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Assessing pig body language: Agreement and consistency between pig farmers, veterinarians, and animal activists¹

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ABSTRACT: This study investigates the interobserver and intraobserver reliability of qualitative behavior assessments (QBA) of individual pigs by 3 observer groups selected for their diverging backgrounds, experience, and views of pigs. Qualitative behavior assessment is a “whole animal” assessment approach that characterizes the demeanor of an animal as an expressive body language, using descriptors such as relaxed, anxious, or content. This paper addresses the concern that use of such descriptors in animal science may be prone to distortion by observer-related bias. Using a free-choice profiling methodology, 12 pig farmers, 10 large animal veterinarians, and 10 animal protectionists were instructed to describe and score the behavioral expressions of 10 individual pigs (*Sus scrofa*) in 2 repeat sets of 10 video clips, showing these pigs in interaction with a human female. They were also asked to fill in a questionnaire gauging their experiences with and views on pigs. Pig scores were analyzed with Generalized Procrustes Analysis and effect of treatment on these scores with ANOVA. Questionnaire scores were analyzed with a χ^2 test or ANOVA. Observers

achieved consensus both within and among observer groups ($P < 0.001$), identifying 2 main dimensions of pig expression (dim1: playful/confident-cautious/timid; dim2: aggressive/nervous-relaxed/bored), on which pig scores for different observer groups were highly correlated (Pearson $r > 0.90$). The 3 groups also repeated their assessments of individual pigs with high precision ($r > 0.85$). Animal protectionists used a wider quantitative range in scoring individual pigs on dimension 2 than the other groups ($P < 0.001$); however, this difference did not distort the strong overall consistency of characterizations by observers of individual pigs. Questionnaire results indicated observer groups to differ in various ways, such as daily and lifetime contact with pigs ($P < 0.001$), some aspects of affection and empathy for pigs ($P < 0.05$), and confidence in the validity of personal QBA descriptors ($P < 0.02$). The main finding of this study is that despite such differences in background and outlook, the 3 observer groups showed high interobserver and intraobserver reliability in their characterizations of pig body language. This supports the empirical nature of QBA in context of the wider anthropomorphism debate.

Key words: animal psychology, animal welfare, anthropomorphism, free-choice profiling, pig, qualitative behavior assessment

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INTRODUCTION

The study of animal welfare is a fast-growing field, stretching across natural and social science disciplines. Interdisciplinary research approaches could enable integration of different ways of assessing animal behavior and welfare. This paper is concerned with a method for qualitative behavior assessment (QBA), which, although primarily relying on human perception, is intended for use as an assessment tool in animal science. Observers are asked to characterize the demeanor of animals as

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an expressive body language, using descriptors such as relaxed, anxious, or content. Such terms refer to an animal's experience and could potentially provide useful information about its welfare state (Wemelsfelder, 1997). Investigating the scientific validity of QBA, a range of studies have found high interobserver and intraobserver reliability in pigs and other species, and reported good and meaningful correlations with ethogram-based behavior measures, and physiological indicators of stress (e.g., Wemelsfelder et al., 2000, 2001, 2009; Rousing and Wemelsfelder, 2006; Napolitano et al., 2007; Minero et al., 2009; Stockman et al., 2011). Recent reviews of research relying on observer judgments of animal behavior found such judgments to be no less valid than other measures and to make specific and valuable contributions to research (Meagher, 2009; Whitham and Wielebnowski, 2009).

An important concern in using observer judgments for the benefit of science is the potential distortion of these judgments by the background, experience, and attitudes of an observer (Meagher, 2009). The aim of the present study was to address this concern, using a free-choice profiling (FCP) methodology developed in previous QBA studies (Wemelsfelder et al., 2001). This method allows observers to generate their own descriptors, making it possible to investigate whether observers who diverge in their outlook on pigs also differ in the way they judge the behavioral expressions of pigs.

MATERIALS AND METHODS

All procedures involving animals were governed by the animal ethics committee at the Scottish Agricultural College and were conducted in accordance with the requirements of the UK Animals (Scientific Procedures) Act 1986.

