Assessing the human–animal relationship in farmed species: A critical review

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Abstract

The present paper focuses on six main issues. First, we briefly explain why an increased understanding of the human–animal relationship (HAR) is an essential component of any strategy intended to improve the welfare of farmed animals and their stockpersons. Second, we list the main internal and external factors that can influence the nature of the relationship and the interactions between human beings and farm animals. Third, we argue that the numerous tests that have been used to assess the HAR fall into three main categories (stationary human, moving human, handling/restraint), according to the degree of human involvement. Fourth, the requirements that any test of HAR must fulfil before it can be considered effective, and the ways in which the tests can be validated are discussed. Fifth, the various types of test procedures that have been used to assess the HAR in a

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range of farmed species are reviewed and critically discussed. Finally, some research perspectives that merit further attention are shown.

The present review embraces a range of farmed animals. Our primary reasons for including a particular species were: whether or not general interest has been expressed in its welfare and its relationship with humans, whether relevant literature was available, and whether it is farmed in at least some European countries. Therefore, we include large and small ruminants (cattle, sheep, goats), pigs, poultry (chickens), fur animals (foxes, mink) and horses. Although horses are primarily used for sport, leisure or therapy they are farmed as draught, food or breeding animals in many countries. Literature on the HAR in other species was relatively scarce so they receive no further mention here.

1. The impact of the human–animal relationship (HAR) on welfare and productivity

Domestication is a "process by which a population of animals becomes adapted to man and to the captive environment by genetic changes occurring over generations and environmentally induced developmental events recurring during each generation" (Price, 1984). Despite countless generations of selective breeding the potentially most frightening events that many farm animals are likely to experience are exposure to human beings and to sudden changes in their social or physical environments (Boissy, 1995; Jones, 1996; Hemsworth and Coleman, 1998). More specifically, unless they have become accustomed to human contact, of either a neutral or positive nature, the predominant reaction of most farm animals to people is still one of fear (Duncan, 1990; Jones, 1997). Not unexpectedly, exposure to rough, aversive and/or unpredictable handling can exacerbate the problem. Furthermore, it has been proposed that animals often perceive contact with a human being as a predatory encounter (Suarez and Gallup, 1982; Jones, 1997; Boissy, 1998). Indeed, many of the occasions on which animals and humans interact in current farm practice are negatively reinforcing, e.g., veterinary treatment, restraint, depopulation, etc., while, other than feeding, few are positively reinforcing. It has also been suggested that contact with humans could become even more distressing if the increasing use of labour-saving technologies, e.g., automation, result in reduced opportunities for the animals to become habituated to people (Duncan, 1990; Rushen et al., 1999a). One of the primary reasons for differences in the HAR found between farms is variation in the number, duration and nature of daily interactions between stockpeople and the animals (Hemsworth and Coleman, 1998). The stockpersons' behaviour is a major variable determining animals' fear of or confidence in human beings and, hence, the quality of the HAR. The nature/quality of human–animal interactions can range from frequent, calm and 'friendly' to infrequent and predominantly negative ones (Hemsworth and Coleman, 1998; Waiblinger et al., 2002).

Negative handling and fear of humans have a number of undesirable consequences for the livestock, farmers and consumers. For instance, the sudden, intense or prolonged elicitation of fear can seriously damage the welfare, productivity, product quality and

profitability of farm animals. These undesirable consequences and their likely underpinning mechanisms are described in greater detail elsewhere (e.g., Jones, 1996; Hemsworth and Coleman, 1998; Mills and Faure, 1990). For present purposes though, we present just a small number of illustrative examples.

In poultry, inappropriate fear reactions, like panic or violent escape attempts, not only waste energy and thereby impose a metabolic cost but they can also result in injury or even death when the birds run into obstacles or pile on top of and claw each other. This is a major welfare insult because injuries can lead to infection, chronic pain, debilitation and social withdrawal (Jones, 1996, 1997). High fear of humans is also associated with reduced egg production, growth, food conversion efficiency, product quality and sexual activity, with increased aggression and handling difficulties, and with immunosuppression (Komai and Guhl, 1960; Gross and Siegel, 1982; Shabalina, 1984; Barnett et al., 1992, 1994; Jones et al., 1993; Rosales, 1994; Jones, 1996). Fear of humans accounted for 28% and 20% of the variation in food conversion efficiency in broiler chickens (Jones et al., 1993) and in egg production by commercial layers (Barnett et al., 1992), respectively, suggesting that fear of people could cost the broiler and layer industries several million pounds each year (Jones, 1996).

In pigs, negative handling increased adrenal weight (indicative of chronic stress), impaired growth and reproductive performance and induced high fear of humans, both in the laboratory (Gonyou et al., 1986; Hemsworth and Coleman, 1998; Seabrook and Bartle, 1992) and on commercial farms (Hemsworth et al., 1989a, 1993a, 1999). The magnitude of the negative correlation coefficients between the avoidance of people and the pigs' farrowing rates demonstrated that fear of humans is a major limiting factor on productivity (Hemsworth and Coleman, 1998).

A similar picture emerges in farm herbivores. Negative interactions or fear of humans are associated with reduced milk yield or milk let down in dairy cows and goats (Seabrook, 1972; Lyons, 1989; Knierim and Waran, 1993; Rushen et al., 1999b; Breuer et al., 2000; Waiblinger et al., 2002). Chronic and acute stress responses, traumatic incidents, injuries, death and poorer meat quality are also more prevalent in cows, heifers and calves that have been handled negatively and that show elevated fear of humans (Fordyce et al., 1985; Hemsworth et al., 2000; Breuer et al., 2003; Lensink et al., 2001b). Regular gentle handling counteracted some of these undesirable effects (Lensink et al., 2000b,c).

High fear of humans also has harmful effects on farmed fur animals, e.g., non-handled foxes were more frightened of humans and novel stimuli, had enlarged adrenals and lower reproductive success than handled ones (Pedersen, 1993b, 1994), whereas regular rewards (tit bits) reduced fear in silver fox vixens and enhanced the cubs' growth and behavioural ontogeny (Bakken, 1998). Foxes or mink selected over several generations for tameness showed lower basal and stress-induced hypothalamo–pituitary–adrenocortical activity, higher reproductive success or reached sexual maturity earlier and were easier to mate than more fearful animals (Plyusnina et al., 1996; Jeppesen and Pedersen, 1998; Nikula et al., 2000; Malmkvist, 2001a).

In horses, fear of humans and/or exposure to negative interactions can cause serious accidents, e.g., using a whip during steeplechasing increases the risk of falling (Pinchbeck et al., 2004). Conversely, early handling improves manageability and reactivity to humans (e.g., Lansade et al., 2004; Søndergaard and Halekoh, 2003). Despite this, most training

techniques are based on traditional methods with a surplus of punishments, although innovative methods using more positive reinforcement are slowly being developed (Waran et al., 2002).

From the stockpersons' point of view, fearful animals are often more difficult to handle and manage (Gonyou et al., 1986; Grandin et al., 1987; Pedersen and Jeppesen, 1990; Boivin et al., 1992b); e.g., defensive reactions make the handler's work more difficult and sometimes cause his or her injury or death (Le Neindre et al., 1996). This, in turn, exacerbates the problems encountered during procedures like routine examination, artificial insemination and translocation, thereby decreasing job satisfaction, motivation, commitment and self-esteem (Jones, 1996; Hemsworth and Coleman, 1998). A negative feedback cycle might then be established whereby the stockpersons' attitudes and behaviour towards the animals in their care worsen and thereby increase the livestocks' fear of humans.

Conversely, the development of a positive HAR (low levels of fear or high levels of confidence in people) can be beneficial. For example, the presence of a familiar human, contingently providing gentle handling, may calm the animals in potentially aversive situations (e.g., isolation, tethering, rectal palpation, insemination) thereby reducing distress and the risk of injury to the animal and the human (Korff and Dyckhoff, 1997; Pedersen et al., 1998; Boivin et al., 2000; Waiblinger et al., 2004) and potentially enhancing reproductive performance. A high quality HAR clearly requires a certain level of positive human contact, and this is most likely in husbandry systems that involve regular, intense and long-term contact with humans; dairy or sow farms provide good examples.

Neutral relationships, where fear of humans is low but the animals still avoid physical contact, can also be found and probably develop via frequent neutral or mildly positive human contact, a lack of negative contact, and none or few intense positive interactions (e.g., in dairy cows: Waiblinger et al., 2003b).

The HAR is also sensitive to stockpersons' decisions on management and housing. Stockperson behaviour and attitudes were related to the emphasis placed on taking the animals' needs into account when making management or resource design decisions, and to subsequent injuries or disease prevalence (Waiblinger et al., 2001; Lensink et al., 2001a). There are at least two explanations. Firstly, attitudes towards animals influence ways of interacting with them and decisions made about them. Secondly, increased contact improves the stockpersons' knowledge of the animals and facilitates the early recognition and solution of any problems (Seabrook, 1984; Waiblinger et al., 2001).

A poor HAR, high levels of fear and inappropriate management and housing represent bad news for the animals, the farmers and the concerned public. Clearly, we need to develop effective, practical strategies for alleviating the animals' fear of humans and for promoting a more positive HAR. These strategies might include genetic selection for increased adaptability and tractability, increased human–animal contact and the modification of the stockpersons' attitudes and behaviour through educational initiatives. Not only would such efforts likely improve the quality of life for livestock and farmers but by engendering the perception of farmers as benevolent guardians rather than unfeeling jailers, it would help to address societal concerns about farm animal welfare. Increased public esteem may also serve to attract more caring people into the industry (English et al., 1992).

2. The human–animal relationship—concept and influential factors

The HAR can be defined as the degree of relatedness or distance between the animal and the human, i.e., the mutual perception, which develops and expresses itself in their mutual behaviour (Estep and Hetts, 1992). It is a dynamic process with the catalogue of previous interactions between the animal and humans forming the foundation for an established relationship that then exerts a feedback effect on the nature and perception of future interactions.

In principle, a relationship develops between two individuals that know each other (Estep and Hetts, 1992), in particular the caretaker and an animal in his/her care. Such relationships require mutual individual recognition and are therefore limited to systems (or experiments) enabling sufficient contact. However, animals might also generalise their experiences with one human to other humans (Jones, 1994; Tanida et al., 1995; Hemsworth et al., 1996a), although pigs (Tanida and Nagano, 1998; Koba and Tanida, 1999), poultry (Davies and Taylor, 2001), cattle (Taylor and Davis, 1998; Rybarczyk et al., 2001) and sheep (Boivin et al., 1997) can discriminate between different people. Stockpeople may also show generalised attitudes and behaviour towards their animals (Hemsworth and Coleman, 1998). Thus, if individual recognition is precluded or generalisation occurs a general HAR may develop. Of course, both individual recognition and generalisation of response can operate within common test situations. For example, lambs that were bottle-fed and received gentle handling showed less isolation distress when a known or unknown shepherd was present, though the effect was greater with a familiar shepherd (Boivin et al., 1997). Handled piglets also interacted more with familiar and unfamiliar humans than non-handled ones, but made contact sooner and more often with the familiar handler and were less agitated when caught by him than by an unknown person (Tanida et al., 1995).

2.1. The animals' perspective—the animal–human relationship

Human–animal interactions can involve visual, tactile, olfactory and auditory perception, and human contact on farm can be subdivided into five main types: (a) (stationary) visual presence, (b) moving between the animals without tactile contact (but maybe using vocal interactions), (c) physical contact, (d) feeding (rewarding), and (e) invasive, obviously aversive handling.

An animal may perceive an interaction as negative, neutral or positive; this is influenced by its existing relationship with humans which is, in turn, based on previous interactions (De Passillé et al., 1996; Munksgaard et al., 1997). However, even if the HAR is very positive, some interactions are aversive because they are painful or otherwise distressing (dehorning, beak-trimming, etc.). In contrast, a high quality HAR might reduce the perceived aversiveness of traumatic events like isolation and restraint (e.g., Hinrichsen, 1979; Grandin, 1984; Boivin et al., 2000).

The period of the animal's life during which human contact occurs can be important, although conflicting results have caused debate (Jones, 1995b; Burrow, 1997; Boivin et al., 2003). For example, no durable effects of early handling were found in dairy calves (Boissy and Bouissou, 1988), foxes (Pedersen, 1992) or horses (Williams et al., 2002), whereas

goats (Lyons, 1989; Boivin and Braastad, 1996), beef cattle (Boivin et al., 1992b, 1994), sheep (Markowitz et al., 1998) and foxes (Pedersen, 1994) showed long-term effects.

Previous experience of a specific interaction and the controllability or predictability associated with it may also be influential. Firstly, for example, previous aversive experiences and unfamiliarity with a squeeze can hamper attempts to lead a cow to the apparatus and to confine it in the head gate (Lewis and Hurnik, 1998). Secondly, silver foxes associated pleasant or unpleasant interactions with the colour of the humans' clothing (Bakken et al., 1993): foxes captured with neck tongs by someone wearing white clothes showed greater hyperthermia to the mere sight of white rather than blue clothing.

The animals' perception of humans and their responses to certain interactions are also strongly influenced by their underlying personality traits, e.g., fearfulness/emotionality (Jones et al., 1994; Jones, 1996; Visser et al., 2001). Indeed, the substantial variation between and within breeds of several species in the animal's responses to humans or handling illustrates the powerful effect of the background genome (e.g., Murphey et al., 1981; Hemsworth et al., 1990; Le Neindre et al., 1993; Grandin and Deesing, 1998; Jones and Hocking, 1999).

Hediger (1965) described the five most common roles or 'meanings' that animals may ascribe to humans: predator, prey, part of the environment without social significance, symbiont, and conspecific. Estep and Hetts (1992) suggested that some of these roles may not be mutually exclusive, and that an animal probably perceives a human in terms of a combination of the above roles and according to the current situational factors. However, some of these terms may more realistically describe observed behaviour than actual perception; this applies especially to symbiont but it is also questionable if animals actually see humans as conspecifics (Boivin et al., 2003), except for hand-reared animals directing courtship behaviours to humans (e.g., Sambraus and Sambraus, 1975). An emotion-based classification of animals' perception of humans results in three main categories: frightening (indicated by fear, avoidance and stress responses in the presence of a human; Hemsworth and Barnett, 1991; Hemsworth and Coleman, 1998), neutral (no signs of fear or positive emotions; Waiblinger et al., 2003b), or a source of pleasant emotions (e.g., reassurance in aversive situations; Boivin et al., 1997; Visser et al., 2002). These categories can also overlap or vary according to the person or location (Rushen et al., 1998, 1999b; Jago et al., 1999).

In short, different emotions and motivations are involved in the perception of and reaction to humans. They belong to two dimensions: positive/pleasant and negative/unpleasant (Fig. 1). Their relative strengths determine an animals' relationship to humans, from negative through neutral to positive.

The nature of any 'communication' between an animal and a human can profoundly influence the way in which the HAR develops. Humans may unconsciously emit calming signals or ones of danger, often overlooking resultant signs of fear, aggression or calmness in the animal, and subtle differences in human behaviour may be crucial (Hennessy et al., 1997, 1998). Species-independent body signals may be important, e.g., threatening or submissive behaviours are often associated with making the body appear larger or smaller, respectively (Eibl-Eibesfeldt, 1999). Conversely, imitating species-specific animal signals has been recommended for effective control of farm animals (Grandin et al., 1983; Grandin, 1987). Indeed, it is widely used in training and behavioural therapy of dogs and
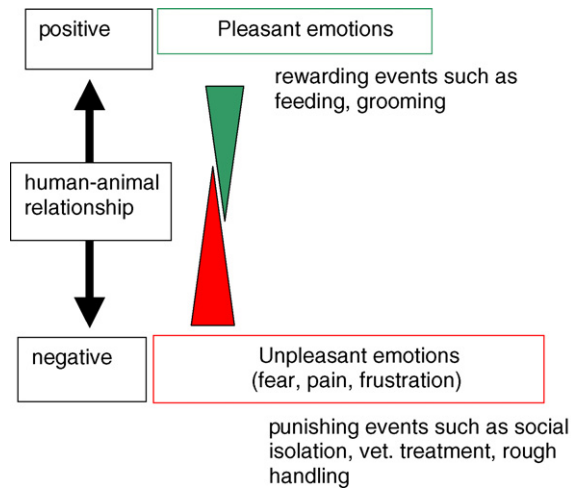
Fig. 1. The two dimensions (unpleasant; pleasant) contributing to the human–animal relationship and examples of influential variables. Increased levels of pleasant emotions improve the relationship and vice versa.

may provide the basis for the success of Fulani herdsman in the control of cattle (Hinrichsen, 1979; Lott and Hart, 1979). Clearly, in-depth investigation of human–animal communication is required. In the meantime, the human's posture, facial expression or vocal communication must be considered as likely influential variables (see Section 3.2).

