannot serve different goals at the same time, animals also have regulatory mechanisms to solve cases of conflict between them. For example, an animal may have to choose between food and escape from danger. Animals are generally very well able to make 'decisions' among different possible courses of action. Such decisions involve a cost-benefit evaluation, which requires a common currency (McFarland, 1989). Most likely, this common currency is the rewarding value that represents the expected benefits of each alternative course of action. In this model, animals, like humans, are supposed to act so as to maximise positive affective states and minimised negative ones. They maximise reward (Cabanac, 1971). This implies that animals themselves assess their different states of need and this overall assessment constitutes their welfare.

OWA based on needs

From the argument above it follows that for overall welfare assessment (OWA) the various states of need of an animal must be assessed and integrated as much as pos-

sible in the way the animals themselves perform the assessment. Below, we will specify the concept of 'needs' further.

An important distinction is between instrumental and intrinsic relevance. Instrumentally relevant are those aspects that are a means to the end of OWA; i.e. they are relevant because they give information about other aspects which are more intrinsically relevant. Intrinsic aspects are ends in themselves. For example, straw is instrumental for pig welfare, because it provides substrate to root. Rooting is intrinsically relevant when rooting is itself rewarding. Rooting would be instrumentally relevant if it were only a means to an end, e.g. a means to obtain food. In the latter case straw could be regarded as intrinsically relevant if it had a dietary value for pigs. The primary task for OWA is to determine what is intrinsically relevant for welfare and how these are affected by other aspects in an instrumental way.

Intrinsically relevant for welfare are all and only the emotional states of animals (Bracke *et al.,* Part 1). However, it is difficult to assess the sign (positive or negative), intensity and duration of all emotional states separately. More suitable for an objective assessment of welfare is the assessment of needs. If emotions represent a state of the organism which has a biological function for a particular need, that state must be accessible for measurement and this indirectly reveals an aspect of the subjective state of the animal. For operationalisation of OWA we postulate a (positive) (cor)relation between biological functioning and subjective welfare. This postulate receives general support in the scientific literature (e.g. Broom, 1998; Duncan, 1993; see also Fraser *et al.,* 1997), but exceptions (which we will discuss below) have also been recognised. Under the assumption that the state of need is a direct reflection of how animals subjectively experience this state emotionally, we may regard needs as intrinsically relevant in the assessment of welfare. They can be assessed objectively and this provides the scientific basis for OWA.

It follows that only proximate needs are intrinsically relevant for welfare. Welfare concerns the proximate causation of behaviour, rather than its ultimate function. Ultimate goals such as survival and reproduction have shaped proximate needs in the course of evolution, but survival and reproduction per se do not matter to animals from their point of view (Duncan & Petherick, 1991). For example, what matters to a female animal in oestrus is a proximate need to mate, rather than the ultimate goal of fertilisation. Because our concept of needs for OWA is closely linked to emotional states, it is very similar to, but more general than, animal 'wants' (cf. Duncan & Petherick, 1991; Duncan, 1996). It is also similar to Rollin's concept of Telos (e.g. Rollin, 1990), when conceived as the genetically and environmentally constrained nature of animals, 'from which flow certain interests and needs, whose fulfilment *matter* to the animal' (p. 203). For the same reason, our concept of needs differs from the concept of needs as suggested by Hurnik and collaborators (Hurnik & Lehman, 1985, 1988; Hurnik, 1993). For example, longevity may be instrumental in OWA, but it is not intrinsically relevant, because animals do not have the concepts of life and death (Webster, 1995, p. 15).

Motivational systems are complex systems. For example, reaching satiety is regulated by various internal and external feedback signals, including the energetic value of the food as well as oropharyngeal signals associated with palatability, chewing

and swallowing. Needs, such as the need for food, can be often be decomposed further into component set-points. As a result, OWA can be regarded at a conceptual level (cf. Stafleu *et al.,* 1996), as a hierarchical assessment: welfare can be decomposed into a set of needs which can be decomposed further into component set-point states, from which welfare can be assessed.