Animals, Housing, and Generation of Video Recordings

Observation of animals was from video footage obtained during a previous study, showing 10 individual female growing pigs in interaction with a human female (Wemelsfelder et al., 2001). These pigs were of Large White \times Landrace breed and around 17 wk of age. Pigs were all in good health and had not previously been used for any other study or treatment. They were kept in a well-ventilated pig house with temperature maintained between 17 and 20°C. Within this house (containing no other pigs), they were confined by an enclosure consisting of 2 identical, directly adjacent, 4- \times 4-m pens. One pen was designated as a test pen. Pens had solid walls and were visually isolated from each other by a 2-m-high solid partition. A door in this partition allowed pigs to be moved between pens. Each pen contained a deep layer

of straw with some fresh oak tree branches (\pm 50 cm in length, 5 cm diam.), a drinker bowl, and food trough. To achieve maximum habituation to both pens and being moved between pens, pigs were housed in each pen on alternate days for 1 wk. Throughout the study, pigs were provided feed for ad libitum intake appropriate to their age. Pens were cleaned and replenished with fresh straw and branches daily.

In wk 2, pigs were trained daily to be separated from pen mates and spend time alone in the test pen adjacent to the home pen. In wk 3, pigs were led from their home pen into the test pen, singly and in random order (determined by randomly drawing pig numbers from a list). Each pig had the opportunity to interact for 7 min with a human female crouching in the center of the test pen. This person was familiar to the pigs from previous training sessions but had never stayed in their pen for any length of time. To elicit a spontaneous flow of expression in pigs, the person consistently responded only to interactions initiated by the pig, engaging naturally by using a few simple rules. If the pig looked at the person or approached her, she would extend a hand. If the pig stayed close by and initiated further interaction, she would pat its nose, head or back, or extend her face toward it. If the pig continued to make contact, she would proceed to gently stroke or rub it. If the pig became aggressive and inclined to bite, she would push it off and remain passive until the pig again initiated interaction. After 7 min, the pig would be returned to the adjacent home pen.

For each of the 10 pigs, interactions were filmed, using a digital Panasonic NV-DX1E camcorder (Panasonic UK, Berkshire, UK). The camcorder was mounted on a tripod at eye level and positioned at the narrow side of the test pen, facing the interactor. A microphone was suspended above the head of the interactor to provide the recordings with sound. The resulting digital recordings were edited in a professional studio to produce 2 high-resolution S-VHS tapes. Both tapes contained 7-min clips of the same 10 pigs but presented in a different (randomly selected) order. To mark the end of the 4-min observation period for observers (see below), a text stating "4-minutes" was digitally imposed on the pig footage of each clip.

Observer Selection, Instruction, and Assessment Procedures

The aim was to select observer groups with different professional and idealistic outlooks on pigs, and different levels of experience interacting with pigs. Three groups were selected: pig farmers, large-animal veterinarians, and animal protectionists. Identifying observers from these groups was constrained by several factors. Address lists for such groups are not readily available due to privacy protection laws. Recruits would need to live and work in

the larger Edinburgh (UK) area, should not be familiar with the QBA research approach, and be willing to commit to 3 full evening sessions spread out over several months. Given these requirements, random recruitment of observers from larger target populations was not feasible. Instead, a nonprobability sampling technique, called “snowball sampling,” was used, relying on existing social and professional networks to reach suitable respondents (Babbie, 2004). A main limitation of this approach was that respondents could not be considered representative of the target populations (e.g., Scottish pig farmers). However, our study did not intend to address observer bias at the population level. Instead, it more modestly and specifically sought to investigate, if QBA observers have well-defined diverging backgrounds, does this then lead to diverging assessments of pig behavioral expression? Thus, 12 pig farmers (9 male, 3 female) were recruited through a Southern Scotland pig discussion group, 10 large animal, nonpig veterinarians (6 male, 4 female) through the University of Edinburgh, and 10 animal protectionists (8 male, 2 female) through their membership of a mainstream Scottish animal protection society. Given the difficulty of finding suitable observers, no further criteria (e.g., a balance of gender or age) were used.