2.2. The humans' perspective—the human–animal relationship and underlying determinants

Starting with Seabrook (1972), substantial literature now reveals the impact that the caretaker's behaviour, personality and attitude can have on farm animals' relationships to humans and on their welfare and performance. This is not unexpected because the human mostly determines the number and nature of the interactions and, hence, the relationship; the animals more often react to humans' actions rather than initiate them. Further, stockpeople differ considerably in the type and amount of their interactions with the animals under their care (Hemsworth and Coleman, 1998; Lensink et al., 2000a; Waiblinger et al., 2002). The housing or production system can be constraining, but in the dairy, pig or veal industries the most important factors determining the behaviour of stockpeople were personality and attitude (Seabrook, 1984; Hemsworth et al., 1989a; Coleman et al., 1998; Breuer et al., 2000; Lensink et al., 2000a; Waiblinger et al., 2002).

Personality is the individual's unique system of traits that affect how he/she interacts with the environment. Farmers' personality characteristics (aggressiveness, agreeableness, self-confidence, etc.) were correlated with their management, interactions with the animals, and animal productivity (Seabrook, 1972, 1995; Seabrook and Darroch, 1990; Waiblinger, 1996; Waiblinger and Menke, 1999; Waiblinger et al., 2002). Unlike attitudes, personality characteristics are relatively stable over time (Costa and McCrae, 1986).

Attitudes towards farm animals and their development have been extensively reviewed (Hemsworth and Coleman, 1998). Herein, we simply identify the most important aspects that should be considered for a better understanding of HAR. Attitudes express a positive or negative evaluation of 'an entity' (species or particular animal), a tendency for or against, a like or dislike, etc. (Hemsworth and Coleman, 1998). Beliefs, emotions and behavioural intentions with regard to animals are different aspects of human attitude that are generally consistent with each other and with human behaviour (Fishbein and Ajzen, 1975; Hemsworth and Coleman, 1998). For example, if a stockperson has an underlying general positive attitude about cows (beliefs) and thinks they are intelligent, learn easily, and like to be stroked, that person is likely to enjoy contact with the cows (emotion), to favour handling animals patiently (behavioural intention), to believe that regular positive contact is important, and to show positive behaviours towards the cows (Waiblinger et al., 2002). Behavioural attitudes are generally considered to be better predictors of the expression of a particular behaviour than are general attitudes, which mainly act on behaviour indirectly by affecting the formation of behavioural attitudes. However, studies on dairy and pig farms found correlations between general attitudes and behaviour, especially that involving close contact with the animals (Coleman et al., 1998; Waiblinger et al., 2002). Attitudes are learned, through experience with or information about the animals, and they can change with new experiences or information (Ajzen, 1988; Paul and Serpell, 1993; Hemsworth and Coleman, 1998). Thus, the daily interactions may affect attitude: if a caretaker believes a pig is difficult to move he tends to use more aversive handling thereby initiating a vicious circle where the pigs' fear of humans and its difficulty of handling are likely to increase (Hemsworth and Coleman, 1998). Attempts to change attitudes can improve the HAR. Indeed, cognitive–behavioural intervention methods have improved stockpersons' attitudes and behaviour towards their animals in the Australian pig and dairy industries (Hemsworth et al., 1994a, 2002; Coleman et al., 2000). However, attitudes can also worsen, e.g., the positive attitudes of new staff towards pigs can deteriorate if they work in a system where the pigs are treated as machines (Seabrook, 2001).

Other factors that can impact strongly on human behaviour, either directly or via changing attitudes, include knowledge of the job, experience of particular animals and the system, job satisfaction, the possibility of performing a particular behaviour or adopting an alternative one, the behaviour of colleagues, the perceived consequences of their behaviour, time constraints, and psychological strain in the work environment or home life (Hemsworth and Coleman, 1998; Lensink et al., 2000a; Seabrook, 2001; Coleman et al., 2003; Waiblinger et al., 2003a). All these factors could therefore influence the HAR. They merit continued investigation.

3. Methods of assessing the animal–human relationship

Measuring the attitudes and behaviour of stockpeople gives insights into their relationships with the animals. Attitudes cannot be measured directly but can be inferred from responses to a series of statements in a questionnaire (Hemsworth and Coleman, 1998). The farmers' behaviour can be observed directly during routine day-to-day

interactions like milking, moving animals or provision of food. Careful instruction is necessary to achieve valid responses or observations.

Measuring animals' reactions to humans enables us to reach conclusions about how they perceive specific human beings or people in general. The animal's reactions reflect a mixture of different emotions (see Fig. 1). Fear is likely to be of primary importance, depending on the type of animal and husbandry system, but inferences can also be drawn about its social attachment to humans, the nature (positive, neutral or negative) of its past experience with people, and the quality of stockmanship (including overall management and environmental design decisions). In the present paper, where animal welfare is a key issue, we concentrate on tests aimed at evaluating the HAR from the animal's perspective.

Many researchers have measured animals' behavioural and physiological reactions to human beings to illuminate selected aspects of the HAR. These include: fear and avoidance of humans (Hemsworth and Barnett, 1989; Hemsworth et al., 1989a, 2000; Jones and Waddington, 1993; Pedersen et al., 2002), confidence in or attachment to humans (Pedersen and Jeppesen, 1990; Boivin et al., 2000; Lensink et al., 2000b), ease of handling (Boivin et al., 1992b; Lensink et al., 2000c) and/or the potential for positive relationships to reduce the animals' distress during aversive events (Rushen et al., 2001; Waiblinger et al., 2004). Many experiments, particularly in the laboratory, focussed on the effects of different types of handling treatments (e.g., rough, gentle, mixed) on the animals' reactions to people (e.g., Hemsworth et al., 1989b; Pedersen, 1993a; Boivin et al., 2000; Hemsworth and Barnett, 1991; Jones and Waddington, 1993; Jones, 1995a). Studies carried out at commercial farms largely examined the relationships between measures of approach/ avoidance and potentially influential variables such as the stockpersons' behaviour and attitude, the type of management and housing, or animal characteristics such as breed or age (Hemsworth et al., 1989a, 2000; Waiblinger et al., 2003b). In addition, individual differences in selected personality traits, such as general reactivity, fearfulness, coping style, temperament or docility (e.g., Tilbrook et al., 1989; Jones et al., 1992a, 1994; Erhard et al., 1999; Visser et al., 2001, 2002) have been evaluated. Therein, animals with the same history of human–animal interactions are compared in their reactions to a human or to handling.

Tests measuring the animals' reactions to human beings fall into three main categories: (1) reactions to a stationary human, (2) reactions to a moving human and (3) responses to actual handling. In the latter category, in addition to specially designed tests, observations taken during routine handling can yield valuable information. As outlined below, the relative importance of possible confounding motivations may differ between the test categories. For example, when testing the animals' approach reactions towards a stationary, unknown human, its motivation might be strongly influenced by its level of curiosity or interest, i.e., the motivation to explore, whereas such motivations seem subordinate to the avoidance reaction when the animal is approached by a human being (Murphey et al., 1981; Marchant et al., 1997; Waiblinger et al., 2003b).

Within each of the categories described above, the precise tests employed may also differ according to the test location, e.g., whether it is familiar or not. Indeed the physical and social environment can strongly influence the test outcome. For instance, the animals' reactions to the test human might be confounded or swamped for a number of reasons including: (a) either fear-induced flight or behavioural inhibition elicited by enforced

exposure to novel, and hence potentially frightening environmental stimuli; (b) distraction of attention by such stimuli; (c) memory of handling associated with the test location or a similar one; (d) human contact incurred in moving the animal from its home cage to a test arena (De Passillé et al., 1996; Rushen et al., 1998; Jago et al., 1999). All these variables must be considered when choosing the most appropriate test for assessing the HAR.

Before discussing these influential variables and the tests in greater detail, we describe the concept of validity and some ways of assessing the validity of HAR tests.

3.1. Validity and reliability

Measures used to study human–animal relationships should ideally be established as reliable and valid prior to their use (see Table 1). Validity refers to the relation between a measured variable and what it is supposed to predict, in this case, the animal's perception of humans. Validity is determined by accuracy, specificity and scientific validity (Martin and Bateson, 1993; Table 1).

Accuracy refers to the degree of freedom from systematic errors that might otherwise cause over- or underestimation of animal characteristics. Assessment of the accuracy of measures of the HAR may involve registering whether different stockpersons or professional observers score the behaviour of the same animals in the same way. If there is a systematic disagreement then the indicators or recording methods may have low accuracy.

Specificity is the extent to which a variable reflects what it is supposed to and nothing else. It is useful here to draw on the principles of construct validation (Cronbach and Meehl, 1955; John and Benet-Martinez, 2000) based on convergent and discriminant validity. Convergent validation involves a search for convergence across independent measures of the same conceptually related construct. In practice, this can be done by testing for predicted correlations between alternative measures of either fear/avoidance or

Table 1
Definitions of the different components of reliability and validity

Subject	Question
Validity	Is the measure accurate, specific and scientifically valid?
Accuracy	Is the measure free from systematic errors?
Specificity	Does the measure reflect what it is supposed to and nothing else?
Convergent validity	Are conceptually related measures empirically associated with one another?
Discriminant validity	Are independent conceptually unrelated measures empirically independent?
Scientific validity	Does the method give scientifically relevant information and answer the research question?
Internal validity	Does the method answer the research question?
External validity	Does the method have relevance in other situations and does it have practical relevance?
Reliability	Does the measure have consistency and high resolution, and is it precise and sensitive?
Consistency	Do repeated measures of the same construct produce the same results?
Sensitivity	Does the measure change with small changes in the true value?
Resolution	What is the smallest detectable change in the true value?
Precision	How free is the measure from random errors?

attraction to humans that have been recorded in different tests thought to measure the same thing. Discriminant validation, on the other hand, searches for divergence across independent measures of different (conceptually unrelated) constructs. This could, for example, involve studies showing that a measure of personality such as general fearfulness or sociality is not correlated with a measure thought specifically to reflect aversive and/or pleasant experiences with a human.

Scientific validity in the present context refers to whether the method and response variable actually tells us anything of scientific importance about some component of how an animal perceives humans. It can be useful, as suggested by Lehner (1996), to subdivide scientific validity into internal validity (which characterises how well the research methodology answers the question in a given study) and external validity (which reflects how applicable the results of a given study are to other situations (times, places) and their practical relevance). Relevance to situations outside of the experiment is especially important for methods developed for on-farm studies.

Measuring animal's reactions to humans involves measuring a number of different emotions, including fear (see Fig. 1), which vary in intensity due to the existing relationship. Because most researchers focussed on fear of humans, it will be used in the following as an example of how methods can be validated. Methods of evaluating the internal validity of putative measures of fear of humans involve testing for predicted effects of a treatment thought to affect it. Aversive treatment would be predicted to increase avoidance/reduce approach, indicating increased fear of humans, whereas pleasant treatment would be expected to reduce avoidance/increase approach indicating reduced fear. If treatment effects are not in the predicted direction the sensitivity (see Table 1) or the internal validity of the putative measures may be considered low. Confirmation of predicted effects on the response variable would entail a partial internal validation. Several experiments have compared the effects of positive and negative handling treatments on avoidance or withdrawal distance (see Hemsworth and Barnett, 1991; Breuer et al., 2003), but if no control treatment (neutral contact) is included, such experiments cannot by themselves show whether the measures have internal validity and sensitivity for measuring effects of only positive or only negative handling.

External validity can be assessed by determining if recorded measures of fear of humans predict zootechnical performance (milk production, egg production, growth, immune function) or other aspects of animal behaviour or physiology thought to be sensitive to variability in fear at on-farm locations. For example, human–animal interactions can markedly affect the productivity of farm animals (Hemsworth and Barnett, 1987; Hemsworth et al., 1993a; Hemsworth and Coleman, 1998; Janczak et al., 2003; Jones, 1996), and a negative relationship between fear, as indicated by avoidance of humans, and productivity was found in pigs, cattle and foxes (Hemsworth et al., 1981a,b; Jeppesen and Pedersen, 1998; Breuer et al., 2000; Nikula et al., 2000).

If the effects of several different treatments are tested, preferably in different studies, the results can be used to evaluate the specificity (discriminant and convergent validity) of putative measures of fear of humans. For instance, we would predict that prior exposure to a novel object, not associated with or similar to humans, has no effect on fear of humans. This could establish that conceptually unrelated constructs, novelty-induced anxiety and fear of humans, are also empirically unrelated, and thus have some discriminant validity. If

repeated exposure to novelty itself affects measured fear of humans, the measure is likely to reflect general fearfulness in addition to or instead of fear of humans. The inverse could also be the case if pleasant or unpleasant handling affects fear of humans in the predicted direction, but also affects fear of novel objects. In these cases, specificity in the form of discriminant validity might not be high. Early handling of cattle reduced the distance at which animals avoided an approaching human, but did not affect reactions to non-human stimuli (Boissy and Bouissou, 1988), suggesting that tests of avoidance of humans or of non-human stimuli may have discriminant validity for cattle. Correlations between different measures can also test for discriminant validity. Here one would predict a lack of correlation between measures of fear of humans and those of novelty-induced anxiety, hunger, aggressiveness or other unrelated constructs. Studies specifically testing for discriminant validity of measures of fear of humans are scarce in the farm animal literature; this approach merits pursuit.

Convergent validity can be evaluated by similar methods, but in this case one would predict that different forms of aversive or pleasant treatments would affect different indicators of fear of humans in the same direction. Cattle handled regularly allowed closer approach by humans, were easier to lead, and fed more in a novel environment in the presence of a human (Boissy and Bouissou, 1988), suggesting that these indicators have convergent validity as measures of fear of humans. A number of studies also showed convergence between increased cortisol concentrations after exposure to humans, increases in basal corticosteroid concentration, and changes in adrenal gland weight and morphology (Hemsworth and Barnett, 2000). Correlations between different putative indicators of fear may also be used to assess convergent validity. Here one would predict a positive association between different indicators that are all thought to reflect fear of humans, as reported in domestic chicks exposed to different handling treatments (Jones, 1993).

Reliability, which is related to the degree to which measures are free from random errors (Martin and Bateson, 1993), is another important requirement of scientific measurement, and will be mentioned only briefly here. Reliability is determined by precision, sensitivity, resolution and consistency (see Table 1). Consistency, e.g., inter- and intra-observer correlations, can be readily assessed in behavioural studies, but this may be somewhat complicated by real changes in animal perception and associated changes in behavioural expression over time. Knowledge about the sensitivity of measures can also be important when evaluating internal validity. A measure may, for example, have low sensitivity to small changes in a treatment variable but be strongly affected by larger changes; thus having little or high internal validity for evaluating small or large changes, respectively.

We recommend that validation should be given more attention in future studies. As a general basis for validating measures it is also important to have insight into the general biology and behaviour of the species in question; a detailed ethogram may be a valuable starting point. This should ideally include detailed species-specific behavioural expressions such as posture, head and tail position, ear position and eye movements. The registration of such detailed behavioural expressions and more comprehensive validation of test methodology may provide considerable information about an animal's emotional state and its perception of humans.

3.2. Technical problems and solutions: confounding motivations and other factors

Defining a test procedure is never simple. The above validation section identifies the steps that should be taken when developing a valid test paradigm. As inferred, from initial design to realisation, many confounding factors could come into play. This is particularly true of tests designed to measure animal's reactions to human beings. By definition, many such tests use a specific person as a 'standardised test stimulus', but others may also be involved, e.g., in bringing the animal to the test situation. The potential impact of 'general' human presence on the animal's behaviour is sometimes minimised through previous habituation to people, but it is necessary to balance the 'standardising' effects of habituation and the risk of dampening responsiveness to humans to such an extent that it compromises assessment of treatment effects. In any case, habituation procedures can be difficult to impose when working with farm animals, particularly larger ones.

The present section identifies those methodological aspects that, in our opinion, merit particular attention. These include the effects of pre- and post-test conditions, variations in test duration, repeated testing and exposure to a number of different tests.