In the literature general consensus exists that an aggregate of several different measures should be used to assess welfare (e.g. Broom & Johnson, 1993). In fact many attributes (characteristics, aspects) of housing and management affect the welfare status of farm animals. In order to specify how these attributes affect welfare, a needs-based approach seems the most appropriate (cf. also Dawkins, 1998). It offers an organising principle and provides a way to check whether the list of welfare relevant attributes is complete. In addition, a risk in OWA is that one component is taken for the whole (Rushen, 1991). The single most important reason to use a needs-based approach for OWA is that it supports assessment of welfare *overall*: it helps to identify welfare problems (frustrated needs) and it helps to identify gaps in our scientific knowledge (to assess the state of need properly).

Scientific paradigms

An assessment of the state of need includes an assessment of the degree of positive and negative reward, the animal's motivational strength to obtain those rewards and the duration of the relevant emotional states. Each need state can be assessed on a scale that ranges from maximum frustration to maximum satisfaction of that need. To assess these needs we must use information about environmental conditions, and empirical information from ethology and physiology (including production and patho-physiology). These can be regarded as different perspectives that provide relevant information to assess a state of need. In addition a subjective, psychological perspective can also be identified that specifies the nature of the emotional states. The psychological perspective and the various perspectives constituted by the empirical sciences are different perspectives on the same phenomenon, the state of need. The problem of OWA is to show how welfare, as defined from this psychological perspective at the conceptual level, can be assessed at the explanatory and operational levels (see Stafleu *et al.,* 1996) while using only empirical information. We suggest that the various scientific paradigms allow the formulation of assessment rules that can be used for this purpose.

Scientific measures relevant for OWA include feral data, preference tests (time budgets and choice experiments), operant techniques (including demand curves), measures of aversion and suffering, measures of the consequences of deprivation on behaviour, stress-physiology, pathology and production. These measures indicate what animals normally, naturally or experimentally are inclined to approach or avoid, how important their preferences are to them and how well animals are able to adapt or cope. Problems exist with the interpretation of all measures (Rushen, 1991; Mason & Mendl, 1993; Dawkins, 1998). For example, feral data may be criticised in that nature may be romantic but cruel (Dawkins, 1980); what animals chose may not

always be what is best for their health (Duncan & Dawkins, 1983); and coping animals may still be suffering (Mendl, 1991). Problems of interpretation have been considered difficult to resolve. However, such problems typically involve cases where different scientific paradigms are in conflict with each other with respect to OWA.

We suggest taking a consensus-oriented approach for OWA. Despite the fact that much remains to be discovered, much knowledge that is relevant for OWA has been collected over the last decades. OWA concerns the attempt to make the best possible assessment based on the knowledge that is available (Bracke *et al.,* Part 1). We believe the available knowledge is sufficient to allow a reasonably accurate assessment. Similarly, despite difficulties in the interpretation of all scientific paradigms, each paradigm can be expected to capture at least part of the truth. This allows the formulation of assessment rules in relation to each paradigm. Every assessment rule includes a 'prima facie' clause indicating that the rule is valid for the most part and other things being equal. For example, prima facie, the more natural the behaviour, the better welfare (e.g. Wemelsfelder, 1997). Similarly for the other paradigms including predictability and controllability (Wiepkema, 1982, 1987; Wiepkema & Koolhaas, 1993), fitness (e.g. Fraser & Broom, 1990) and consumer demand theory (Dawkins, 1983).

However, from the conclusion above that OWA should be in accordance with welfare assessment as performed by the animals themselves it follows that of all scientific paradigms the study of preferences of animals takes a special place. For OWA we must answer the questions 'what do animals want, i.e. what do they find rewarding and/or aversive?' and 'How important is the satisfaction of these wants or needs for them?'. Other scientific paradigms, e.g. studies of natural behaviour or stress-physiology have a more supportive function in that they provide additional information about proximate needs.