Each observer group met 3 times, separately from the other groups, over a period of several months at a location familiar to them. To ensure independence of individual assessments within a group, silence was strictly maintained during assessments and observers were told to refrain from any discussion regarding their descriptors or ratings throughout the entire study. These measures were considered sufficient, considering that any inadvertent reduction of variance within a group was more likely to accentuate than reduce variance among groups and thus work against the hypothesized reliability of QBA, rather than artificially boosting it. The 3 groups were all given the same information and instructed to follow the same assessment procedures. At the first meeting, observers were told that this study was part of a research program investigating the reliability of qualitative assessments of animal behavioral expression but were not told of the existence of other observer groups. Behavioral expression was defined as “style of interaction,” describing how an animal behaves as opposed to what it does—or in more popular terms, as a “body language” apparent in the entire demeanor of an animal. It was explained that an important characteristic of this study was that observers would be asked to generate their own qualitative descriptors for scoring the expressions of pigs. At subsequent meetings, the principles of QBA, as well as the FCP procedures facilitating this process, were outlined to observers in detail. To watch the video recordings of pigs, observers were seated in front of a widescreen TV monitor.

The FCP procedures used were developed in food science (Oreskovich et al., 1991) and adapted by Wemelsfelder et al. (2001) for use in animal science. Free-choice profiling generally consists of 2 phases. In phase 1, observers focused on generating personal descriptors for pig expressions assessed from video. An experimenter then added visual-analog scales (125 mm in length, ranging from “minimum” to “maximum”) to these descriptors. In phase 2, observers used their personal rating scales to quantitatively score the expressions of the pigs from the same video clips. On d 1, observers watched each of the 10 pigs on tape 1 for 4 min. After the signal, they used the remaining 3 min of the clip to write down terms that best summarized the expressive qualities of that pig’s behavior. Thus, each observer compiled a set of terms that described the expressive repertoire of the 10 pigs. On d 2, several weeks later, the observers, as before, watched each pig on tape 1 for 4 min. After the signal, they scored each pig on each of their personal terms by ticking the line at an appropriate point between “minimum” and “maximum.” On d 3, several weeks after d 2, observers repeated this process by scoring the same 10 pigs in different order from tape 2.

Several months after d 3, observers were sent a questionnaire, consisting of 5 parts (see Appendix). Part 1 asked them to reflect on their experience of generating and using qualitative descriptors for pig behavioral expression in the recent FCP study. Part 2 asked observers to rate relevant details of their lives. Parts 3, 4, and 5 gauged the affectionate disposition of the observers toward pigs, amount of empathy with pigs, and view of pigs’ cognitive abilities. Methods of analysis and outcomes of this questionnaire are given in the appendix. Differences in responses found among observer groups confirmed that establishment of 3 distinct observer groupings as envisaged had been achieved.

Statistical Analysis

Data Processing. At the end of the study, each of the 32 observers had produced 2 sets of scores for the same 10 pigs on their personal rating scales. These scores were determined by measuring the distance in millimeters between the left “minimum” point of the scale and the point where the tick of the observer crossed the line. The 2 score sets were entered together into one data matrix for each individual observer, with each matrix defined by total number of pigs (2 times 10, numbered as 1 to 20) and number of terms used by a particular observer. Thus 32 observer data matrices were obtained for analysis.

Computation of Consensus Within and Between Observer Groups. The statistical procedures described in this section consist of a complex series of calculations. These were integrated into a single program by E. A.

Hunter. This program can, with some training, be run by statistical nonexperts and is available without cost from F. Wemelsfelder.