3.2.1. Pre-test conditions

First, the animal is often brought to the test environment; this may involve sorting and isolating it from its social group, catching it, and carrying or leading it to the test arena. Similarly, physiological tests often require fitment of radiotelemetry devices or the withdrawal of blood. Such procedures themselves elicit reactions. However, very rarely are such procedures precisely described or any observations performed during their execution, despite the potential knock-on effects of variables such as the handler's familiarity, personality, attitude, haste and calmness (Boivin et al., 1997, 1998b; Hemsworth, 2003; Tanida and Nagano, 1998; Seabrook, 2001). Some animals may also react to visible observers (Boivin and Braastad, 1996), though there was little effect on the open-field or tonic immobility responses of chickens unless the observer stared directly at the bird or wore unfamiliar clothing (Jones, 1987a, 1990, 1996).

Researchers must also consider the animals' expectations during a test. For example, choice tests measuring animal's preferences for or aversion to different handling procedures (Rushen, 1986; Pajor et al., 2003) indicated that they could predict which procedure was likely (feed, hit/shout, isolation, etc.) from environmental or human cues. Experience-dependent variations in the animals' perception of the test procedure could conceivably reduce its general value.

3.2.2. Test conditions

3.2.2.1. The physical and social environment.
Statistical constraints, such as the need for a sufficiently large sample, often demand that animals are taken from a group and tested individually in an environment that differs substantially from their home area. Even if tested in the home pen or in a group in the novel environment, the animal's neighbours or pen mates could influence its behaviour. Here we identify some potentially confounding variables.

Firstly, the familiarity/novelty of the test environment can vary markedly across studies. Sometimes novelty and isolation are central features if one wishes to test the reassuring

properties of human presence (e.g., Boivin and Braastad, 1996; Boivin et al., 2001), but their description is often neglected. Novelty is hugely important. For example, calves reactions to a human previously associated with positive or negative reward varied with the familiarity of the test pen (De Passillé et al., 1996). In an attempt to minimise this potential confound several researchers use prior habituation (varying from minutes to hours or to repeated exposure with and without peers over several days) to the test pen (Hemsworth and Coleman, 1998; Jago et al., 1999; Krohn et al., 2001; Lyons et al., 1988a; Visser et al., 2001, 2002), but the optimum duration of habituation is unknown and it may even depend on the animal model, its background genome and the husbandry conditions. Repeated habituation that includes contact with a handler also bears the risk of confounding the animal's test response (see above).

Secondly, farm animals are social species and their reactions at test can be strongly influenced by social factors such as isolation, disruption and/or the identity of the audience. Social separation is widely known to be highly distressing per se (Jones, 1996; Boissy and Le Neindre, 1997). Furthermore, the expression of social reinstatement behaviour during isolation can compromise the interpretation of chickens' and other animals' responses to a wide range of test stimuli (Jones, 1996; Jones and Mills, 1999). Moreover, the nearby presence of calm or distressed conspecifics can affect the animals' responses to humans (Lyons et al., 1988b; Boissy et al., 1998; Munksgaard et al., 2001).

Thirdly, spatial constraints can vary substantially; animals may be tethered or otherwise restrained in the home cage or test arena while others may be loose or even on pasture. Such variability normally reflects the species, husbandry system or the precise objective of specific tests, e.g., if they are used to assess reactivity to motionless or moving humans or to actual handling. However, many test environments and procedures are commonly used without a clear understanding of their effects on behaviour. The nature and magnitude of the animals' behavioural and physiological reactions may differ substantially if they are tested in a situation that either enables or precludes flight from the human, and the presence or absence of shelter may determine whether flight or immobility behaviours are shown (Jones, 1996). These issues merit further investigation.

3.2.2.2. The characteristics of the human stimulus: discrimination/generalisation. Researchers have asked if animals generalise from their experience with a known human to other people. Several studies demonstrated that the response to an unknown human is influenced by previous treatments based on different types of human contact (Jones, 1996; Hemsworth and Coleman, 1998; Rushen et al., 1999a; Boivin et al., 2003 for reviews), but some only exposed the animals to one experimenter and thereby only to his or her specific characteristics (size, weight, sex, odour, etc.). Although our understanding of farm animals' perception of humans and of the cues they use to discriminate between people (colour of clothing, facial differences, height, etc.) is progressing (Rushen et al., 1999a; Rybarczyk et al., 2003), the precise nature and influence of the mechanisms underpinning their ability to generalise from familiar caretakers to an unknown person need further exploration. Moreover, the behaviour of the human stimulus (passive, active, seated, standing, looking at the animal) often varies despite reports (Gonyou et al., 1986; Kendrick, 1998; Pajor et al., 2003; Erhard, 2003) that a standing person looking at the animals induced less approach than a seated one who merely glanced at the animals or sat with his

or her back to them. Similarly, chickens showed shorter tonic immobility fear reactions if the experimenter averted his gaze (Gallup et al., 1972; Jones, 1990). We therefore strongly recommend that the physical appearance and behaviour of the human stimuli should be reported. We may need to standardise such variables, although differences might be useful when assessing generalisation of response. Logically, Boivin et al. (1998b) suggested that discrimination/generalisation of response in beef calves could depend on the collective impact of all incoming sensations at test, e.g., the quality of the situation (perceived as positive, neutral or negative) and the physical and behavioural characteristics of the human stimulus. Discrimination (Y-axis) could be plotted on an inverted U-curve with situational quality as the X-axis. Perception of the test situation as positive or negative might confound our assessment of discrimination, but the animal would be expected to show measurable discrimination when overall sensation fell between these two extremes.

3.2.3. Consequences of variation in test duration or repetition and the application of multiple tests

Variations in test duration (commonly from 2 to >10 min, see Tables 2–7), the use of repeated testing and/or the imposition of several tests may all affect an animal's reactivity to humans. Furthermore, responsiveness to humans has often been included as just one of a battery of 'personality' tests, such as social motivation or neophobia, without always balancing the test order (e.g., Romeyer and Bouissou, 1992; Vierin and Bouissou, 2002; Visser et al., 2001, 2002). In many cases, the use of cross-over or Latin square designs has often enabled a number of experimental procedures to be carried out on the same animals, while in others the tests have been repeated at different ages, sometimes before or after a handling intervention (Boivin et al., 2001; De Passillé et al., 1996; Markowitz et al., 1998). This is not a problem in well-designed experiments. However, unless they are deliberately built into the experimental question(s) we must consider the possible effects of habituation (decreased responsiveness to humans or the test situation), sensitisation (increased reactivity), frustration or reinforcement that may accompany repeated testing. Of course, exposing the animal to repeated or multiple tests may also change its perception of humans simply through increased contact with people. Encouragingly, although the level of responding decreased with repeated testing and age, the consistency of test variables was high in horses (Visser et al., 2001, 2002).

3.3. Tests used for assessing the HAR

Farm animals frequently encounter familiar and/or unfamiliar humans during their everyday life; these may be stockpersons, veterinarians, inspectors, catching crews, etc. The human–animal interactions that take place at these times may be voluntary or involuntary and can involve visual, auditory, tactile and olfactory stimulation. Imposition of a painful surgical procedure by a veterinarian represents one (negative) end of a response scale while a stockperson feeding the animal represents the other extreme, while a stationary stockperson probably occupies an intermediate position. On this basis, tests involving various human actions have been developed to measure the animal–human relationship in numerous species, including farm animals. Tables 2–7 list the main tests used to assess the HAR in cattle, sheep and goats, pigs, poultry, fur animals and horses,

Table 2

Tests of responsiveness to humans and handling in cattle

	References	Test-type[a] sizes	Time	Context[b]	Species/ type[c]	Procedures and other factors[d]	Variables	Validity[e]	Main confounding factors/motivations (mot)[f]
1	Munksgaard et al. (1997, 1999, 2001), Rushen et al. (1998, 1999b)	RSH-H	60 s	G; U/F; K	Dairy cows	P stands still for 60 s, hands in pockets; 0.8 m or 0.5 m in front of bar. Scores at 5 s intervals	Cow's position scored from 1 (contact with P) to 6 (muzzle behind tie bar and head turned away from P)	NEG, POS	Interference by neighbouring cows. Exploratory mot
2	Lensink et al. (2000a,b, 2001b,c)	RMH-H, App MoveHd		I; F/U; K	Veal calves	P approaches from the side 10 s after A starts to drink or eat, stands still 5 s, 0.5 m behind bucket, then touches calf's forehead	Calf's reactions to appearance/ to touch: none or withdrawal (5-point score); latencies to resume drinking or feeding	POS	Social mot; feeding mot
3	Lensink et al. (2001b)	RMH-H		I; U; K	Veal calves	P passes behind the crates and touches the calf's hip	Reaction score from 1 (no movement) to 5 (escape attempt)	REL	Startle
4	Waiblinger and Menke (1999), Waiblinger et al. (2003b)	RMH-H; App		G; U; K	Dairy cows	P approaches A in the feeding rack from front, 1 step/s, hand held at 45°, until A withdraws	Distance of withdraw (DW), i.e., between hand and head/nose, when cow withdraws percentage of animals with DW of 0	CONV, REL	Interference by neighbours; feeding mot
5	Jago et al. (1999), Krohn et al. (2003), Lensink et al. (2000b, 2001c), De Passillé et al. (1996)	RSH-H; 0.9 × 2.2; 2.1 × 1.85	2–5 min	I; F/U; K	Calves	P stands in front of pen 10 s, P enters pen and stands still for 2.5 or 10 min. A are separated in their box if not housed singly	Latency to approach and contact human. Frequency and duration of bouts of contact. Orientation to human. Position in pen	POS, CONV	Exploratory mot
6	Murphey et al. (1981)	RSH-H		G; U; K	Cows	P approaches largest concentration of cows on pasture and lies on ground	Approach/avoidance responses and behaviour directed to observer		Exploratory mot
7	Waiblinger and Menke (1999), Waiblinger et al. (2003b), Rousing and Waiblinger (2004)	RSH-H	15 min	G; U; K	Dairy cows	P enters cowshed and stands still at a central place	Latency to approach; proportions of standing animals that approach to 1 m, make contact	ACC, CONV, REL	Exploratory mot; feeding mot
8	Breuer et al. (2003)	RSH-H	30 s	I; F; K	Heifers	P enters pen and stands still at its centre for 30 s. Blood samples taken via fixed catheters with extension 12 times for −40 to +90 min	Plasma cortisol concentration		
9	Sambraus (1974), Waiblinger and Menke (1999), Waiblinger et al. (2002, 2003b), Murphey et al. (1980)	RMH-H; App		G; U; K	Cows	30 min habituation to P, P slowly, 1 or 2 step/s, approaches standing animals from front, flank or within visual field, hand held overhand 45° or hang	Distance of withdraw (DW), i.e., between human's body or hand and cow's head/nose herd value: percentage of animals with DW of 0; median of DW	CONV, REL	Available space; feeding mot

No	Reference	Test	Duration	Codes	Animal	Description	Measures	Context	Motivation
10	Rousing and Waiblinger (2004)	RMH-H; App		G; U/F; K	Dairy cows	P approaches standing A from front, 1 step/s, arms by side, stops at 1 m, after 10 s reaches to touch cow	Categories of withdrawal (>2 m, 1.5–2, 1–1.5, accepts arm stretched, accepts touch)		Available space; feeding mot
11	Boissy and Bouissou (1988)	RMH-H; App		G; ?; K	Heifers; loose	P approaches lying A from front (6× per animal)	Score from 6 (flight at >2 m) to 1 (remains lying, tolerating touching) to 0 (approaches human)	POS, CONV	Lying mot
12	Breuer et al. (2003), Hemsworth et al. (2000, 2002)	RMH-T; App		I; U/F; N/K	Dairy cows	Follows RSH-T and carried out in same arena. P walks furthest from A and then approaches at 1 m/s	Distance of withdraw		Carry-over from RSH-test; isolation (novelty)
13	Jago et al. (1999), Krohn et al. (2001, 2003)	RMH-T; App; 2.4 × 7.4; 2.2 × 5.5		I; U; K	Calves	P enters pen, waits till A looks at him/her, approaches A until it withdraws (preceded by RSH-T)	Distance of withdraw; approach/avoidance/baulking	POS	Isolation (novelty) (carry-over from RSH-T)
14	Lensink et al. (2000b)	RMH-T; App; 3.7 × 4.5	3 min	I; F/U; K	Calves	Preceded by 5 min RSH-T. P approaches A from behind and tries to touch and stroke its back	Latencies to, durations and frequencies of touching and stroking	POS	Carry-over from RSH-test; isolation
15	Boivin et al. (1992a)	RMH-T; App	2.5 min	A; U; N/K	Calves	Preceded by sorting test. A spends 30 s alone, 30 s with stationary P, 2 min with P following it	Time spent looking at human, ambulation (squares crossed)	POS	Carry-over from sorting test; social mot
16	Boivin et al. (1992a, 1998a)	RMH-T; MoveHd; PRH-T; 10 × 2	15, 1.5 min	I; F; K/N	Calves	A isolated in a (small) pen. P tries to stroke the animal (offers concentrate), in 1998a combined with RSH directly before	Times spent accepting stroking, standing still, vocalising, sniffing pen, lying down, playing with human, within 1, 2, 4, 6, 8 m of and touching handler. Escape attempts	POS	Isolation (carry-over from RSH-test)
17	Boivin et al. (1998b)	RMH-T; MoveHd	3 min	A; U/F; K		P enters pen and stands still 10 cm from bucket, A released in pen. If A feeds for 10 s P tries successively to touch shoulder, head, nostril, offers food for 10 s each	Latency to feed from bucket and to accept touching on different body parts	POS	Social mot; feeding mot
18	Boivin et al. (1998a)	RSH-T; PRH-T; 10 × 2	1.5 min	I; F; K	Calves	A left alone in arena for 1 min, then P enters the pen, stands motionless for 1.5 min	Times spent standing still, vocalising, sniffing pen, within 1, 2, 4, 6, 8 m of and touching handler. No. of escape attempts	POS	Carry-over from RMH-test, exploratory mot, isolation
19	Boissy and Bouissou (1988)	RSH-T; 10 m²	1–5 min	I/A; U/F; K	Heifers, calves	A placed alone in a holding pen for 30 s. P then stands near the feeder	Latency to feed. Times spent feeding, >1 m from bucket, orienting to and interacting with human	POS, CONV	Feeding, social, exploratory mot, isolation
20	Jago et al. (1999), Krohn et al. (2001, 2003)	RSH-T; 2.4 × 7.4		A; U; K	Calves	A left alone for 90 s, P enters pen and stands still opposite to audience	Latencies to approach and to touch human. Time spent <1 m from human		Social mot, exploratory mot
21	Jago et al. (1999), Krohn et al. (2001, 2003), Lensink et al. (2000b)	RSH-T; 2.4 × 7.4; 2.2 × 5.5; 3.7 × 4.5	3.5 min	I; F/U; N/K	Calves	After 24 h familiarisation with test arena P enters and stands still or (b) calf released into arena where P is standing (combined with RMH of 3 min)	Latency to contact, duration and frequency of contact with human. Time spent < 1 m from human. No. of escape attempts, squares crossed, defecations	In K: POS, CONV, DISC	Isolation, exploratory mot (novelty)

Table 2 (*Continued*)

	References	Test-type[a] sizes	Time	Context[b]	Species/ type[c]	Procedures and other factors[d]	Variables	Validity[e]	Main confounding factors/motivations (mot)[f]
22	Breuer et al. (2000, 2003), Hemsworth et al. (1987b, 1989b, 1996a, 2000, 2002), Tilbrook et al. (1989)	RSH-T	2 + 3.5 min	I; U/F; N	Dairy cows	A left alone in arena for 2 min, P enters the pen and sits on a stool	Latencies to approach and to touch human. Time spent within 1–3 m of human. Frequency of physical contact. Percentage of animals within 1.3 m of human	CONV	Isolation, novelty, exploratory mot
23	Becker and Lobato (1997), De Passillé et al. (1996)	RSH-T (testing discrimination)	90 s, 5 min	I; F/U; N/K	Calves	A left alone for 30 s/5 min, two P (U/F or positive/aversive handler) enter pen, sit down in centre or stand at either side of pen	Time spent moving, looking at experimenter. No. of escape attempts, aggressive actions. Latency and frequency to interact	POS	Isolation, exploratory mot
24	Rybarczyk et al. (2001)	RSH-T (testing discrimination)		A; U/F; K		Cows trained at operant conditioning apparatus (rewarder against empty chamber). Tested with rewarder against unfamiliar P	Correct choices		
25	Lensink et al. (2000c)	RHd-T		I; F + U; N/K	Calves	Calves are loaded individually onto a cart and transported for 2 min	Time needed for loading. Defecation; score of struggling during transport	POS, CONV, DISC	Isolation, novelty
26	Lensink et al. (2001b,c)	RHd-T		I/G; U; N	Calves	P moves calves individually to truck, loads, transports and unloads them. P restricted to special behaviour (e.g., pushing and vocal command)	Effort required to load calves. No. of turns, buck kicking, running per m. Latencies to time get calf out of crate, to move it to truck and to load it. Number of potentially traumatic incidents. Plasma cortisol. Heart rate	POS, CONV	Isolation, novelty
27	Breuer et al. (2003), Tilbrook et al. (1989)	RHd-T; 48 m		I; U/F; N/K	Heifers	A moved individually along a route to a crush or from home pen to test arena; (after RMH; RSH-tests)	Latency to reach crush. No. and time of interactions used by experimenter. No. of animals baulking. Distance from human maintained by animal		Carry-over effects from RMH and RMS tests, isolation
28	Breuer et al. (2003)	RHd-T; 2.8 × 0.8		I; U; K?	Heifers	P who had moved the A in the crush stands 0.5 m besides the head and scores the A's restlessness	Score reactions from 0 (quiet, no movement) to 3 (vigorous movement)		Carry-over effects of multiple tests, isolation
29	Boissy and Bouissou (1988)	RHd-T		G; ?; K	Heifers 15 mth	P catches A within a group and places a halter on it	Time to capture and put a halter on the animal	POS, CONV	Social mot
30	Lewis and Hurnik (1998)	RHd-H		G; ?; K	Dairy cows	P places a halter on the cow while in the tie stall	Score from 1 (holds head still) to 5 (aggressive)		