For every 'prima facie' assessment rule we also expect to find exceptions, which become evident when rules conflict. For example, the argument that nature may also be cruel constitutes a conflict between one rule that says that natural conditions indicate good welfare, and the second rule that says that disease indicates poor welfare. Nature is cruel when it subjects animals to disease. Such a conflict between assessment rules can be resolved when, in accordance with our definition of welfare, the primacy of the animal's emotional states is recognised: nature is good provided the animal doesn't experience poor health. Further specifications can be expected. For example, poor health indicates poor welfare, but an abdominal tumour may not be associated with negative emotional states. If so, again, the assessment rule should be refined. This revision of assessment rules into more and more specific rules may become very complicated and difficult. At some point we may have to stop formulating more and more specific rules. At such a point, these rules can be used as heuristic rules for OWA. As heuristic rules they will allow a most reasonable assessment of welfare despite the fact that some assessment errors will inevitably be made. Since large numbers of attributes are involved in OWA the use of heuristic rules may be the most rational approach to OWA until further research can provide a more complete set of specific assessment rules.

Types of needs

It is beyond the scope of this paper to specify the different set points of animals, also because they tend to be very (species, age, sex) specific. However, we will attempt to specify which needs farm animals have.

Animals have many control systems that are designed to obtain or maintain a certain (local) goal or set point. Not all control systems are equally relevant for welfare, because they are not all equally associated with emotional states. Emotional states especially arise when the attention of the whole animal and a close monitoring of the efficiency of responses is required. We will call needs associated with such systems 'cognitive'. Other systems are more under autonomic regulation. Examples include many processes at cellular and tissue level, but also the immune system, the regulation of heart rate and respiration. These autonomic systems are either largely internally organised or only use rather stable environmental factors (such as oxygen). They don't require additional emotional states for normal regulation. However, when autonomic regulation fails, emotional states do occur even in these systems, e.g. by general symptoms of fatigue or illness. It follows that for welfare both types of control are relevant, but they are not relevant to the same degree. The tolerance for deviations between actual state (Istwert) and set point (Sollwert) is generally much lower where emotional states are involved which deal with (more fluctuating) environmental events. It is those needs that have an association with emotional states that are especially relevant and functional for welfare. However, although some needs are more important than other needs, they cannot be classified into necessities and luxuries, because their importance ranges over a continuum and because their relative importance may vary according to the circumstances.

Needs can also be classified into appetitive (e.g. hunger, thirst, sex) and aversive systems (e.g. fear and aggression) (cf. Toates, 1986). Appetitive needs have a special subclass of needs: the ethological needs. Ethological needs are those needs where the performance of behaviour is intrinsically rewarding, rather than, or in addition to, the attainment of some functional end-point that is normally associated with the performance of that behaviour. For example, rooting of pigs is itself rewarding, even when the normal consequences associated with this behaviour, i.e. food, is provided ad lib. Ethological needs concern activities that are essential in the environment of evolutionary adaptation (EEA). They are regulated by being positively rewarding, for example because the ultimate goal is beyond the cognitive capacities of the animal or because it would be disadvantageous to stop the behaviour in the absence of immediate functional consequences. According to Toates (1995) it is now generally accepted that animals indeed are motivated to perform certain species-specific behaviours (however see also Baxter 1983) and that reward value is associated with the ability to perform these behaviours.

The above distinctions (appetitive-aversive, cognitive-autonomic and ethological) result in the following classification of needs. Appetitive cognitive needs include food, water, sex, rest and social contact. This class shows overlap with appetitive ethological needs such as exploration, play and body care related needs. Appetitive autonomic needs include thermoregulation and respiration. Aversive autonomic

needs include health and no injury. Fear is an aversive cognitive need. This classification is tentative and provides an ordering principle, rather than an absolute classification.