Interobserver agreement within and between observer groups was investigated using a multivariate statistical technique that does not depend on the use of fixed variables, called Generalized Procrustes Analysis (GPA; Gower, 1975; Oreskovich et al., 1991). Generalized Procrustes Analysis can be thought of as a pattern matching mechanism, assuming that even if observers use different variables (terms) for measurement, the distances between samples (pigs) will be comparable because the samples are the same. Each data matrix is regarded as a multidimensional configuration with as many dimensions as it has terms, on which pigs are located through their scores. Equidimensionality of configurations is achieved by adding columns of 0s to individual matrices to match the matrix with the largest number of terms. Configurations are then matched through a series of iterative transformations (translation, rotation/reflection, and scaling) but maintaining relative intersample distances within each configuration. The mean of these transformed configurations is taken and thought of as the “consensus profile.” The “goodness of fit” of the consensus profile is quantified by the Procrustes Statistic (PS), which gives the percentage of variation among observer configurations explained by the consensus [see Wemelsfelder et al. (2000) for a more detailed explanation of GPA computation steps]. A consensus profile was calculated for each of the 3 observer groups separately (referred to as “separate analyses”) and all observers joined together as 1 group (“joined analysis”).

The significance of these consensus profiles was evaluated using a randomization test (Wakeling et al., 1992). Original observer data matrices were analyzed in randomized form 100 times and mean and standard deviation of the ensuing 100 PS values were calculated to reflect a random association among matrices. A 1-tailed Student-t-test ($n = 100$, $df = 99$) was used to determine whether the consensus PS differed significantly from this randomized PS. A probability of $P < 0.001$ was taken to indicate that the consensus profile was a meaningful feature of the data set and not a statistical artifact. Principal Coordinate Analysis (PCO) of PS values for all possible pairs of observers (i.e., the distances among transformed observer configurations) made it possible to map observers onto a 2-dimensional “observer plot.” Using robust methods (i.e., not influenced by outliers), PCO estimates the center of distributions of observers together with a standard deviation and draws a 95% confidence region. Observers lying outside this region were potentially outliers (Gains and Thomson, 1990) and possible reasons for their greater distance from the consensus

were considered. Generalized Procrustes Analysis was rerun without these observers to investigate whether and how their data affected the consensus profile.

Interpretation of Consensus Profiles. Generalized Procrustes Analysis transforms individual observer configurations into 1 multidimensional consensus profile, independently of any interpretative judgment of the observers’ terms. This consensus profile is defined in terms of its geometrical properties and has no semantic connotations attached to it. A first step toward interpretation was to determine the main dimensions of the consensus profile explaining most of the variation through Principal Component Analysis (PCA). This produces 1 or more 2-dimensional “pig plots” with a SE ellipse indicating the reliability of the position of each pig on the main consensus dimensions. The second step was to confer semantic meaning on to those dimensions by correlating their coordinates with those of each of the 32 original individual data matrices. This analysis resulted in 32 two-dimensional “word charts” (1 for each observer). In each chart, all terms of a particular observer are correlated to the first 2 (or third and fourth) principal dimensions of the consensus profile. The greater the correlation of a term with a dimension, the more weight it has as a descriptor for that dimension.

Comparison of these word charts is as important a measure of agreement as the PS. The question is whether meaningful semantic concurrence can be detected among individual observer word charts in their alignment of descriptors along consensus dimensions. In principle, it is possible to find a significant consensus profile that semantically makes little sense. However, if alignment of terms across observer word charts does make sense, a third and final step of interpretation is for the experimenter to summarize this information into 1 or more labels for the main consensus dimensions. This interpretative role is entirely “posthoc” and plays no role in the computation of the consensus profile. The strength of GPA is that it preserves semantic information as part of the analysis of object-based data sets, independently of the interpretation of that information by the experimenter. This makes it possible to investigate whether or not observers apply their qualitative vocabulary in similar ways to characterize animals.

Comparing Levels of Agreement and Variation Between Observer Groups. From these procedures, variables emerge describing the consensus within each observer group, and through joined analysis, also describing the consensus among all observers as a single group. Comparing these variables (Procrustes Statistics, observer plots, pig plots, and word charts) allows assessment of whether and how observer groups varied in their judgments of pigs.