31	Boissy and Bouissou (1988), Lewis and Hurnik (1998)	RHd-T; 20 m/76 m		I/G; ?; K/N	Heifers, dairy cows	A are taken out of the pen or stall after the halter was placed and led through a corridor (past herd members in the second paper)	Ease of leading; relative time of walking voluntarily, walking when coaxed, running and refusing to walk; or score from 1 (none to mild hesitation) to 5 (escape or aggression)	POS, CONV	Carry-over from test of placing halter, isolation, social mot
32	Lewis and Hurnik (1998)	RHd-T		G; ?; N	Dairy cows	A are scored three times: (1) being moved into the squeeze, (2) head gate closed, (3) being backed out of squeeze	Score from 1 (none to mild hesitation) to 5 (escape or aggression) for each of the three situations		Carry-over from test of placing halter and leading, social mot
33	Boivin et al. (1992a,b, 1994)	RHd-T; 100 m²	Maximum 3 min	G; U; N/K	Beef cattle	A group of around 10 A is placed in pen. P separates each animal (moving it out of the pen) in pre-determined order	Time needed to separate the animal from the group	ACC, POS, DISC	Social mot
34	Boivin et al. (1992a,b, 1994), Le Neindre et al. (1995), Grignard et al. (2000, 2001)	RHd-T; 55 m², 6 × 6, 5 × 5 or 3.5 × 5	2.5–3.5 min	A; U; N/K	Beef cattle, calves, heifers	A successively exposed to 30 s alone in arena, 30 s with passive P, P tries to move it to a 2 × 2 m corner opposite other A and keep it there for 30 s; then tries to touch it	Latency to restrain animal in corner. No. of aggressive animals and of escape attempts. Time spent motionless, running, orienting to human, accepting touch. Aggregate docility score	ACC, POS; CONV; DISC	Social mot; novelty
35	Boivin et al. (1998b)	RHd-T		I; U/F; N	Calves	P leads calf to a weighing scale, leaves it alone for 30 s, then strokes it for 30 s	Time needed to lead onto scale		Isolation; novelty
36	Rushen et al. (1999b), Munksgaard et al. (2001)	RHd-H		G; U/F; K	Dairy cows	Cow milked with or without a familiar/ unfamiliar or aversive/non-aversive P standing nearby	Steps, kicks, tail movement, defecations, urinations. Heart rate. Milk yield; milking duration, residual milk	Partly NEG, REL	
37	Hemsworth et al. (1987b, 1989b, 2002), Knierim and Waran (1993), Breuer et al. (2000), Waiblinger et al. (2002), Seabrook (1984)	RHd-H		G; U/F; K	Dairy cows, heifers	Observations during regular milkings, e.g., with relief or regular milkers. On farm surveys	Flinch, step, kick, tail flick. Dislodged clusters, assistance needed by milker. Cortisol in milk, heart rate; milk yield. Latency to enter parlour	POS, CONV, ACC, REL	Previous experience of unfamiliar people in parlour
38	Rushen et al. (2001)	PRH-T		I; F; N	Dairy cows	Milking in isolation in a novel room with/without a P brushing the cow	Steps, kicks, tail movements, defecations, urinations, vocalisations. Heart rate; plasma cortisol and oxytocin. Milk yield; milking duration, residual milk	CONV	Novelty
39	Waiblinger et al. (2004)	PRH-H	4 + 5 min	G; F/U; K	Dairy cows	Rectal palpation with sham insemination with/without a P stroking the cows	Steps, kicks, tail movements, butts. Licking and leaning at the person, stretching the neck. Heart rate	POS, CONV, REL	
40	Tulloh (1961), Fordyce et al. (1985)	RHd-T	1 min	I?; ?; K?	Steers	P touches the animal in the crush	Temperament score (vigour of movement, audible respiration, bellowing, kicking, kneeling, going down) docile—aggressive		Isolation? Social motivation

Table 2 (*Continued*)

	References	Test-type[a] sizes	Time	Context[b]	Species/ type[c]	Procedures and other factors[d]	Variables	Validity[e]	Main confounding factors/motivations (mot)[f]
41	Grignard et al. (2001)	RHd-T	8 min	I; U; N	Beef heifers	A 5 min alone in crush, 30 s P motionless 1 m in front of animal, 30 s P strokes the animal's head	Time spent standing still, moving leg, tail or head. No. of eliminations, vocalisation, sniffs and licks at human. Heart rate	CONV	Isolation
42	Grandin (1993), Grandin et al. (1995)	RHd-T			Cattle	Observation of A restrained in a crush for vaccination, ear tagging, blood sampling, etc.	4- or 5-point score (from calm, no movement to violent movement and vocalisation)		Social motivation

[a] *Test-type*: PRH = test for positive response to human. RMH = test for reactions to moving human. App: human is approaching; Ret: human is retreating; MoveHd: human stands still, but moves the hand. RSH = test for reactions to stationary human. RHd = reaction to handling (T = in test environment, H = in home environment).

[b] *Context*: social conditions during the test (I = social isolation, G = group, A = audience); experimenter characteristics (F = familiar; U = unfamiliar); familiarity of environment (N = novel, K = known/familiar—at least one test performed in same test environment before or home).

[c] Type = type of production or animal age class, e.g., dairy; beef; cow, heifer.

[d] P = person; A = animal; procedures in brackets used only in some references.

[e] *Codes for validity*: ACC = repeatable between observers without systematic error; CONV = convergent validity: relation in expected direction of behaviour with cortisol; heart rate; production, to other tests or correlations with human behaviour in on-farm studies; DISC = discriminant validity: no relation to other fear reactions, e.g., reaction to a novel object, activity in open field when alone; NEG, POS, NEU = sensitive to 'negative' (hitting...), 'positive' (stroking...) or 'neutral' (habituation) treatment; NEG ≠ POS = discriminates between 'negative' and 'positive treatment'; REL = external validity: test is usable on farm.

[f] Excluding personality traits.

	References	Test-type[a] sizes	Time	Context[b]	Species/ age	Procedures and other factors[c]	Variables	Validity[d]	Main confounding factors/motivations (mot)[e]
1	Boivin et al. (1997, 2000, 2001, 2002)	PRH-T; 6 × 2 m	1.2 + 2 + 1.2 min	I; F; N, K	Sheep; lambs	A left alone in arena for 1, 2 min. P enters and sits for 2 min, calls, stretches the arm and touches the A if it approaches within 1 m, P leaves and A left alone for 1, 2 min	Latency of contact with the human, duration in contact (<1 m). Number of vocalisations of sections entered	POS	Isolation; novelty
2	Markowitz et al. (1998)	PRH-T; 5 × 1 m	5 min	I; U; N, K	Sheep; lambs	A put in a box 30 s before the test, A then released in arena where P sits still. After the first contact, P presents the hands allowing the A to reach the fingers	Mean distance from the person, latency of contact, time spent in proximity (<2 m), in contact with the human (<1 m), number of sections entered, number of human contact	POS, DISC, CONV	Isolation; novelty
3	Le Neindre et al. (1993)	RSH-T; 4 × 6 m	4 min	I; U; N, K	Sheep; lambs; adult	A released in arena with a P standing motionless. Included in a battery of tests in the same arena	Latency, number of sniffs at P. Duration in proximity of P. Number of sections entered, sniffs, vocalisations, defecations, urinations, rearings		Isolation; carry-over effects from other tests
4	Lyons et al. (1988a)	RSH-T; 1 × 8 m	10 min	I; ?; K	Goat; lambs, adult	2-Day period of familiarisation to the arena in group before the test. A restraint in a starting zone for 45 s and release in the arena with a P standing	Latency of proximity with the human, duration in proximity (within 2 m), sections crossed, mean distance from the humans	POS, CONV, ACC, DISC	Isolation
5	Mateo et al. (1991)	RMH-T; movehd	5 min	G; F; N, K	Sheep; lambs	Three lambs (from different treatments) placed in arena with P sitting in the middle with hand outstretched, touching A if they approached	Latency to sniff human's hand, number of contacts	POS	Novelty
6	Lyons and Price (1987)	RSH-T; 1 × 1 m	5 min	A; U; N	Goat; lambs	A placed 5 min in the arena, peers behind a fence, then P enters and stays still for 5 min. Heart rate recorded by telemetry	Duration in contact with the human. Number of vocalisation. Heart rate	POS, ACC	Isolation; social mot
7	Boivin et al. (2002)	RMH-H movehd	2 min	A; F; K	Sheep; lambs	P approaches out of the home pen and stretches his hand towards the animals	Latency of contact with the human, duration in proximity close to the human, vocalisation, number of escapes	POS	
8	Romeyer and Bouissou (1992), Vandenheede and Bouissou (1993), Vierin and Bouissou (2002)	RSH-T; 4 × 4, 10 × 10	4 min	I; A; U; K	Sheep; lambs, juvenile	2–10-Day period of habituation to the arena with a food trough. A entered the test arena with the P standing or sitting still behind the trough	Latency to enter the section in front of the trough, feeding latency, feeding duration, number of sections entered. Synthetic score computed from the variables recorded during the test	POS, CONV	Feeding mot. Test included in a battery of tests

Table 3 (*Continued*)

	References	Test-type[a] sizes	Time	Context[b]	Species/ age	Procedures and other factors[c]	Variables	Validity[d]	Main confounding factors/motivations (mot)[e]
9	Lankin (1997), Lankin and Bouissou (2001)	RMH-T; movehd	3–5 min	G, I; U; N	Sheep	A placed in A arena after 12 h food deprivation. P enters, fills the feeder, lets A approach and eat for 1 min. Then P attempts to mark the sheep on their back at three times	No. of paints placed on sheep's body (back)	REL	Feeding mot
10	Le Neindre et al. (1993)	RSH-T; 4 × 6	4 min	A; U; N, K	Sheep; adult	A placed in arena with P standing in front of peers behind a fence	Latency and number of sniffs at human. Duration in proximity with the human (1 × 2 m section). Number of section entered, sniffs, vocalisations, defecations, urinations, rearing against the walls, looks towards the human		Social mot. Order of testing; test included in a battery of tests
11	Fell and Shutt (1989)	RSH-T; 15× 4 m	10 min	G; F; N, K	Sheep; lambs	Three or four A placed in arena with P standing in front of peers behind a fence	Mean, minimum and maximum distance from the human (distance observed 4×/min)	NEG	Social mot; novelty
12	Goddard et al. (2000)	RSH-T; RMH-T; 4.5 × 4.5	5 min	G; U; N	Sheep; lambs, adult	Four A left alone in arena for 10 min, P enters and stands still for 5 min, then P walks around at constant speed for 5 min. Heart rate recorded with Polar Sports Tester™	Latency to move from the original position, duration spent facing the human, number of sections entered. Heart rate and total plasma cortisol with plasma samples taken just after the test	NEU	Novelty
13	Boivin and Braastad (1996)	RMH-T; Movehd; App		I; F; N, K	Goats; lambs	A left alone in arena for 1 min, P enters and stands still for 1.5 min, then P approaches and tries to pet A for 1.5	Duration in proximity (<2 m), in contact with the human. Vocalisation, sections crossed,	POS	Isolation; novelty
14	Lyons et al. (1988b), Lyons (1989)	RSH-H; RMH-H App; 12.2 × 9.8; 1 × 8	3× 3 min; 3× 2 min	I, G; U; K	Goats; adult	Three successive parts of 2, 3 min: P enters pen and stands still, P moves back and forth along the front fence, P tries to touch A	Latencies to approach the human (<1 m) and to make contact, duration in proximity (stationary or moving)	POS; CONV	Isolation
15	Lyons et al. (1988a), Markowitz et al. (1998)	RMH-T App (circular corridor, 6.1 m radius)	3.5 min	I; U; K	Goats, sheep; lambs	A placed in a circular runway, P walks (0.5 steps/s) behind it for 3.5 min; blood sampling taken 3 days before the test, immediately after and 3 days after	Mean flight distance, following, approach, avoidance, vocalisation, human contact, urination (plasma cortisol)	POS, CONV, ACC, DISC	Isolation
16	Hutson (1982)	RMH-T; App		I, G; ?; N, K	Sheep; adult	A placed in test corridor. P approaches the (group of) A at a constant speed	Flight distance, head orientation		

17	Hargreaves and Hutson (1990)	RMH-T App; 18 × 1.5 m Cage:1.7 × 0.5		I; ?; N, K	Sheep; adult wethers	A placed in corridor or restraint in a cage at the end of the corridor. P approaches A at a constant speed. Heart rate telemetry	Flight distance and heart rate	NEU, POS, REL	Isolation; novelty; restraint
18	Mateo et al. (1991)	RSH-T; App	2 min	I; ?; K	Sheep; lambs	A put in a halter, lead to arena and tethered to a post. The P sat quietly next to the A for 2 min	Time spent pulling on the halter, vocalisations	POS	Isolation; restraint
19	Lyons (1989)	RHd-H	21 days	G; F; K	Goats; adult	A milked twice daily for 21 days by two P. Then, the P scored each goats behaviour	Seven behavioural scales: excitable, tense, watchful, apprehensive, confident, friendly to humans, fearful of humans. Milk ejection	POS, CONV, REL	
20	O'Connor et al. (1985), Le Neindre et al. (1998)	RHd-H		G; ?; K	Sheep	Within 24 h after parturition on pasture, the shepherd approached the ewes and tagged the lambs. Responses of the ewe were scored	Maternal behaviour score: 5-point scale from 1 (flees at the approach of the shepherd, no return to the lamb's) to 5 (stays close to the shepherd during handling of their lambs)	REL	Maternal mot

[a] *Test-type*: PRH = test for positive response to human. RMH = test for reactions to moving human. App: human is approaching; Ret: human is retreating; MoveHd: human stands still, but moves the hand. RSH = test for reactions to stationary human. RHd = reaction to handling (T = in test environment, H = in home environment).

[b] *Context*: social conditions during the test (I = social isolation, G = group, A = audience); experimenter characteristics (F = familiar; U = unfamiliar); familiarity of environment (N = novel, K = known/familiar—at least one test performed in same test environment before or home).

[c] P = person; A = animal.

[d] *Codes for validity*: ACC = repeatable between observers without systematic error; CONV = convergent validity: relation in expected direction of behaviour with cortisol; heart rate; production, to other tests or correlations with human behaviour in on-farm studies; DISC = discriminant validity: no relation to other fear reactions, e.g., reaction to a novel object, activity in open field when alone; NEG, POS, NEU = sensitive to 'negative' (hitting. . .), 'positive' (stroking. . .) or 'neutral' (habituation) treatment; NEG ≠ POS = discriminates between 'negative' and 'positive treatment'; REL = external validity: test is usable on farm.

[e] Excluding personality traits.