Needs have also been classified into those needs that are largely internally motivated (e.g. food, water, ethological needs) and those that are largely externally motivated (e.g. aggression, predator avoidance). However, it is now generally recognised that all needs have both internal and external factors. Like the internal-external distinction the distinctions we use in our classification (appetitive-aversive; cognitive-autonomic; ethological) do not create mutually exclusive categories, but are differences that vary over a continuum and often (if not always) include elements of both extremes. Even within needs some elements may fit in one class, while other elements fit better in another class. For example, vasoconstriction and vasodilatation as part of thermoregulation are under autonomic control while nestbuilding, which is also part of thermoregulation, may be an ethological need. Although our classification is only tentative, we will use it as stepping stones that should not obstruct flexibility in the assessment procedure.

Interviews with experts

In order to perform actual OWA we have built a prototype welfare-model for pigs (more specifically for pregnant sows; Bracke *et al.,* 1999). In this model we assessed overall welfare using a list of needs. To explore the degree of consensus for this model 21 experts from 8 different countries were interviewed about their concept of welfare and about needs. Together 11 Dutch experts, 9 experts from other European countries and one North-American expert were included with expertise in the fields of general farm animal welfare, fundamental ethology, physiology, veterinary science and experimental psychology (fields listed in the order of importance). All experts were scientists.

Issues that specifically concern weighting of welfare components were explicitly excluded from these interviews, because our aim was to explore the degree of consensus for the assumption that logically precedes weighting, namely using needs for OWA. We wanted to know whether our concept of welfare was in accordance with expert opinion, and whether OWA may be performed as a function of need states.

Three questions were asked about the concept of welfare and two questions were asked about needs.

1. How do you define welfare?
2. What type of welfare definition do you favour, in terms of measurable parameters or in terms of feelings?
3. Can welfare be assessed objectively?
4. What are the components of welfare and what is your opinion about the prototype need-list (which was presented to the expert, cf. Table 1)?
5. Do you believe OWA based on an assessment of needs is the proper way to proceed?

In response to the first question relatively few experts cite definitions from the literature: five experts cited three definitions. A common characteristic of the definitions as stated by the experts is that they all make reference to biological functioning. Furthermore, the importance of subjective feelings showed as follows: 18 out of 21 experts used mental terminology, 2 experts refused to give a definition of welfare and only 1 expert completely refrained from using mentalistic terminology in his first stated definition. However, when asked what type of definition was preferred (question 2), 9 experts favoured a definition in terms of measurable parameters over subjective feelings; 8 experts preferred a combination of both feelings and measurable parameters, and only 4 experts favoured feelings. 18 Experts answered that welfare can be measured at least in part objectively, while 3 experts stated that welfare cannot be measured objectively (question 3). This suggests that, while subjective feelings are considered important for welfare conceptually, scientists, as a group, believe welfare can be assessed objectively.

The components of welfare were discussed with the help of the prototype list of needs as specified in the first column of Table 1. The interviewer explained that this list was not intended as a hierarchical ordering of behavioural elements, but that its function was to 'break down' the complex problem of welfare into manageable chunks which could support OWA. This implies that each component in the list must be necessary for assessing welfare overall. For example, health, food, water, and thermocomfort are not the only needs, because there may be a social welfare problem. So, this social component must be added to the list, etc.

Responses to this list were diverse. It was said to be a standard list, but, when asked further several remarks were obtained. One remark was that the list was not uniform in that it puts incompatible terms on the same level, such as health, mental terms (e.g. 'no fear', 'no pain') and behavioural systems. A common denominator would be preferable. Furthermore, the concept of a hierarchy of needs was challenged on the grounds that components will overlap and that every hierarchy is necessarily artificial. Furthermore, experts differed with respect to the classification of needs and their definition. For example, some experts classified rooting as part of the need for food, but other experts classified it as a separate need. While several experts identified the need for stimulation as a separate need that refers to environmental complexity and novelty, the frustration of which can be expressed as apathy (as in Wemelsfelder, 1993), other experts argued that the need for stimulation reduces to other needs, such as exploration, locomotion and social contact. Despite these differences a consensus area could also be identified. For example, all experts included the needs for food, water, rest, social contact and thermocomfort.

At the end of the interview we asked the expert to state his/her opinion about the suggestion to assess overall welfare as a function of need states (question 6). Most experts (17 out of 21) had a positive attitude toward this suggestion; 2 experts showed a neutral attitude, saying that it may be possible to do so, and 2 experts tended to be negative about this approach.