In addition, GPA provides information on the variation from the consensus that exists among observers, allowing a more detailed examination of the consistency of their assessments. This information can best be obtained from the joined analysis of all 3 groups, as this allows us to compare and contrast the variation within groups with that between groups as part of 1 GPA analysis. Thus, we assessed: 1) whether or not observer groups differed in the overall variation from the (joined) consensus profile [input: consensus residuals for individual observers (non-normal distribution); analysis: Kruskal-Wallis 1-way ANOVA; treatment = group]; 2) whether or not groups differed in the scores they attributed to pigs on the main (joined) consensus dimensions, using a model that controls for within-group and within-pig variation [input: GPA pig scores (normal distribution); analysis: ANOVA; treatment = group/person + pig + group \times pig. To take into account that each pig was assessed twice, the analysis was blocked for pig repeat, hence $n = 10$]; and 3) whether or not groups differed in the variance ratio (F-statistic) of the scores they attributed to pigs on the (joined) consensus dimensions (ANOVA as under 2, F-statistics for “pig stratum,” restrictions applied to obtain F-statistics for separate groups in joined analysis). The F-statistic for the pig scores of a group is obtained by dividing the mean square of those scores (i.e., meaningful variation among pigs) by the amount of residual variation among those scores (i.e., random variation among observer assessments) and thus provides information on the ability of that group to discriminate among pigs.

Computation of Intraobserver Reliability. The extent to which observer groups were able to repeat their qualitative assessments of the 10 pigs was determined by comparing data from tape 1 and tape 2. It would not be appropriate to analyze data from the 2 tapes separately and then correlate the resulting pig scores, because the consensus dimensions of these analyses may differ. Rather, data from the 2 tapes should be entered into the same data matrix for each observer (see “data processing”) so they are part of the same GPA/PCA analysis and can be correlated relative to the same dimensions. Pearson correlations were used, provided pig scores were distributed normally. Intraobserver reliability was determined for observer groups analyzed both separately and together.

RESULTS

Interobserver Reliability

Consensus Profiles. Table 1 shows that for both separate and joined analyses, the consensus profile explains a greater percentage of variation among observer assessments than the mean of 100 randomized profiles ($P < 0.001$), indicating significant observer agreement both

within and between the 3 observer groups. Comparison of PS values and associated variance and t-values indicates similar levels of consensus for the 3 observer groups, reflected in equivalent outcomes for the joined analysis. In addition, the 3 groups show no difference in level of overall variation from the joined consensus profile (Kruskal-Wallis 1-way ANOVA; $H_2 = 2.65$, $P = 0.27$).

Figures 1a to 1d show the observer plots for separate and joined analyses of the observer groups. Separate observer groups all show some outliers. Pig farmer outliers 7 and 8 (Figure 1a), and veterinarian outliers 1 and 6 (Figure 1b) appear again as outliers (numbers 7, 8, 13, and 16, respectively) in the observer plot for the joined analysis (Figure 1d). Inspection of the word charts of these observers (data not shown) suggests that what may have set them apart from other observers is that they did not make effective use of the second consensus dimension to differentiate among pigs. Although observer groups may collectively identify certain consensus dimensions, it does not mean all observers use these dimensions effectively. However, reanalysis without outliers did not markedly alter GPA outcomes (data not shown). The joined analysis observer plot does not show greater distance among observer groups than within these groups, indicating equal closeness of these groups to the consensus.

Consensus Dimensions. Table 2 shows the percentage of variation among pigs (**root %**) accounted for by the first 3 consensus dimensions of the separate and joined analyses, indicating that the first 2 dimensions absorb most of the variation among pigs and are worth investigating further (for interpretation of these dimensions, see below). The dimensions identified by the 3 observer groups were generally of similar strength, with the animal protectionists showing a slightly weaker first dimension and a slightly stronger second dimension than the other 2 groups. Table 2 also shows the F-statistics for these dimensions, which are all significant at $P < 0.001$, indicating good overall ability among observer groups to identify dimensions of pig expression. However, veterinarians show somewhat reduced F-values relative to the other groups,

Table 1. Procrustes Statistic for separate and joined analyses of observer groups

Observer group	Consensus Procrustes Statistic	Mean randomized Procrustes Statistic ¹ \pm SD	Student's <i>t</i> (df = 99)
Pig farmers	71	41 \pm 0.63	46***
Veterinarians	69	39 \pm 0.77	35***
Animal protectionists	76	51 \pm 0.71	36***
Joined observers	69	38 \pm 0.24	96***

*** $P \leq 0.001$

¹Mean of 100 Procrustes Statistic values obtained through 100 Generalized Procrustes Analysis of randomized data matrices.

particularly on the first dimension. Closer inspection of ANOVA outputs (data not shown) indicates this to be due not to the ability of veterinarians to discriminate between pigs (i.e., the height of the mean square of their pig scores) but to their agreement in doing so (i.e., the residual variation between pig scores).