Table 4
Tests of responsiveness to humans and handling in pigs

	References	Test-type[a] sizes	Time	Context[b]	Species/type[c]	Procedures and other factors[d]	Variables	Validity[e]	Main confounding factors/mot.s (mot)[f]
1	Hemsworth et al. (1981a, 1986, 1994b, 1996a,b), Hemsworth and Barnett (1992)	RSH-T	2 + 3/5 min	I; F/U; N	Gilts; boars; piglets	A left alone in test pen for 2 min, P enters and stands still for 3 min	Latencies to approach within 0.5 m and to touch experimenter. Time spent near human. No. of physical interactions	NEG, NEU, POS, CONV	Isolation; novelty; exploratory mot
2	Hemsworth et al. (1994b)	RHd-T	–	I; F/U; N	Gilts	P moves pigs individually along a standard route (100 m) using a board and positive interactions. Negative interactions used if pig baulks and remains stationary for >5 s	Time to move along a standard route; no. of baulks, negative interactions by handler; score from 0 (very difficult) to 4 (easy) for ease of movement	NEG, NEU, POS, CONV	Isolation; novelty
3	Gonyou et al. (1986), Hemsworth et al. (1987a), Paterson and Pearce (1992)	RSH-T	2 + 3 min	G/I; U; N	Gilts; young males	A left alone in test pen for 2 min, P enters and stands still for 3 min. Group testing preceded individual testing	Latencies to approach to 0.5 m and to interact with human. Time spent near human. Physical interactions. Plasma cortisol	NEG, NEU, POS, CONV	Isolation; novelty; exploratory mot, social mot
4	Gonyou et al. (1986)	RMH-H	-	G; F; K	Breeding sows	P enters the pen, walks towards the pigs, squats and pets an approaching pig	Measures as for 3. Ranking of the different treatments	NEG≠ POS, CONV	
5	Hemsworth et al. (1989a, 1990)	RSH-T	2 + 3 min	I; U; N	Breeding sows	A left alone in test pen for 2 min, P enters and stands still for 3 min	Locomotion during the familiarisation period. Latencies to approach within 0.5 m and to touch human. Time spent near human. Physical interactions	CONV, DISC, REL	Isolation; novelty; exploratory mot
6	Hemsworth et al. (1999)	RMH-H MoveHd	15 s	I; U; K	Lactating sows	P1 slaps sows in farrowing crate to make her rise. P2 places a food tray in front of crate and withdraws. After pig has fed for 5 s, P2 approaches front of crate and places hand 5 cm from sow's snout	Withdrawal response; reaction time; time within 5 cm of food tray	CONV, REL	Feeding mot
7	Tanida et al. (1995)	RSH-T	1 min	I; U/F; N	Weanling pigs	A released into arena where P is sitting	Latency to touch experimenter	NEU, POS, CONV	Isolation; novelty; exploratory mot

Table 4 (*Continued*)

	References	Test-type[a] sizes	Time	Context[b]	Species/type[c]	Procedures and other factors[d]	Variables	Validity[e]	Main confounding factors/mot.s (mot)[f]
8	Tanida et al. (1995)	RHd-T	3 min	I; U/F; N	Weanling pigs	A released into arena containing P; P lifts A's hind legs briefly, then sits still till the A makes contact, then P walks after pig	Pig's response to lifting scored subjectively (0– 3; low to high struggling). Latency to approach	NEU, POS, CONV	Isolation
9	Tanida et al. (1995)	RMH-T	Not specified	I; U; N	Weanling pigs	P stands still in test room; A released in waiting box, enters the test room voluntarily; when A touches P, he/she starts to walk along the grids	Average distance from the experimenter to the pig	NEU, POS, CONV	Isolation; novelty
10	Wemelsfelder and Lawrence (2001), Wemelsfelder et al. (2000, 2001)	RSH-T	7 min	I; F; K	Growing female pigs	Individual pigs placed in test room containing a human squatting in the centre	Observers' own descriptive (subjective) terminology	NEG, NEU, POS, ACC, CONV	Isolation; exploratory mot
11	Marchant et al. (2001), Marchant-Forde (2002), Marchant-Forde et al. (2003)	RSH-T; RMH-T	2 + 3 min	I; U; N	Gilts; 6 months in groups	A fitted with heart rate monitor, released to arena where P stands motionless. 3 min observation after 2 min familiarisation. P then approaches gilt to touch her snout	Locomotor behaviour. Latencies to approach to 0.5 m and to touch the human. Time in physical contact. No. of contacts and of short and long vocalisations. Heart rate	NEU, CONV, REL	Isolation; novelty; exploratory mot
12	Janczak et al. (2003)	RSH-H	1 + 3 min	I; F/U; K	Gilts and sows; 8 and 24 weeks in groups	P enters the home box, places a plywood to separate test animal from littermates, exits. A left alone for 1 min. P re-enters, walks to the wall opposite the entrance, stays still	Durations and frequencies of exploring the P, standing, walking, exploring the room	CONV	Isolation exploratory mot, social mot

[a] *Test-type*: PRH = test for positive response to human. RMH = test for reactions to moving human. App: human is approaching; Ret: human is retreating; MoveHd: human stands still, but moves the hand. RSH = test for reactions to stationary human. RHd = reaction to handling (T = in test environment, H = in home environment).

[b] *Context*: social conditions during the test (I = social isolation, G = group, A = audience); experimenter characteristics (F = familiar; U = unfamiliar); familiarity of environment (N = novel, K = known/familiar—at least one test performed in same test environment before or home).

[c] Type = type of production or age class, e.g., gilts, breeding sows.

[d] P = person; A = animal.

[e] *Codes for validity*: ACC = repeatable between observers without systematic error; CONV = convergent validity: relation in expected direction of behaviour with cortisol; heart rate; production, to other tests or correlations with human behaviour in on-farm studies; DISC = discriminant validity: no relation to other fear reactions, e.g., reaction to a novel object, activity in open field when alone; NEG, POS, NEU = sensitive to 'negative' (hitting...), 'positive' (stroking...) or 'neutral' (habituation) treatment; NEG ≠ POS = discriminates between 'negative' and 'positive treatment'; REL = external validity: test is usable on farm.

[f] Excluding personality traits.

Table 5
Tests of responsiveness to humans and handling in poultry

	References	Test-type[a] sizes	Time	Context[b]	Species/ type[c] age	Procedures and other factors[d]	Variables	Validity[e]	Main confounding factors/ motivations (mot)[f]
1	Barnett et al. (1993), Hagedorn et al. (1996), Jones (1996)	RSH-H	2–3 min	I/G; F/U; K	Chickens (layers); quail	P disturbs food in trough at front of home cage to alert bird(s), stand in front of cage, measure reactions at 10 s intervals	Position in cage (front, mid, rear); orientation (0–4 for head out of cage, face front, face side, face rear, escape); cumulative scores	NEU, POS, CONV, DISC, REL	Neophobia to U human; interference by cagemates
2	Jones (1985, 1987b, 1996), Keer-Keer et al. (1996)	RSH-T	2–3 min	I; F/U; N	Chickens; adult	A placed in arena containing P seated or standing in centre. Measure position every 10 s	Position in one of four areas of pen at increasing distances from centrally located human (1 = near, 4 = far); cumulative scores	NEU, POS, CONV, DISC,	Isolation; novelty
3	Jones (1993, 1995a,b), Jones and Waddington (1993)	RSH-T	5 min	I; F/U; N	Chickens	A placed in rectangular arena with P seated in front of wire-mesh end wall. Measure position every 10 s. Other measures continuous	Position in one of four areas at increasing distances from human seated at front of cage (1 = near, 4 = far); cumulative score. Freezing, vocalisation, ambulation, pecking	NEU, POS, CONV, DISC	Isolation; novelty
4	Barnett and Hemsworth (1989), Hemsworth et al. (1993b), Jones (1985)	RMH-H; App	15 s–2 min	G; F/U; K	Chickens (layers); quail; juvenile + adult	P approaches to 1, 0.5, 0 m from cage. Measure behaviour of focal bird at each point or numbers of birds with head out of cage	Small groups—behaviour on scale of 0–5 (head out of cage, face front, face side, face rear, escape); cumulative score. Larger groups—numbers of birds with heads out of cage	NEU, CONV, DISC, REL	Neophobia to U
5	Barnett et al. (1992), Hemsworth and Coleman (1998)	RMH-T; App	1 min	I; F/U; N	Chickens; generic; juvenile + adult	A placed on table at one end of a corridor. P approaches from 2.4 m. Measures taken at 2.4, 1.8, 0.8 and 0 m	Proportions of birds withdrawing, turning away at selected distances	CONV, DISC, REL	Isolation; novelty; neophobia to U
6	Jones et al. (1993), Hemsworth and Coleman (1998)	RMH-H; App	Variable	G; U; K	Chickens (broilers); juvenile + adult	P with VCR on shoulder walks through poultry shed, stops for 3 0 s every 20 paces, videotapes analysed	Numbers of birds in 75 cm semi-circle in front of human; cumulative score of individual scans	CONV, REL	Neophobia to U

7	Bessei et al. (1983), Carmichael et al. (1999), Satterlee and Jones (1997)	RHd-H	Variable	G; F/U; K	Quail; generic for small/young birds	Unsighted P catches one bird at a time from caged group, transfers it to other cage, continues till all are caught. Capture/recapture procedure repeated up to 20 times	Rank order in which birds are individually captured/recaptured from established group	ACC, CONV, REL	Ambulatory difficulties; space restriction
8	Jones et al. (1981)	RMH-T; App; RHd	Variable	I; F/U; K	Chickens (layers); adult	Telemetry device implanted. Bird acclimatised (3–4 days) to new cage at end of corridor + food delivery to ensure forward orientation. P approaches slowly from 28 m, ultimately opens cage and captures bird	Distances at which orient, withdraw, startle, alarm call, escape and panic responses are first shown. Heart rate throughout P's approach	CONV, DISC	Isolation; neophobia to U
9	Gallup (1979), Jones (1986), Jones et al. (1991, 1992b)	RHd-T	5–20 min	I; F/U; N	Chickens; quail; any age over 7 days	Birds restrained by hand laterally on table or ventrally in cradle for 15 s, one hand cupping head + one on sternum. Usually performed in unfamiliar room	Number of inductions required to obtain tonic immobility (TI) lasting 10 s. Duration of TI (i.e., till self-righting)	NEG, NEU, POS, CONV, ACC, DISC, REL	Isolation; novelty; neophobia to U
10	Webb and Mashaly (1984), Jones et al. (1994), Korte et al. (1997)	RHd-T	5–10 min	I; F/U; K	Chickens; quail; any age	Bird removed from home environment and manually restrained for 5–10 min before blood withdrawal for assay of corticosterone. Controls bled during resting conditions	Plasma corticosterone concentrations	POS, CONV, DISC, REL	Isolation; novelty; neophobia to U; different handling and bleeding skills

[a] *Test-type*: PRH = test for positive response to human. RMH = test for reactions to moving human. App: human is approaching; Ret: human is retreating; MoveHd: human stands still, but moves the hand. RSH = test for reactions to stationary human. RHd = reaction to handling (T = in test environment, H = in home environment).

[b] *Context*: social conditions during the test (I = social isolation, G = group, A = audience); experimenter characteristics (F = familiar; U = unfamiliar); familiarity of environment (N = novel, K = known/familiar—at least one test performed in same test environment before or home).

[c] Type = type of production, e.g., layers, broilers.

[d] P = person; A = animal.

[e] *Codes for validity*: ACC = repeatable between observers without systematic error; CONV = convergent validity: relation in expected direction of behaviour with cortisol; heart rate; production, to other tests or correlations with human behaviour in on-farm studies; DISC = discriminant validity: no relation to other fear reactions, e.g., reaction to a novel object, activity in open field when alone; NEG, POS, NEU = sensitive to 'negative' (hitting…), 'positive' (stroking…) or 'neutral' (habituation) treatment; NEG ≠ POS = discriminates between 'negative' and 'positive treatment'; REL = external validity: test is usable on farm.

[f] Excluding personality traits.

Table 6
Tests of responsiveness to humans and handling in foxes and mink

	References	Test-type[a] sizes	Time	Context[b]	Species gender age	Procedures and other factors[c]	Variables	Validity[d]	Main confounding factors/motivations (mot)[e]
1	Pedersen and Jeppesen (1990), Pedersen (1992, 1993a,b, 1994), Pedersen et al. (2002), Korhonen and Niemela (1996)	RSH-H	15 s	I; U; K	Foxes; juvenile/adult	P approaches cage, attracts animal's attention by waving hand, stays or retreats 1 m and stand still. Predominant behavioural reaction after 15 s is recorded	Body movement and posture, facial expressions, ear positions, vocalisation	ACC, NEG, NEU, POS, CONV, REL	Exploratory mot
2	Bakken et al. (1999), Moe (1996)	RSH-H	5 min	I; F; K	Silver foxes; females, adult	Implanted telemetry for measuring deep-body temperature. P stands close to the cage for 5 min. Behaviour video-recorded before, during and after exposure to P	Behavioural response, activity and deep body temperature	NEG, POS, NEU, CONV	Exploratory mot
3	Bakken et al. (1999), Moe (1996)	RSH-H	5 min	I; U; K	Silver foxes; females, adult	Implanted telemetry for measuring deep body temperature. A group of P stands close to the cage for 5 min	Behavioural response, activity and deep body temperature	NEG, POS, NEU, CONV	Exploratory mot
4	Harri et al. (2000)	RSH-H	5 + 90 min	I; U; K	Blue foxes	Implanted telemetry for measuring deep body temperature, heart rate and activity. P stands in front of cage for 5 and 90 min	Body temperature, heart rate, activity	NEU, CONV	
5	Bertelsen (1995), Pedersen et al. (2002), Pedersen and Jeppesen (1990)	RSH-T	15, 6 min	I; U; N	Foxes; juvenile; adult	A left alone for 5 min. P enters and sits still	Latency to approach, contact, defecate and jump. Numbers of approaches, contacts, squares entered, jumps, defecations	NEU, POS, CONV	Novelty, exploratory mot
6	Pedersen (1992)	RSH-H-Hand	15 s	I, F + U; K	Silver foxes; juvenile	P opens cage door and reaches one bare hand towards the fox	Body movement and posture, facial expressions, ear positions, vocalisation	ACC, NEG, NEU, POS, CONV; REL	Exploratory mot
7	Bakken (1988), Korhonen and Niemela (1996), Pedersen and Jeppesen (1990)	RMH-H MoveHand		I; F; K	Foxes; juvenile/adults	P stands in front of cage, holds hand above it. When the fox looks up, hand is moved quickly down towards cage roof without hitting it	Scores of behaviour: offensive attack, offensive threat, alert, defensive threat, crouching and fleeing	CONV; REL	
8	Malmkvist (1996, 2001b)	RSH-H	30 s	G; U; K	Mink; juvenile	P stands in front of cage, opens door and inserts hand	Scores from −3 (escaping) to +3 (crawling confidently onto the hand)	ACC; CONV, REL	Exploratory mot
9	Hansen (1996), Malmkvist (1996, 2001b), Malmkvist and Hansen (2001)	RSH-H	10 s	I/G; ?; K	Mink; juvenile/adults	P stands near cage, inserts a 15 cm long stick and keeps it there for 10 s	Scores: 1(curious, sniffing persistently); 2 (fearful, flee to back); 3 (unspecified), 4 (aggressive, attack, bite stick)	ACC; CONV; REL	Exploratory mot
10	Kristensen (1988), Korhonen and Niemela (1996), Korhonen et al. (2000)	RSH-H-stick	30 s	I; U; K	Foxes, sable; adults	P stands near cage, inserts a 15 cm long stick and keeps it there for 10 s	Immediate response to stick inserted into cage (escape, explore, attack, unknown). Latency to touch stick	CONV, REL	Exploratory mot

11 Bakken (1998), Nordrum et al. (2000), Rekila (1999)	RSH-H	30 s	I; U; K	Silver foxes; adult;	P stands still in front of the cage and offers a tit bit through the wire-mesh for 20 s. The tit bit is left at the cage bottom if not taken by the fox	Position of the fox at the 20th second	ACC; CONV, REL	Feeding mot; exploratory mot
12 Jeppesen and Pedersen (1998)	RSH-H	20 s	I; U; K	Silver foxes; juvenile	P offers a dog biscuit through the cage door for 20 s	Behaviour (explorative, fearful, aggressive), latency to take the tit bit	ACC; CONV, REL	Feeding mot; exploratory mot
13 Nikula et al. (2000), Kenttamies (2000), Rekilä et al. (1997), Rekila (1999)	RSH-H	30 s	I + G; U, K	Foxes; juvenile/ adult	Starved for 24 h. P places food on the roof of the cage and withdraws 1 m	Feeding yes or no	ACC, CONV, REL	Hunger, exploratory mot
14 Pedersen (1993b, 1994), Pedersen et al. (2002), Bank (1996), Rekilä et al. (1997), Rekila (1999)	RHd-H	Variable	I; F + U; K	Silver foxes; adult	P captures fox with neck tongs, blood samples drawn at 0 and 20 min post-capture	Behaviour and plasma cortisol levels to capture by neck tongs	CONV, DISC	
15 Bakken et al. (1998), Moe (1996)	RHd-H	5 min	I; U + F; K	Foxes; juvenile/ adult	Implanted telemetry. P captures fox by hand	Behaviour and deep body temperature to capture by hand	ACC; CONV	
16 Harri et al. (2000)	RHd-H	? m	I; U; K	Blue foxes; adult	Implanted telemetry. P captures fox with neck tongs	Deep body temperature, heart rate, behavioural responses to capture, rectal temperature	ACC, CONV	
17 Bakken (1992), Braastad et al. (1998)	RHd-T	20 s	I; U; N	Foxes; cubs	Cubs are transported in a box 50 m to a test room. Reactions to being taken out of the box and held are measured over 20 s	Score: 1 (no reaction, calm), 2 (reaction but calmed down within 20 s), 3 (reacted and did not calm down during the 20 s)	ACC, CONV	Body-strength, exploratory mot
18 Ahola et al. (2000)	RHd-H + T capture + restraint	Variable	G; U; K + N	Silver foxes; juvenile	A are caught by neck tongs, restrained in a small box and exposed to rectal temperature measurement	Stress-induced hypothermia prior to and after being confined in a small novel cage. Behavioural response	ACC, CONV	

[a] *Test-type*: PRH = test for positive response to human. RMH = test for reactions to moving human. App: human is approaching; Ret: human is retreating; MoveHd: human stands still, but moves the hand. RSH = test for reactions to stationary human. RHd = reaction to handling (T = in test environment, H = in home environment).