With respect to expert opinion about needs, we conclude that, although not without difficulties and opportunities for further improvement, broad consensus exists for a scientific approach to OWA based on needs.

Table 1. Overview of need lists for welfare assessment (Author, publication year, focal species and focal attention). The lists are ordered hierarchically in two levels. The first-level items are stated in bold. As much as possible, corresponding terms have been put on the same row. '–' indicates that an aspect, which is found in other lists, appears to be missing in the present list. Dotted lines indicate clusters of needs, namely appetitive cognitive, appetitive ethological, appetitive autonomic, aversive autonomic and aversive cognitive needs (see text).

Bracke et al *Prototype list* *Pigs* *Needs*	Bracke et al *Revised list* *Pigs* *Needs*	Fraser *1983* *Pigs, sheep, cattle* *Maintenance*	Baxter & Baxter *1984* *Pigs* *Needs*	Schlichting & Smidt *1989* *Pigs* *Behaviour systems*	Sundrum et al. *1994* *Farm animals* *Influencing areas*	Taylor et al. *1995* *Poultry* *Maintenance*
	Ingestion	**Ingestion**		**Ingestion**	**Intake**	**Ingestion**
Food	Food	Feed	**Hunger**	Feed		
Water	Water	Drink	**Thirst**	Drink		
Rest	**Rest**	**Rest**	**Sleep**	**Rest**	**Rest**	**Rest**
Social contact	**Social contact**	**Association**	**Sociality**	**Social**	**Social**	**Social**[3]
Reproduction	**Reproduction**					
Sexual	Sexual	–	**Sex**	**Sexual**	–	
Nest building	Nest building	–	Nest building	–	–	
Maternal	Maternal	–	**Maternal**	–	–	
Move	**Kinesis**	**Kinesis**[1]	**Living space**	**Locomotion**	**Locomotion**	**Kinesis**
Exploration	**Exploration**	**Exploration**	**Neophilia/recreation**	**Exploration**	**Comfort/explore**	**Exploration**
	Explore novelty			Explore novelty		
Learn				Nibble		
Root	Forage (root)			Root		
Play	Play			Play		
Body care	**Body care**	**Body care**	**Skin comfort**	**Comfort**		**Body care**
Groom	Groom, scratch	Groom		Body care		
Wallow	Wallow			Wallow		
		Thermoregulation		Thermoregulation		
		Comfort–seeking				
Eliminate	**Evacuation**	Evacuation	–	**Evacuation**	**Evacuation**	**Elimination**
–	**?Territorialism**	Territorialism[2]				Territoriality
	? Stimulation			**Abnormal behaviour**		
Thermocomfort	**Thermoregulation**		**Thermoregulation**			**Thermoregulation**
–	**Respiration**	–	**Respiration**	**–**	–	**Respiration**
Health	**Health**	**–**	**Health**		**Hygiene**	–
	No illness					
No pain	No injury					
No fear	**Safety**	**Reactivity**	**Predictability and controllability**	**Fight/flight**	–	**Self-protection**
	No danger					
	No aggression					

[1] Fraser (1983) includes locomotion, play and stretching into 'Kinesis'.
[2] Fraser (1983) includes individual space, home range and feeding rang into 'Territorialism'.
[3] Taylor et al., (1995) include hierarchy formation, allelomimetic behaviour, peer bonding, reproductive and maternal behaviour in the social maintenance need.