While investigating whether or not observer groups differed in their characterization of individual pigs, we found no effect of group on mean individual pig scores for the first consensus dimension of the joined analysis (ANOVA; $F_{18,261} = 1.17$; $P < 0.29$) but a significant effect for the second dimension (ANOVA; $F_{18,261} = 3.52$; $P < 0.001$). Animal protectionists, on average, attributed more extreme scores (i.e., more for positive scores and less for negative scores) to the 10 pigs than the 2 other groups, suggesting that they discriminated among pigs more effectively on this dimension

(characterized as aggressive/nervous to relaxed/bored, see below) than the other groups. If this was the case, one would also expect animal protectionists to have a greater variance ratio (F-statistic) for the “pig” stratum of this ANOVA. Table 2 shows this is indeed the case and closer inspection of the ANOVA output indicates this greater value to be due to a greater mean square of pig scores for animal protectionists than for the other groups. Thus, animal protectionists perceived a stronger second dimension and also used this dimension more effectively to discriminate among pigs than the other 2 observer groups. However, quantitatively, this difference was small and did not distort the overall consistency of the characterizations of individual pigs by observers.

A further test of observer consistency is to correlate the scores attributed to individual pigs on the consensus dimensions by the 3 observer groups. To maintain

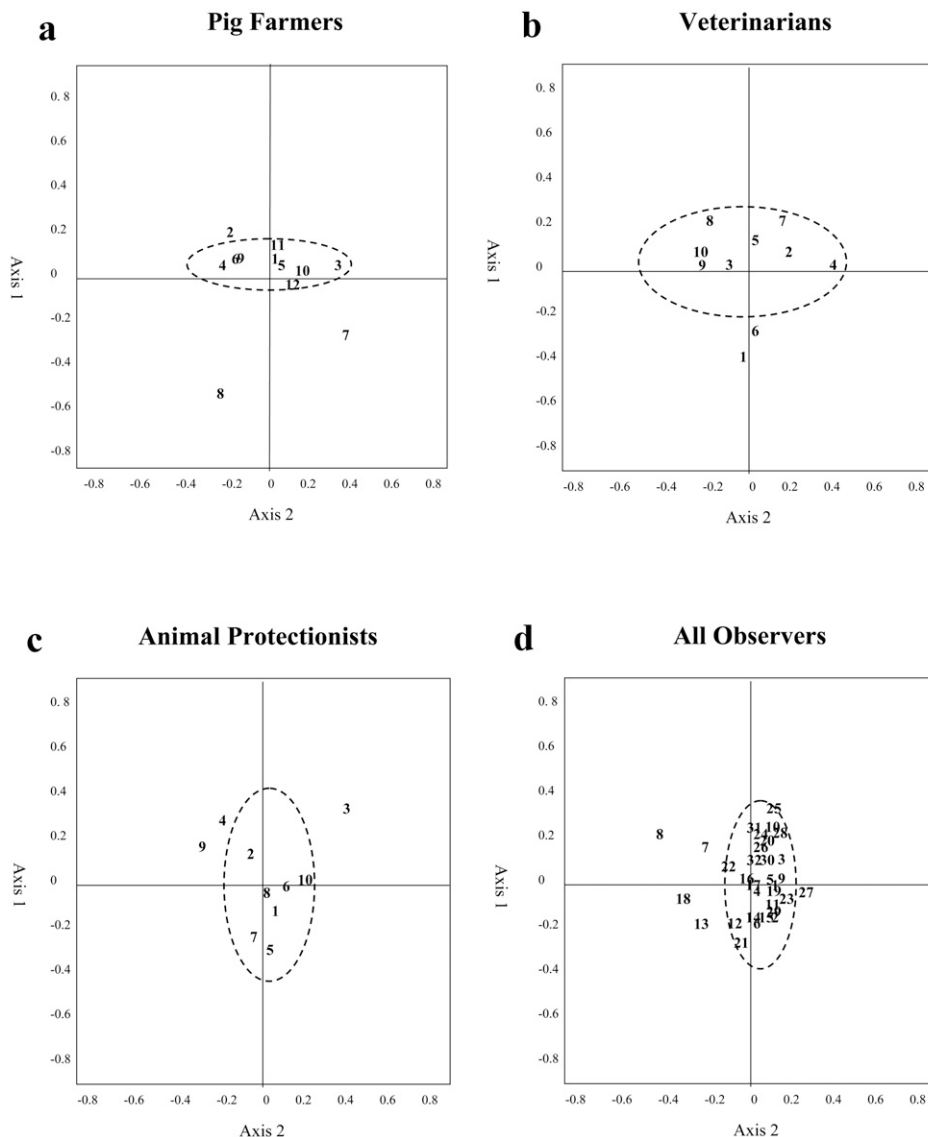


Figure 1. Observer plots for different observer groups. Axes reflect Principal Coordinate Analysis scaling values for relative observer distance. Numbers denote individual observers. The ellipse represents a 95% confidence region of what may be considered the “normal population” of observers. Observers falling outside the region are considered outliers.

maximum independence of these pig scores, for this test we used pig scores taken from the separate analyses of observer groups. The Pearson correlations among these pig scores are extremely high for both dimension 1 and 2, ranging from 0.91 to 1.00 (all $P < 0.001$). These results indicate that the 3 observer groups ranked the observed pigs in virtually identical ways and confirm the strong overall consistency of their assessments. In addition, we correlated the pig scores of each observer group to the scores obtained in a previous study for the same pigs by an observer group consisting of 9 graduate science students, most of whom had experience in observing animals, but not pigs. These scores were obtained by calculating the average value for scores from 3 repeat assessments of the 10 pigs: 2 video assessments (using the same videos as the present study) and 1 live assessment, from which the video footage was derived (for details, see Wemelsfelder et al., 2001). These scores correlated very highly to those from the current study, with r -values ranging from 0.92 to 0.97 (all $P < 0.001$).