[b] *Context*: social conditions during the test (I = social isolation, G = group, A = audience); experimenter characteristics (F = familiar; U = unfamiliar); familiarity of environment (N = novel, K = known/familiar—at least one test performed in same test environment before or home).

[c] P = person; A = animal.

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[e] Excluding personality traits.

Table 7
Tests of responsiveness to humans and handling in horses

	References	Test-type[a] sizes	Time	Context[b]	Species/type[c]	Procedures and other factors[d]	Variables	Validity[e]	Main confounding factors/ motivations (mot)[f]
1	Søndergaard and Halekoh (2003)	RSH-H	Maximum 3 min	I/G; F/U; K	Warmblood colts	P walks to centre of paddock and stands still	Latency to touch human	REL	Interference by group mates; exploratory mot
2	Søndergaard and Halekoh (2003)	RMH-H; App & MoveHd		I/G; F; K	Warmblood colts	P enters paddock and approaches horse/horses slowly (1 step/s, hands at sides); P attempts to touch horse's neck	Score 1–4 (1 = horse moves away, 4 = person could touch the horse)	REL	Interference by group mates
3	Søndergaard and Halekoh (2003)	RSH-T; RHd-T	6, 9 min	I; U; N	Warmblood colts	A is left alone in arena (phase 1, 3 min), P enters and stands still next to wall (phase 2, 3 min), A is left alone (phase 3, 3 min), A is caught	Restlessness, exploration, vocalising, standing alert. Latencies to first contact, of contacts. Time taken to capture; heart rate: mean, deviation from baseline	CONV, NEU	Isolation; novelty
4	Hausberger and Muller (2002)	RSH-H		I; U; K	Riding horses; adult geldings	P appears suddenly at door (closed) of box and notes horse's first reaction	First reaction score A–E (friendly –indifferent–very aggressive)	REL	Startle
5	Mal et al. (1994)	RMH-T, App		I; U; N	Foals	P walks slowly (0.61 m/s), quietly and deliberately towards foal with arms at sides	Distance of withdrawal, number of steps, gait	REL	
6	Jezierski et al. (1999)	RMH-T; App RHd	3 min	A; F/U; ?	Foals	A released in paddock and left alone for 3 min. Behaviour scored in four situations (catching, led away, hooves picked up, approached)	Ease of manipulation scored 1–5 (1 = not executed, 5 = executed very easily), sum of scores = total behavioural score (TBS); mean heart rate	CONV; NEU	Social mot
7	Visser et al. (2001, 2002)	RSH-T; RHd-T	9 min	I; F; K	Warmblood foals	A left alone in test box for 3 min, P stands in front of box for 3 min, then enters box and holds horse for 3 min	Latencies to first pawing. Frequencies of restless behaviour (pawing, rearing, striking, head shaking). Locomotion; heart rate: mean, variability	CONV; NEU	Isolation
8	Visser et al. (2001, 2002)	RHd-T	<3 min	I; F; K	Warmblood foals;	P tries to lead horse across a bridge (maximum three attempts)	Attempts to cross bridge, reluctance behaviour (pawing, rearing, striking, head shaking, walking sideways, pulling backwards), locomotion; heart rate: mean, variability	CONV; NEU	Isolation; novelty
9	Hama et al. (1996)	RHd-T	90 s	I; U; K	Thoroughbred	P stroke horses for 90 s. Horses were equipped with wireless ECG monitor	ECG recordings		Isolation (when group-housed)

10	Lynch et al. (1974)	RSH-H	2 min	I; F; K	Thorough bred	P stands in front of the stall. Horses were equipped with ECG telemetry system	ECG recordings		
11	Lynch et al. (1974)	RHd-H	2 min	I; F; K	Thorough bred	P pets and speaks quietly to the A. Horses were equipped with ECG telemetry system	ECG recordings		
12	Wolff et al. (1997)	RHd-H	<10 min	I; ?; K	Standard-bred	P tries to lead horse across a bridge (wooden planks on the ground)	Total time to cross bridge, retreat, jumping. Standing still	CONV	Isolation; novelty
13	McCann et al. (1988)	RHd-T	1.5 min	I; ?; N	Yearlings	P enters stall, quietly approaches A and attempts to stroke it for 1.5 min. Horses were equipped with ECG telemetry transmitters	Heart rate	ACC, CONV	Novelty; isolation
14	Chamove et al. (2002)	RHd-T	?	I; U; N	Standard-bred mare	P lead horse around pre-determined course	Head position, ear movements and position, resistance	REL	Novelty; isolation
15	Mal and McCall (1996)	RHd-T	10 min	A; U; K	Foals;	Halter training test on 5 consecutive days, i.e., P restrains foal, places halter, tries to lead 20 m away from dam	Duration of initial struggle. Numbers of lunges. Latencies to first forward step, to five consecutive forward steps, to move 20 m. Subjective test rating score	REL	Novelty; social mot
16	Lansade et al. (2004)	RHd-T	<7 min	I; ?; N	Foals	P approaches the foal in test pen, halters, picks up feet, leads A through corridor	Time taken to fit with halter, pick up feet, 'walk ratio', defences	CONV; NEU + POS	Novelty; isolation
17	Lansade et al. (2004)	RSH-T	2 min	I; ?; N	Foals	P enters the pen, stands stationary opposite the door	Time spent in certain squares, of immobilisation. Latencies to first neigh, to sniffing P. Mean duration sniffing. Number sniffs, glances at P, neighs, defecations, squares entered	CONV, NEU + POS	Novelty; isolation

[a] *Test-type*: PRH = test for positive response to human. RMH = test for reactions to moving human. App: human is approaching; Ret: human is retreating; MoveHd: human stands still, but moves the hand. RSH = test for reactions to stationary human. RHd = reaction to handling (T = in test environment, H = in home environment).

[b] *Context*: social conditions during the test (I = social isolation, G = group, A = audience); experimenter characteristics (F = familiar; U = unfamiliar); familiarity of environment (N = novel, K = known/familiar—at least one test performed in same test environment before or home).

[c] Type = type of use or age class.

[d] P = person; A = animal.

[e] *Codes for validity*: ACC = repeatable between observers without systematic error; CONV = convergent validity: relation in expected direction of behaviour with cortisol; heart rate; production, to other tests or correlations with human behaviour in on-farm studies; DISC = discriminant validity: no relation to other fear reactions, e.g., reaction to a novel object, activity in open field when alone; NEG, POS, NEU = sensitive to 'negative' (hitting. . .), 'positive' (stroking. . .) or 'neutral' (habituation) treatment; NEG ≠ POS = discriminates between 'negative' and 'positive treatment'; REL = external validity: test is usable on farm.

[f] Excluding personality traits.

respectively. Appropriate references, details of the test procedures, stage of validation and potential confounding factors are all shown. We now describe and discuss the various tests, having first allocated them to one of three categories: stationary human, moving human and handling.

3.3.1. Reactions to a stationary human (RSH-test)

Variations of this type of test have been applied to all the animals considered here. Larger ones are generally tested outside their home pen whereas smaller ones are mainly tested in the home environment. This partly reflects the fact that most of the large species are kept socially in paddocks so it is difficult to apply a RSH-test to a single animal in that situation. Conversely, smaller species, e.g., chickens, mink and foxes, are often kept singly, in pairs or in small groups so it is easier to apply the test in their home environment.

3.3.1.1. RSH-test in home environment (RSH-H).

3.3.1.1.1. Procedures. Research teams have largely developed their own variations but there are often common features across teams and species. For example, the observer draws the animals' attention to his/her presence prior to measuring their reactions (e.g., poultry table, ref. 1; fur animals table, ref. 1), or a familiarisation period (10 s–1 min) precedes the measurements (e.g., pig table, ref. 12; cattle table, ref. 5). These features are important steps in the standardisation of test methodologies; they give the animal an opportunity to become accustomed to the human's presence, thereby diminishing the likelihood of potentially confounding startle responses to the sudden appearance of a stimulus. The observer then stands motionless close to or at a prescribed distance (15 cm–1.5 m) from the pen, cage or animal. The literature is varied concerning eye contact; researchers either avoid it, make eye contact, or give no information. The experimenter may reach towards the animal (fur animals table, refs. 6, 8), present it with a treat (fur animals table, refs. 11, 12) or hold a stick/pencil near the front of the cage (fur animals table, refs. 9, 10), but he/she always stands still when measuring the animal's position, orientation and behaviour. The above modifications may increase the intensity of human contact, e.g., reaching out towards the animal reduces the distance between person and animal; decrease it by placing an object between them; or provide positive reinforcement through the presentation of food. Such modifications may actually elicit competing motivational states, such as hunger or neophobia, that could, in turn, elicit the expression of fear, exploratory and approach responses to the experimenter and thereby cause interpretational difficulties.

3.3.1.1.2. Measures. Some researchers recorded just one parameter in certain tests (horse table, refs. 1, 4; fur animals table, refs. 8–11, 13; cattle table, refs. 1, 6, 8), but most measured more than one. The latter approach is certainly preferable. Behavioural data can include: ordinal (e.g., subjective scores: aggressive, confident, fearful); binary or dichotomous (e.g., approach or not, fearful or not, confident or not, eating or not); frequency-based (e.g., numbers of attacks, alarm vocalisations, approaches); proportional (e.g., percentages or proportions of the population showing a certain behaviour); positional (e.g., distance from human, distance at withdrawal, orientation towards human); and temporal parameters (e.g., latencies to respond, durations of responses). Further, either independently or in combination with behavioural records, heart rates have been monitored

in chickens, foxes and horses, and deep body temperature has been recorded in foxes (fur animals table, refs. 2–4; poultry table, ref. 8; horse table, ref. 10).

3.3.1.1.3. Discussion—value, confounding factors and motivations. How useful is the RSH-H test and what are its advantages and demerits? On the positive side, testing the animal in its familiar home environment eliminates exposure to a number of potentially confounding factors, such as the stressful effects of capture, transport and novelty. The animal may also feel more secure and safe, thereby minimising the risk of panic. Additionally, in group-housed animals, separation distress is avoided. Disadvantages include the difficulty in interpreting the behavioural state of animals that neither approach nor withdraw as one of fear-induced immobility or mere indifference, unless detailed behavioural observations are taken. However, the latter arguments may be more cogent with animals that routinely receive frequent, intense and/or non-threatening human contact, such as dairy cattle, because they are more likely to appear to ignore the stimulus person. Conversely, the test may be more suited to species that receive less direct contact with humans, e.g., intensively reared chickens (Barnett et al., 1993; Jones, 1996) and/or those that have been more recently domesticated, e.g., foxes (Harri et al., 2000; Pedersen et al., 2002). Indeed, RSH-H tests were sensitive to positive, neutral and negative treatment in such animals, showing that they have some internal validity. Correlations with deep body temperature further support the existence of convergent validity.

Regardless of the above arguments, many factors have to be considered when striving for standardisation. For example, the observer's approach towards the cage/pen/pasture/ animal is an integral part of the procedure, but influential features, such as the suddenness of appearance or speed of approach, are often not described. Additional factors are discussed in Sections 3.1 and 3.2.

Meaningful interpretation of RSH-test results requires awareness that habituation to human presence can vary according to species, management and housing. For instance, might a human standing still in the home environment be perceived as more threatening than one just passing by while carrying out routine duties?

To conclude, the RSH-H test can provide useful indications of the HAR, i.e., positive or negative. Furthermore, it can easily be applied on farms, so external validity may be high. Ideally though, it should be included as one of a battery of tests in order to reach firmer conclusions.

3.3.1.2. RSH-test in a novel environment (RSH-T). The stationary human test performed in a novel environment has been widely used to evaluate the HAR in the species included here. Most tests used animals that were housed in pairs or groups and then tested individually (to yield individual data points) in some sort of arena. The test animal was sometimes given the option of approaching either a human or a conspecific in a two-choice test (e.g., sheep and goats table, ref. 15).

3.3.1.2.1. Procedures. The RSH-T test is often carried out in various forms of open field arenas. The term open field is actually a misnomer; the apparatus is invariably an enclosed area that can vary dramatically in shape, size and construction both within and between species. Test methodologies also vary significantly, largely reflecting differences in 'tradition' as well as in the size and/or age of animals, location of test site, method of introducing the animal to the arena, type of technical equipment, etc. For example, the

walls can be solid (wood, metal, canvas) or open (bars). Some animals (e.g., poultry) are placed in the arena by hand whereas larger ones (pigs, cattle) are led to it. The arena may already contain a motionless human (tables: cattle, ref. 21; sheep and goats, refs. 1, 2; poultry, refs. 2, 3; pigs, refs. 7, 11) or the animal may be allowed a familiarisation period before the human enters the arena (tables: fur animals, ref. 5; cattle, refs. 18–23; sheep and goats, ref. 3; horses, ref. 3; pigs, refs. 1, 3, 5). Sometimes, entrance into the arena is voluntary (e.g., fur animals table, ref. 5). The animal may be tested with either a familiar or unfamiliar human; some studies even incorporated discrimination between them as a measure. Photographs or models may also be used as substitutes for humans (e.g., sheep and goats table, ref. 9). Sometimes, the human stands besides a feeder (cattle table, ref. 19). Even something as simple as test duration can vary widely (1–15 min). Finally, some researchers expose animals consecutively to a range of animate and inanimate stimuli, e.g., novel object, startling stimulus, human being (e.g., sheep and goats table, ref. 9), but as mentioned above, unless the order of presentation is balanced this can introduce confounding carry-over effects.

3.3.1.2.2. Measures. The most common behavioural measures include: latencies to express a particular behaviour, numbers of delineated areas entered or lines crossed, time spent near the human and latency to enter this zone, orientations towards and frequency and duration of interactions with the human, rearing, vocalisation, and defecation. Heart rates (pigs table, ref. 11; horse table, ref. 3; sheep and goats table, ref. 7), cortisol levels (pigs table, ref. 3; sheep and goats table, ref. 8) or both (sheep and goats table, ref. 13) may also be measured simultaneously with behaviour, thus allowing assessment of the association between behavioural and physiological responses as well as their temporal relationships.

3.3.1.2.3. Discussion—value, confounding factors and motivations. The open field test was initially developed for laboratory rodents where Denenberg (1962) found that fearful rats were more reluctant to move around and stayed closer to the walls than non-fearful ones. Rightly or wrongly, it has since been used to evaluate general fearfulness in farm animals. A human stimulus was added in some situations so the animal was faced with social separation, a novel environment and human presence. For confident animals, a familiar human might represent a reassuring stimulus (see Section 4.3) but for those with little experience of or attachment to people the human might increase test novelty and thereby elicit greater fear.

How useful then is the RSH-T test? On the plus side, it has enabled researchers to compare the responses of positively- or negatively-handled animals with those of controls (see Tables 2–7). Furthermore, reported associations between RSH-T results and those of other presumed tests of the HAR as well as production and human behaviour were in the expected direction, thereby suggesting test validity. However, few studies have investigated test specificity. Such information about discriminant validity is necessary when tests are applied on farms and to strains differing in general fearfulness or other traits that could confound interpretation of data. The need to construct a special test arena and for moving the animals to it means that the RSH-T is not very practical for rapid assessment of large numbers of animals and/or farms—at least in larger animals that cannot be caught and moved easily by hand. The possible consequences (see Section 3.2) of leading the animals to the arena raise other concerns.