List of needs

For the purpose of actual OWA it is necessary to have a specified list of needs. Table 1 shows various lists of needs (Fraser, 1983; Baxter & Baxter, 1984; Schlichting & Smidt, 1989; Sundrum *et al.,* 1994; Taylor *et al.,* 1995). This table shows clear differences between authors. Most often 'left out' are items concerning respiration, territorialism, health and items related to reproduction. In addition, the hierarchical organisation differs; e.g. play is part of kinesis for Fraser (1983) and part of exploration for Schlichting & Smidt (1989). Furthermore, different terms are used to denote overlapping concepts, for example 'body care' and 'comfort'. Conversely, similar terms may be used for partly diverging concepts. For example, Fraser's list contains territorialism, which includes various aspects of space, namely individual space, home range and feeding range. Others do not include territorialism in their list, but have incorporated these aspects into other components such as social contact, locomotion and ingestion. These differences illustrate the importance of standardisation and unifying definitions in the field of OWA. However, maybe even more important for OWA is that Table 1 also identifies underlying consensus. It confirms that these authors believe needs are important constituents of welfare and that the list of needs for OWA includes ingestion (food and water), thermoregulation, rest, social contact, kinesis, exploration and body care/comfort. In addition to these needs, needs related to fear/avoidance and sex are also well established (Toates, 1986).

We made some minor revisions in our prototype list of needs for actual OWA in the case of pigs (see Table 1). The revised list does no longer contain the subjective terms 'no fear' and 'no pain'. As a common denominator we have chosen motivational systems. Although further revision may prove necessary, this list provides the starting point for development of a tool to assess the overall welfare-status of pigs. It contains the elements that we believe to be necessary to assess the overall welfare status of pigs.

The revised list includes the following needs: ingestion (including the need for food and water), rest, social contact, reproduction-related needs (sex, nest building and maternal care), kinesis, exploration (including exploration of novelty, foraging and play), body care, evacuation, territorialism, thermocomfort, respiration, health (including no injuries or pain) and safety (including 'no danger' and 'no aggression').

Specific for pigs are behavioural elements such as rooting, nest building, wallowing and the ability to separate the resting from the elimination area. For application to other species or to specific subgroups (e.g. pregnant sows or growing pigs) especially the ethological needs require modification. Below, we will discuss the needs that are relevant for welfare assessment in pregnant sows.

Body-care concerns the behavioural elements of scratching (grooming) and wallowing in pigs. Evacuation concerns the eliminative behaviour that is specific to pigs, namely to separate the resting area from the elimination areas, and, possibly, to mark the home range.

The need to explore concerns the active behavioural processes by which an animal

assimilates information about its environment. Exploration is especially evoked by mild disparity between sensory input and stored representations or expectations. (A larger disparity results in fear and avoidance, which we have classified under 'safety'.) Two major components of exploration are the need to explore novelty and the need to forage (rooting in pigs). Foraging is appetitive feeding behaviour. As such it could be argued to be part of the need for food. However, scientific data concerning contrafreeloading, where animals have been shown to work for food even when ad lib food is available, support a classification of foraging as a separate need. Since recent evidence suggests that foraging may be part of the need to explore or to gather information (Bean *et al.,* 1998), we have classified rooting as part of the need to explore. Play has also been subsumed under exploration, because a main function of play involves learning.

The need to move, kinesis, may not be controlled by a separate control system. Instead it may be argued that it is part of various other needs, e.g. exploration. However, since there seems universal consensus that space and the ability to move are important components of welfare, we incorporate the need for kinesis as a separate functional element in the need list.

In line with other authors we include respiration as a separate need (cf. Table 1). Baxter & Baxter (1984) defined respiration as the need 'to prevent the sow feeling asphyxiated or choked' (p. 283). This need has its own control centre in the brain and accordingly may classify as a separate need. However, it may also be subsumed under 'safety' or under 'health' as noxious stimuli (e.g. NH3, CO2, H2S, dust levels), because it is probably largely under autonomic control, meaning that only gross deviations are relevant for welfare.

The need for health is the need to be free from disease, i.e. the absence of clinical symptoms or pathological anatomical abnormalities. It is included as a separate need because it is related to a semi-behavioural system, namely 'sickness behaviour' (Hart, 1988). Health is clearly associated with welfare relevant emotional states. In addition, when activated, sickness behaviour must clearly compete for time and motor output with other behaviour systems such as feeding, sex or the avoidance of danger. Often sickness behaviour takes priority indicating that combating the disease is important for the animal (and its welfare). Like other motivational systems sickness behaviour is functional for survival (Hart, 1988). It also involves learning processes. Examples of such learning include food aversion learning, self-narcosization to alleviate pain and so-called antidotal thirst to alleviate sickness (reviewed in Toates, 1986, e.g. p. 76).