Interpretation of Consensus Dimensions. For each observer, 2 word charts were generated, 1 by analyzing groups separately and 1 by joined analysis. Visual comparison of “separate analysis” and “joined analysis” charts for each observer showed the positions of their terms in these charts to be practically identical. The implication is that the consensus dimensions identified by separate groups were left virtually unaffected by joined analysis with other groups, providing further evidence for the strong concurrence of assessments across observer groups. To avoid cumbersome repetition, only word charts generated by joined analysis will be discussed further.

Figures 2a to 2c show the word charts of a farmer, veterinarian, and animal protectionist (who are observers 9, 14, and 24, respectively, in the joined analysis observer plot in Figure 1d). From these particular word charts, the first consensus dimension appears to characterize pigs as ranging from playful/confident to cautious/nervous, and the second dimension characterizes them as ranging from curious/excitable/nervous to relaxed/bored. These 2 dimensions interact to create 4 quadrants of pig expression, characterizing observed pigs as either positive mood/high arousal (playful/excitable), positive mood/low arousal (content/relaxed), negative mood/high arousal (nervous/stressed), or negative mood/low arousal (bored/indifferent).

These characterizations are based on just 3 examples; however, they are borne out by the larger picture provided by all observer word charts for the joined analysis. For all 32 observers (grouped both in separate categories and added together), Table 3 lists which 2 terms of their vocabularies show the greatest positive and negative correlations with the 2 consensus dimensions of the joined analysis. From these term groupings, a common pattern for judging the expressions of the pigs

emerges. The presence of different descriptors (e.g., confident, playful, aggressive, bold, lively, inquisitive, as positive descriptors for dimension 1 under “all observers”) does not so much reflect a lack of agreement among observers, as it reflects their focus on subtly different, complementary aspects of a particular style of interaction. It does appear that different observer groups favor particular terms. The term “aggressive,” for example, figures prominently in the pig vocabularies of the farmers, while “lively” only features in that of the animal protectionists. Despite such (small but interesting) differences, there clearly is substantial coherence in the meaning of descriptors used by the different groups. All 3 observer groups characterize dimension 2 with descriptors that differentiate positive and negative mood as characterized by dimension 1, thus creating the 4 quadrants of expressive meaning described above.