Some recommendations for improvement can be made. (1) Moving the animals into the test pen several hours before testing (e.g., cattle table, ref. 21) or using part of the animals' home environment as an arena (e.g., sheep and goats table, ref. 4) could minimise the confounding effects of environmental novelty. However, this is not always possible. (2) Recording the animal's general behaviour rather than only the latency to approach the human and the duration of contact might increase discriminant validity. For example, if an animal sniffs, walks around calmly and explores the arena and the human, we might infer that it is coping well with environmental novelty and that the HAR seems to be at least neutral. Alternatively, if an animal runs to the human and stays nearby we might infer that it is frightened by social separation and novelty and therefore seeks reassurance from the familiar human, possibly indicating a positive HAR. At the other end of the scale a fearful animal with a poor HAR might run frantically around or stay close to the walls, urinating, vocalising and avoiding contact with the human. The varied behavioural profiles can then be related to the prevailing physiological states, thereby reinforcing their interpretation. (3) Individual testing is likely to cause separation distress in social species hitherto housed in groups (Jones and Mills, 1999). The resultant expression of social reinstatement behaviours, like running and jumping, would interfere with measurement of the HAR, but this can be ameliorated by testing the animal with other conspecifics in the arena or positioned nearby (e.g., Lyons and Price, 1987; Fell and Shutt, 1989; Goddard et al., 2000). Alternatively, repeated individual exposure to the arena before test could strengthen habituation. (4) Social rank should also be considered because the responses of individual animals may be correlated with their social ranking (Gonyou et al., 1986). (5) Finally, reliance on simple measures of activity is not sufficient to support firm conclusions, so several parameters should be recorded in the RSH-T and the data subjected to, e.g., factorial or principal components analyses.

3.3.2. Reactions to a moving human (RMH-test)

Direct approach by a human is a potentially powerful fear-eliciting event for many animals. Indeed, it has long been recognised that any type of looming stimulus induces fear (Schaller and Emlen, 1962). This phenomenon has been exploited in the RMH-test that, like the RSH-test, can be applied both in the familiar home environment and in a novel one. Other than fur animals, some version of a RMH-test has been applied to all the farmed species considered here.

3.3.2.1. RMH-test in home environment (RMH-H).

3.3.2.1.1. Procedures. Members of some social species may be individually approached in their home pen/paddock in the presence of their group mates (cattle table, refs. 2–4, 9–11; horse table, ref. 2; poultry table, refs. 4, 6–8, sheep and goats table, ref. 15). For horses and cattle, a single animal in the group is identified and then approached by an observer in a slow standard manner. The test is completed when the animal withdraws or turns away. The RMH-test is also used for animals that are housed singly or that have been isolated from their companions for the purpose of the test, but the latter situation may elicit separation distress and confounding reinstatement behaviours (see Section 3.3.1.2).

The experimenter can approach from the front (poultry table, refs. 4, 5, 8; cattle table, refs. 9–11; horse table, refs. 2, 5; pigs table, ref. 6), side (cattle table, ref. 2) or rear (cattle table, ref. 3) with his/her hands down and arms held close to the body or at 45°; he/she may also either stop and/or reach out towards the animal and touch it. The observer may also walk through a flock (poultry table, ref. 6) or back and forth in front of a cage or pen (e.g., sheep and goats table, ref. 15). These techniques involve varying types of movement and intensities of stimulation.

3.3.2.1.2. Measures. Measures include: latencies to approach and contact the experimenter and to resume eating/drinking in the observer's presence (cattle table, ref. 2); the accumulated time spent near the human (sheep and goats table, ref. 15) and within 5 cm of the food tray (pigs table, ref. 6); the distance at which the animal first shows withdrawal (cattle table, ref. 4), or other specific behaviours (poultry table, ref. 8). However, scales have also been used for poultry (ref. 4) and horses (ref. 2), where scores reveal how confident the animal is with human proximity. Implanted telemetry devices have also been used to measure heart rate during human approach, e.g., poultry table, ref. 8.

3.3.2.1.3. Discussion—value, confounding factors and motivations. The advantages of a test applied in the home environment are discussed in Section 3.3.1.1. Here though, approach by a human might resemble a situation that the animals experience every day. Therefore, this test could be particularly feasible for on-farm assessment of HAR (e.g., in farm assurance schemes), at least in some species. It is conceivable that an animal tested in its home environment might allow closer approach or physical contact than one observed in a novel test arena.

Where possible, it is important to discount or at least consider the potential impact of locomotory difficulties in any test involving approach or avoidance of a stimulus. For example, ease of ambulation might influence the responses of broiler chickens to a human walking through the shed (poultry table, ref. 6) thereby compromising assessment of the HAR. Further, the home pen should be large enough for behavioural reactions to be clearly measurable and interpretable, e.g., flight distance.

The major advantage of the RMH-H test is that it can be easily applied on farm to evaluate the HAR on a herd or flock basis. However, the nearby presence of the animal's companions could hamper standardisation and interpretation if it is disturbed by or attracted towards one or more of them. Regardless, the sensitivity of animals' responses to different handling treatments (e.g., cattle table, refs. 2, 9, 11), and reported correlations with stockperson behaviour support the validity of the RMH-H test.

To summarise, this test can yield valuable information about the HAR, though we again recommend the use of several parameters and more than one test.

3.3.2.2. RMH-test in a novel environment (RMH-T).

3.3.2.2.1. Procedures. Like many of the other unfamiliar test arenas described herein the one used for RMH-T tests may differ widely in size, design and construction materials. It might be a novel paddock (horse table, ref. 6), a corridor (poultry table, ref. 5; sheep and goats table, refs. 17, 18), a pen (cattle table, refs. 13–15), a circular runway (sheep and goats table, ref. 16), etc. Furthermore, the arenas vary in size depending on the species, the age of the animals tested, and the preferences of the various research teams. The nature of human approach can also vary tremendously. In most cases, the human approaches from

the front (sheep and goats table, refs. 17, 18; pigs table, refs. 6, 11; cattle table, refs. 12, 13, 16, 17; horse table, ref. 6; poultry table, ref. 5), but in others the human approaches from behind the animal (cattle table, refs. 14, 15; sheep and goats table, ref. 16), tries to pursue and/or touch it (cattle table, refs. 14, 16–18; sheep and goats table, refs. 14, 15) or just walks back and forth or in a circle at a constant speed (pigs table, ref. 9; sheep and goats table, ref. 13). Furthermore, in some studies the RMH-T test is preceded by a RSH-T test (pigs table, ref. 11; cattle table, refs. 13, 14; sheep and goats table, refs. 13, 14), thereby incurring the risk of carry-over effects. The duration of the test has also varied between 1 and 15 min.

3.3.2.2.2. Measures. Measures are primarily activity-related and they include: the latencies to approach or withdraw from the human, to vocalise, and to contact the experimenter (with different parts of the body); the distance at which withdrawal is first shown; the times spent looking at, close to, or being touched by or touching the experimenter; the numbers of areas of the arena entered, vocalisations, escape attempts, occasions the animal allows itself to be touched or stroked; and the animal's location. Heart rate is measured simultaneously in some studies (sheep and goats table, ref. 18; horse table, ref. 6) and plasma cortisol may be measured before and after test (sheep and goats table, refs. 16, 13).

3.3.2.2.3. Discussion—value, confounding factors and motivations. Much of the discussion in Section 3.3.1.2 of the effects of testing in a novel environment on responses in the RSH-T test also holds true for the RMH-T-test. Animals that are highly fearful of people will avoid the human even if they are motivated to explore the arena (Hemsworth et al., 1993a). Enforced exposure to a novel environment containing a moving human stimulus might be considered more frightening than if the human was standing or sitting still, although much may depend on how the human approaches. At first glance, an approach from the front with full eye contact might, all else being equal, be perceived as more threatening and intense than approach from the side or back with gaze aversion. However, approaching the animal from behind (e.g., cattle table, ref. 14) could induce a startle response (independent of any response to the human per se), and following (e.g., sheep and goats table, ref. 16) may elicit fear of pursuit. Moving steadily back and forth in front of the animal might be the least threatening procedure since in many ways it more closely resembles an everyday situation. Regardless, researchers should always specify exactly why a particular pattern of human movement was chosen and what they expect this to mean to the animal. However, if steps are taken to ensure that the animal is responding solely, or at least predominantly, to the human stimulus the RMH-T test can still yield useful information about the quality of the HAR. Compared to the RSH-T test it has the advantage that the animal is forced to react to the human stimulus. Animals not approaching due to disinterest are thus easier to discriminate from animals fearful of humans, while in the RSH-test (both in the home and test environment) the motivation to explore is likely to be a highly influential variable (cattle table, ref. 7; Marchant et al., 1997). Meaningful comparison of results across research teams and laboratories demands that a number of factors, e.g., appearance, behaviour and familiarity of human, etc., should be standardised (see Section 3.2 and elsewhere). Further, when both RSH-T and RMH-T tests are applied to the same animal a balanced order of presentation should be used in order to control for potential knock-on effects.

Though useful in an experimental setting for illuminating underlying principles, individual testing of normally group-housed animals in a novel environment may have limited relevance to some commercial situations, particularly for larger animals. The on farm applicability of RMH-T is as limited as that of the RSH-T (need for a testing arena and to move the animals). In this event, its external validity may not be high. Nevertheless, some results support the internal and external validity of the RMH-T test (cattle table, ref. 12).

3.3.3. Reactions to handling (RHd-test)

Routine management practices inevitably incur some degree of handling by humans, which can occur occasionally, regularly or intensively at certain periods, e.g., during the mating season. Such practices include: moving the individuals/groups from pen to pen, providing veterinary care, examination for heat or pregnancy, separating mother and young, taking an animal to a mating area/partner or a transport vehicle and so on. Smaller farm animals, e.g., poultry and mink, or medium size ones, such as young pigs, sheep, and fox cubs are often caught using bare or gloved hands. Here the term "handling" defines a situation where humans are physically working with the animals. However, the term "handling" is also applied to situations in which the human does not or only rarely touch the animals, e.g., when he or she simply walks in front of or behind the animals to move them in a certain direction; this is common practice in cattle, horse and pig husbandry. Studying the animals' reactions in these different handling situations can provide important information about the HAR.

Specific methods have been developed to allow the observation and evaluation of animals' reactions to handling. Evaluations can be made during everyday management routines or in specific test situations that have grown from on-farm observations. The various test situations are assigned to four main categories: (1) leading/moving, (2) capture, (3) restraint within handling facilities and (4) specific handling procedures linked to the type of animal, the imposition of painful procedures (e.g., castration, branding, etc.), therapeutic intervention (e.g., laparoscopy, vaccination, etc.), or management practice (e.g., transporting live animals).

3.3.3.1. Leading/moving.

3.3.3.1.1. Procedures. Husbandry, especially for farm ungulates, often necessitates moving animals from one point to another, e.g., to pasture, to handling facilities, to a truck or during slaughter. Observations have been made at these times (cattle table, ref. 26; Grandin, 2000; Coleman et al., 2003) as well as of the animals' reactivity to being led or moved over a certain distance (pig table, ref. 2; cattle table, refs. 26, 27, 31, 35; horse table, refs. 8, 12), in a trolley (cattle table, ref. 25) or to facilities involving aversive handling (Hargreaves and Hutson, 1990). The animals are sometimes tethered with a halter (cattle table, ref. 31; horse table, ref. 15) but generally have freedom of movement. Normally, they are tested individually but group testing has also been conducted (Syme, 1981). Test duration is generally not given though it could be used as the measured variable, e.g., when the animal or the truck has reached its destination.

3.3.3.1.2. Measures. Direct measures include the time required for the animal to move a certain distance, the numbers of vocalisations or of the times it stops, and the time spent

running. Indirect measures include: the effort the handler expends to move the animal expressed as the numbers of shouts, pushes and hits. Physiological parameters (heart rate, stress hormones, meat characteristics, i.e., lactate or glucose concentration, colour and pH) have also been measured (e.g., cattle table, refs. 26, 39).

3.3.3.1.3. Discussion—value, confounding factors and motivations. Leading/moving tests have discriminated between animals exposed to positive, negative or neutral human contact prior to testing (e.g., cattle table tests 25–27, 31) but interpretation is not always straightforward. For example, the animals might adopt different coping strategies. Thus: (a) animals that run quickly in front of the human might be expressing a fear reaction, an active coping strategy or both, (b) those that are frightened of humans might run away or remain immobile, and (c) docile animals might walk quickly or slowly depending on their motivation to explore their surroundings. Taking detailed behavioural records rather than just durations should thus enhance test validity (Boissy and Bouissou, 1988; cattle table test 31). The handlers/experimenters can also react differentially to the above animal responses, and since their experience, attitude and behaviour are likely to be influential variables standardisation is again important. Ideally, the animals' reactions should be foreseen and the handlers' correspondent responses determined prior to the test (see cattle table test 26). Additionally, the physical and social environments could be important in determining the animals' responses to being led, especially when tested in a group. In particular, the distance over which they are led and their previous experience with the test area should be controlled. Clearly, more information should be given about the precise methodology and its validity. Evaluating the repeatability of the measurement and the robustness of the test procedure is another important research priority.

3.3.3.2. Capture.

3.3.3.2.1. Procedures. Catching by hand, often followed by restraint, is a common human-contact test applied to the species considered herein, particularly poultry (table, refs. 9, 10 and Beuving and Vonder, 1978; Korte et al., 1997). The test bird is captured, removed from the home cage and either held upright or restrained on its back or side by the experimenter for a certain period. Often, the aim is to induce a tonic immobility (TI) fear reaction (Jones, 1986, 1996). In foxes, cubs or juveniles are caught by hand whereas a neck tong is used for adults, but always with a firm grip on the tail (fur animals table, refs. 14–16, 18). Manual restraint tests have been applied to fox cubs and poultry (fur animals table, ref. 17; poultry: Korte et al., 1999). Capture of larger animals, e.g., pigs, involves gripping them by the hind legs (Tanida et al., 1995; Erhard et al., 1999) though TI has also been induced by supine restraint (Hessing et al., 1993; Erhard et al., 1999). Bighorn sheep were caught by their horns after trapping (Reale et al., 2000), and cattle are often restrained using specific facilities, though Boivin et al. (1992b) and Le Neindre et al. (1995) developed a so-called ''docility test''. Here, the experimenter carries a stick and tries to restrain an isolated animal for 30 s in the corner of a test arena. In dairy cattle, a halter was placed on the animal's head when tied or after being captured within a group (cattle table, refs. 30, 31). Though rarely used, capture tests in horses involve leading the animal into a corner and catching it by the neck with a rope/halter (horse table, ref. 6, 15).

3.3.3.2.2. Measures. These test procedures embrace a wide range of measures. A common one is the time required to catch or restrain the animal. Ordinal parameters, where

behaviour is categorised into scores, have been recorded in poultry, foxes, horses and cattle (e.g., fur animals table, refs. 15, 16). In poultry the number of inductions required to induce tonic immobility and the duration of the reaction are also often recorded (poultry table, refs. 9, 10). When established groups are tested, the rankings of individual animals in repeated capture/recapture trials have been used to indicate boldness or shyness in poultry (poultry table, ref. 7) and bighorn sheep (Reale et al., 2000). Implanted telemetry devices have recorded heart rates and deep body temperature prior to, during and after capture in poultry and fur animals (poultry table, ref. 8; fur animals table, refs. 15, 16). Cardiac responses to capture were also measured in horses using external devices (horse table, ref. 6). Behavioural responses are sometimes video-recorded and analysed using scan-sampling techniques (fur animals table, ref. 15). Finally, adrenocortical responses to capture and restraint have been measured in foxes and poultry (fur animals table, ref. 14; poultry table, refs. 9, 10).

3.3.3.2.3. Discussion—value, confounding factors and motivations. Capture is a relatively common feature of farm animal husbandry, although its intensity and frequency vary across species and the type of production system. Given the marked involvement of human beings in this process the animals' reactions to capture and/or restraint can inform us about the state of the HAR.