The need for health includes specific illnesses and injuries. The injury sub-component captures the 'no pain' item in the prototype list. Pain and fear are related motivational systems, but 'whereas the fear system is responsible for motivating escape from a dangerous location, the pain motivational system determines the behaviour of resting to allow recuperation.' (Toates, 1986, p. 154).

The fear system has been renamed as the need for safety. This need is associated with the flight/fight/fright syndrome that serves to maintain the integrity of the whole body against potential disturbance and damage. It does not imply that the goal is absolutely no fear. Exposure to mild or moderate fear is even thought to be benefi-

cial (Jones, 1997). It seems to be a feature of various types of environmental stimuli that too much as well as too little stimulation may be suboptimal for need satisfaction (Fraser *et al.,* 1975, p. 655). Other examples of this phenomenon include temperature, food and social contact. The terms 'safety' and 'fear' are used here to denote only one component of welfare. In a wider sense, where safety would include aspects of health, ingestion, thermoregulation, etc., it could be interpreted to cover (almost) the entire field of welfare. In this paper, safety denotes only one of the classes of things that motivate animals.

Not included in our list for pigs are territorialism, predictability and control, abnormal behaviour and stimulation. Territorialism is an ethological need that does not apply to pigs because pigs do not defend a territory, although they do live in home ranges (Graves, 1984). For pigs we will subsume the aspects that are related to territorialism under other needs such as kinesis and exploration. Abnormal behaviour (Schlichting & Smidt, 1989), and predictability and control (Baxter & Baxter, 1984) are not separate needs, but seem to be more general indicators of welfare problems. Even if the underlying motivational basis is not always well understood (e.g. Rushen *et al.,* 1993), they generally subsume under other needs. Similarly, for stimulation we prefer to subsume it under the need to explore (novelty).

As this discussion illustrates, drawing up a list of needs requires making decisions about issues that have not been fully resolved. It seems necessary to compare various need lists and to examine their practical implications. However, for actual OWA it is necessary to have a specified list. By making choices explicit we hope these issues will be re-actualised, which in turn may lead to improved welfare assessment.

Conclusions

This paper deals with the question how OWA can be performed on a scientific basis. We suggested to perform OWA based on an assessment of needs. A needs-based approach allows welfare to be concerned with what matters from the animal's point of view, while at the same time allowing a scientific approach. This is because the term 'need' has both subjective and objective elements in its meaning. Needs were defined as the states of the animal's motivational systems, which specify the animal's proximate goals. The concept of emotional states plays a functional role, both in channelling various kinds of input to produce an efficient response (the causation of behaviour) as well as in constituting the animal's welfare status. However, emotional states do not provide an immediate operational tool for OWA. By contrast, the concept of needs provides a more useful approach to assess welfare. A needs-based approach provides the stepping stones to organise welfare relevant attributes. It also ensures that welfare is assessed *overall.*

OWA requires taking into account all available scientific evidence. The various scientific paradigms concerned with welfare all provide relevant data. In addition, these paradigms may allow the formulation of various assessment rules. These rules should be specified as much as possible and apparent conflicts between them should be a reason to specify the rules in more detail. At some point these assessment rules

may have to be used as heuristic rules for operational OWA.

Interviews with experts confirmed that feelings are an important element in the concept of welfare, but they also confirmed that they believe welfare can be assessed objectively and that OWA is probably best performed based on an assessment of needs.

For actual OWA it is necessary to specify a list of needs. A list of needs for pigs was formulated. It includes needs in relation to ingestion, rest, social contact, reproduction, kinesis, exploration, body-care, evacuation, thermoregulation, respiration, health and safety. This list is not final, but it will be used as a starting point to perform actual OWA in the case of pregnant sows.

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