Capture–recapture tests can differentiate animals that had received a positive handling regime from those from negative handling or control treatment groups (e.g., cattle table, ref. 31; horse table, ref. 15), as well as different genotypes (Bessei et al., 1983; Satterlee and Jones, 1997, poultry table, ref. 7). Of course, we must: (a) distinguish between the effects of variations in the HAR and the animals' coping strategies, and (b) discount locomotor difficulties. The animals' experience with the capture procedure and its consequences (neutral, negative or positive) and/or their familiarity with the experimenter can also modulate their responses to capture (e.g., Bank, 1996; fur table, ref. 14). Unless they represent experimental treatments these factors should be strictly controlled.

3.3.3.3. Restraint using 'handling' facilities.

3.3.3.3.1. Procedures. Simple manual restraint tests are often used to measure fearfulness, stress susceptibility and the HAR in smaller species, such as poultry (table, ref. 9; fur animals, table, ref. 15) and piglets (Erhard et al., 1999). Cattle or horses cannot be easily restrained by hand so special devices were developed, and are particularly useful for inspection, care and maintenance. The animals' reactions to restraint in head bails, weighing scales or crushes have been recorded during routine management practices or as a test procedure (Hearnshaw et al., 1981; Fordyce et al., 1982, 1982; Vanderwert et al., 1985; Grandin, 1993; Grignard et al., 2001; Watts and Stookey, 2000; Boivin et al., 1998b). The animal may also be tethered with a rope or halter (Boissy and Bouissou, 1988; Mateo et al., 1991; Gauly et al., 2001) or restrained in a box as an integral part of a "stress" treatment (fur animals table, ref. 18).

3.3.3.3.2. Measures. The most frequent measures are: the numbers or durations of leg, head or tail movements, escape attempts and vocalisations, and the latencies to show these behaviours. Episodes of violent struggling (Veissier et al., 1989; Watts and Stookey, 2000) and the animals' reactions (flight speed) when they exit the restraint apparatus have also been recorded (Burrow and Corbet, 2000). The behavioural reactions are often used to

construct a composite score (cattle table, refs. 32, 40, 42). Complementary neuro-endocrine, deep-body temperature and/or cardiac responses, as well as vocalisation structure are sometimes measured (e.g., fur animals table, ref. 18; Watts and Stookey, 2000).

3.3.3.3.3. Discussion—value, confounding factors and motivations. Scores of reactions to restraint are often repeatable (Grandin, 1993; Burrow, 1997) and correlated with productivity and product quality (e.g., Voisinet-Bartlett et al., 1996; Voisinet et al., 1997; Jones and Hocking, 1999; Burrow, 2001; Faure et al., 2003). Low fearfulness and/or a good HAR are generally associated with heightened performance. As expected, responsiveness varies according to previous handling experience or genotype.

Interpretation of results may be open to debate, with states such as fearfulness, temperament, lethargy and coping strategy all being evoked. As with the other tests, it is important to control (and perhaps standardise) the methods used to move the animals into the test facilities, the distances over which they have to move, and their previous experience of restraint (Hargreaves and Hutson, 1990; Grandin, 1989; Lewis and Hurnik, 1998). Furthermore, the handler's position and behaviour during testing should be adequately described (Grignard et al., 2001).

3.3.3.4. Specific handling procedures.

3.3.3.4.1. Procedures. Specific handling procedures used in particular husbandry systems have also been used as tests. For example, the reactions to milking, shearing or sham-shearing, laparoscopy, marking, tagging, branding, cleaning, brushing, standardised veterinary examination, etc. have been assessed in cattle (cattle table, refs. 36–39; Schwartzkopf-Genswein et al., 1997), sheep and goats (table, refs. 18, 20–22; Mears et al., 1999; Haresign et al., 1995; Dyckhoff, 1998), and horses (horse table, ref. 6).

3.3.3.4.2. Measures. The behavioural and physiological parameters are generally similar to those measured in the other handling tests described above (leg, head or tail movements, defence and escape behaviour, vocalisations, heart rate, cortisol). Sometimes, interactions with the handler, e.g., sniffing, licking and leaning towards him/her are measured (Dyckhoff, 1998; cattle table, ref. 36). Milk yield, residual milk (via oxytocin injection) and milk cortisol levels have also been recorded.

3.3.3.4.3. Discussion—value, confounding factors and motivations. The cows' reactions during milking and the milk cortisol levels are related to the number of negative interactions experienced during milking (see also Sections 1 and 2). These measures, as well as physiological and behavioural reactivity to veterinary procedures, also differed between animals that had received positive human contact and controls (cattle table, refs. 36, 39; Dyckhoff, 1998). However, interpretational difficulties may arise due to variations in the specifications of the milking machines, the animals' previous experience and their behavioural strategies. The sheer diversity of the test situations and their specificity to certain animals virtually preclude concise discussion of methodologies. We strongly recommend the application of additional tests of the HAR rather than reliance on 'reactivity to specific handling procedures', unless the latter forms the main research question.

3.3.4. Closing comment

The correspondence between the various tests described in Section 3.3 has rarely been comprehensively evaluated. It is also unlikely that a single test situation could cover the

broad concepts of "temperament", "fearfulness" or "docility" as defined/claimed in some studies. We need improved understanding of the mechanisms underpinning the HAR concept, e.g., general reactivity, fearfulness, coping style, gregariousness, previous experience and perception of humans, human–animal communication, etc., in order to develop simple, rapid and reliable tests that can be used to facilitate the on-farm assessment of animal welfare and to provide a platform for welfare-friendly genetic selection programmes and husbandry developments.

4. Future research requirements

The present review of ways of assessing the HAR grew from the exchange of information and ideas between European scientists with many years of experience in this field; their knowledge spans a range of species and husbandry systems. Tests were placed in one of three categories according to the nature of human involvement (stationary, moving, handling). As well as providing a general overview of the principles underpinning test development we identified the state of validation for each method, some possible confounding factors and the main technical problems that can arise. Now, we briefly discuss some current gaps in knowledge, and research requirements.

Our paper pays particular attention to the need to evaluate the animals' perception of the human stimulus and the test situation. Likely influential features include the appearance and behaviour of the human stimulus and the characteristics of the test environment. Perception can vary markedly according to species, housing and husbandry; e.g., each species has its own set of sensory and cognitive abilities. Thus, reliable scientific validation of methodologies demands a good understanding of the likely influential variables.

Some researchers are already investigating the above issues, and we refer to their studies to provide examples of areas meriting further development. We recommend that future research priorities should include: (1) clarifying animals' perception of humans by identifying the influential features of handling procedures and of human appearance, behaviour and attitude, (2) illuminating the animals' emotional and cognitive capacities in respect to human contact, (3) determining the existence, nature and intensity of positive human–animal relationships, and (4) assessing the scope for and the acceptability of genetic and/or ontogenetic modification of animals' responsiveness to humans.

4.1. Perception of influential features of humans and handling procedures

Visual cues that influence animal perception of humans (colour of clothing, facial features, spectacles, height, posture, etc.) have been studied in pigs, sheep, cattle and poultry (Jones, 1996; Rushen et al., 1999a; Hemsworth, 2003), often via preference and approach/avoidance tests. However, other potentially important cues, e.g., vocal and olfactory signals, have received much less attention, perhaps because they are more difficult to manipulate and standardise.

One difficulty is the sheer abundance and complexity of stimuli presented by a human being; many of these exert marked effects on the animals' perception and response but they are often difficult to control, not only across experiments and laboratories but also from one

stimulus person to another within experiments. Attempts to dissociate some of the cues and then present them individually or in concert could provide valuable information and lead to increased repeatability of subsequent experiments. The use of ''artificial'' human stimuli such as dummies, photographs or video images might also be very helpful. Dummies have already been used as alternatives to real people in studies of pigs, sheep and dogs (Millot et al., 1987; Miura et al., 1996; Bouissou and Vandenheede, 1995). More often, slides and videos of people have been used as test stimuli, but their effectiveness is not always clear (Kendrick et al., 1995; Vandenheede and Bouissou, 1994; Munksgaard et al., 1997; Kendrick, 1998). We propose that the reactions of all farm animal species to live humans and to dummies, slides and videos of humans should be systematically investigated, with emphasis on the dynamics of response. Using artificial representations of human beings has at least two advantages. Firstly, it enables standardisation within and between laboratories by eliminating the potentially confounding effects of differences in stature, general appearance and behaviour of real humans. Secondly, artificial stimuli lend themselves to manipulation that could, in turn, facilitate assessment of the relative importance of selected human features.

It is also necessary to determine animals' perceptions of different human behaviours or handling procedures. There are various ways. First, the animals' latency to approach an experimenter may indicate its willingness to make contact or to be handled (e.g., Erhard, 2003). Second, aversion learning enables comparison of handling procedures, e.g., raceways were used for this purpose in dairy cattle (Pajor et al., 2000) though this method required large numbers of animals. Third, preference tests have been used to evaluate the perceived aversiveness of various restraint techniques in sheep (Rushen, 1986), cattle (Grandin et al., 1994) and red deer (Pollard et al., 1994). In a Y-maze, dairy cattle preferred humans talking softly rather than shouting, but there were few detectable effects of other human-related treatments (Pajor et al., 2003). Despite the limitations (need for training, discontinuous scales, possible confounding side preferences), the preference approach merits further investigation.

Additionally, we propose that the relationships between the various tests described herein should be fully evaluated. One starting point could be the calculation of intra-individual correlations between animals' responses to a stationary human, a moving human, and to handling. The benefits of this approach are two-fold. First, it may help to establish the relative importance of some of the component features of human stimulation in complex handling situations. Secondly, the existence of strong positive correlations (high convergent validity) may indicate that relatively simple and rapid tests, such as exposure to a motionless person, could be effective substitutes for more complex tests, e.g., those involving herding, handling and/or restraint.

4.2. Human contact and the animals' emotional and cognitive capacities

Following Désiré et al. (2002) and the cognitive theory of emotion, an animal's appraisal of a human or of a situation involving human contact could generate an emotional state. Farm animals may react spontaneously to human characteristics, e.g., size, sudden approach, or they may learn to associate the presence and behaviour of all or certain humans with positive, neutral or negative consequences. Such knowledge could help them

evaluate and/or predict the emotional consequences of later human contact. We still have much to learn about the emotional and cognitive abilities of our farm animal species, but interesting findings are emerging. For instance, the random incorporation of negative human contact within a programme of positive stimulation could have equally detrimental effects on welfare as a consistent regime of negative handling (Hemsworth et al., 1987a). Interestingly too, although negative human contact was subjectively considered to increase chickens' fear of people (Gross and Siegel, 1982), application of a rough handling regime (suspension by the legs) reduced chicks' subsequent avoidance of humans (Jones, 1993). The latter finding is consistent with Levine (1958) suggestion that any type of stimulation is better than none.

Clearly, we need to determine whether or not farm animals can predict and/or control the future consequences (positive or negative) of human contact. Important questions include: (1) can animals anticipate the consequence of a future interaction with humans after regular exposure to it or do they just react to releasing stimuli? (2) To what extent can an animal generalise its knowledge of humans across situations differing in environmental novelty or in the nature of the human–animal interaction? (3) Do animals show frustration in the absence of expected rewards from their caretaker? (4) Could the presence of a human reassure animals in otherwise stressful situation, e.g., social isolation, veterinary interventions, and, if so, what are the critical features of the situation and the animals' prior experience with humans? (5) Do animals have positive expectations, e.g., food delivery, when a human enters the home pen and negative ones, e.g., unpleasant handling, when they encounter a human in a novel environment? Collectively, the generated knowledge could facilitate the interpretation of animal's reactions in a range of laboratory and on-farm situations as well as the development of new methodologies.

4.3. Positive human–animal relationships

As previously mentioned, most researchers have measured HARs at the negative end of the scale, i.e., with regard to aversive states such as fear and pain (Fig. 1). Attempts to measure responses that reflect positive HARs may require a slightly different theoretical approach. Animals can perceive human beings as neutral stimuli or sometimes associate them with rewards, such as food (Murphy and Duncan, 1977; Mac Millan, 1999; Boivin et al., 2003); such perceptions may develop through operant or classical conditioning in the form of reinforcement (Kostarczyk, 1992; Hemsworth et al., 1996b; Rushen et al., 1999a) or via non-reinforced exposure learning (Sluckin, 1972). The latter leads to familiarity simply through exposure, e.g., to a particular environment or to their companions. This may also be true for habituation to humans that are often present but that neither reward nor punish the animals (e.g., Jones, 1993, 1995a). It might even be argued that animals come to perceive humans as social partners or conspecifics (Lorenz, 1935; Sambraus and Sambraus, 1975; Kraemer, 1992; Scott, 1992) or as a source of desirable environmental stimulation (Jones, 2004). In this case, the close proximity of humans might be perceived as positive per se and/or reassuring by animals exposed to aversive events. Associating humans with rewards might increase their reassuring qualities. In measuring positive aspects of the HAR the focus shifts from avoidance to attraction (Pedersen and Jeppesen, 1990; Jones, 1993, 1995b; Hemsworth et al., 1996b; Markowitz et al., 1998; Boivin et al.,

2000). The idea that certain animals may be attracted to and develop a relationship with specific humans presupposes that they can learn about people and discriminate between them. Such discrimination has been reported in several species (e.g., Davies and Taylor, 2001; Tanida and Nagano, 1998). Appropriate methodologies and rationales for testing for discriminative ability are described elsewhere (Sluckin, 1972; Tanida and Nagano, 1998; Koba and Tanida, 2001). It is also important to establish if discrimination between humans requires reinforcement or just exposure learning.

Attraction to humans can be measured using modifications of approach-avoidance, choice or operant tests (Hemsworth and Coleman, 1998; Marin et al., 2001; Hauser and Huber-Eicher, 2004) that focus on quantifying attraction rather than avoidance. For example, one could measure the relative times spent near familiar and unfamiliar humans situated at opposite ends of a runway, or the intensity of operant responses that allow access to familiar rather than unfamiliar humans. If evidence of recognition and discrimination is found the tests could be further modified to allow assessment of the relative strength of attraction to different humans, and whether or not there is generalisation.

Determining if humans can reassure animals during aversive events requires stringent testing of the prediction that the presence of a familiar human attenuates the elicited stress responses, e.g., by comparing the relative frequency and intensity of escape attempts, immobility, distress behaviour and physiological stress responses shown in the presence or absence of a familiar human. We already know that agitation, escape, vocalisation, heart rate and cortisol secretion were lower when exposure to a (familiar) human accompanied social isolation (Price and Thos, 1980; Korff and Dyckhoff, 1997; Boivin et al., 1997, 2000), aversive handling or veterinary procedures (Korff and Dyckhoff, 1997; Waiblinger et al., 2004), but similar tests need to be applied across the range of farm animal species and husbandry systems. Another valuable approach might be to test the hypothesis that stress responses would be more pronounced when a familiar rather than an unfamiliar human leaves the animal alone in a test pen (see Boivin et al., 2000, 2001 for sheep). Currently, the fact that evidence of attachment/reassurance is apparent mainly in studies focussing on farm ungulates that were artificially fed by humans at an early age limits our conclusions (Kraemer, 1992).

4.4. Genetic and ontogenetic effects on human–animal relationships

Domestication has undoubtedly increased docility but many farm animals are still frightened of humans (Jones, 1996; Boissy et al., 2002). Firstly, therefore, it is important to develop husbandry practices that effect rapid, efficient and long-term improvements in the animal's perception of humans. Secondly, many studies demonstrated a genetic influence on the HAR, thereby indicating the value of further genetic selection (e.g., Boissy et al., 2002; Jones and Hocking, 1999; Faure et al., 2003). A genetic strategy requires the continued development of reliable test procedures and selection criteria that can be applied easily and rapidly to large numbers of animals. The earlier a selection test can be applied the greater is its practicality, so we should measure animals' responses to humans at different stages of development, using the same battery of tests. Reactivity can be affected by different genes throughout ontogeny (Nol et al., 1996), and this demands firm evidence of the predictive value of neonatal measures concerning later responsiveness.

Next, many researchers have tried to improve the HAR by providing positive human contact when the animal is young and/or during a presumed 'sensitive period' (reviewed by Burrow, 1997; Boivin et al., 2003). Such periods seem apparent in some species but are not consistently demonstrated (Jones and Waddington, 1993; Lansade et al., 2004). Sensitive periods in early life could reflect a balance between familiarisation towards conspecifics and the development of fear of strangers (Sluckin, 1972; Scott, 1992), but any period of reorganisation, associated with stress, could also be one of special sensitivity to external stimuli (Bateson, 1979). Such hypotheses are largely untested in farm animals other than chickens. Further investigation is clearly required.

Finally, we should determine if a noxious experience with a human early in life will henceforth shape the animal's responses to all humans or if its responses are specific to the 'nasty' human or similar ones. To our knowledge, this question has been poorly investigated.

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