Taking into account terms frequently used by observers, and the larger semantic pattern emerging from Table 3, the first consensus dimension was labeled as ranging from “playful/confident” to “cautious/timid,” and the second as ranging from “aggressive/nervous” to “relaxed/bored.” These labels will be adopted in the further presentation and discussion of results below.

Intraobserver Reliability

Figure 3 shows the pig plot of the joined analysis, with suffixes a and b indicating tape 1 and tape 2 repeat assessments of individual pigs. The SE of the position of individual pigs on the plot is small and so this position reliably characterizes the coordinates of each pig on the 2 consensus dimensions. Dimensions 1 and 2 explain 61% and 16% of the variation among pigs, respectively, giving a total of 77% explained. This variation in behavioral expression can be interpreted semantically through a comparison of the word charts as discussed above. Thus, for example, pig 10 could be regarded as playful, confident, and somewhat aggressive, pig 8 as still confident but both

Table 2. Percentage of variation (root %) accounted for by consensus dimensions 1 to 3 of separate and joined analyses, and variance ratio (F) for the “pig” stratum from ANOVA of pig scores ($df = 9$) on each of these dimensions

Observer group	Consensus dimension					
	1		2		3	
	Root %	F_9^1	Root %	F_9	Root %	F_9
Pig farmers	64.6	61.52	14.0	32.07	4.3	25.14
Veterinarians	67.8	33.48	14.5	26.99	4.0	18.75
Animal protectionists	51.8	67.61	19.0	37.70	5.2	26.80
Joined observers	61.2	149.28	15.9	95.81	4.1	69.13

¹All F -values in this table $P < 0.001$

more cautious and more relaxed than pig 10, and pig 3 as more cautious, timid, and nervous than the other pigs.

The repeatability of these assessments can be determined by comparing and correlating tape 1 and tape 2 pig scores. Figure 3 indicates that the a- and b-scores of the pigs appear in close vicinity to each other, suggesting high repeatability on both consensus dimensions. This is confirmed by the Pearson correlations between tape 1 and tape 2 scores for both the joined analysis and separate analyses, which range from 0.86 to 0.99 (all $P < 0.001$).

Some observer groups showed a slight order effect in their assessments. Animal protectionists, on average, rated the pigs as 4% (of the distance between the least and greatest scores) more playful/confident on tape 2 than on tape 1 (2-tailed paired Student-t; $t_9 = 3.64$, $P < 0.01$), a tendency also observed in pig farmers ($t_9 = 2.04$, $P < 0.07$) and in the joined analysis of all observers ($t_9 = 2.19$, $P < 0.06$). However, this difference was too small to significantly alter the characterizations of individual pigs (Figure 3).

DISCUSSION

The results of this study demonstrate that 3 observer groups specifically selected to differ in professional background, amount of contact with pigs, and outlook on pigs, showed a high degree of interobserver and intraobserver reliability in their qualitative assessments of pig body language. Using FCP methodology, 12 pig farmers, 10 large animal veterinarians, and 10 animal protectionists showed significant agreement both within and between observer groups, and repeated their assessments of the 10 observed pigs with high precision. Levels of data resolution were high for each observer group, with the consensus profiles of separate and joined analyses explaining between 69 and 76% of the variation among pigs. Accordingly, observer terminologies correlated strongly to the principal dimensions of these consensus profiles and were transformed from a loose collection of terms into a structured and meaningful framework for characterizing the behavioral expressions

Table 3. Terms (2 for each of 32 observers, grouped both in separate categories and added together) that showed greatest positive and negative correlations with Dimensions 1 and 2 of the consensus profile of the joined analysis. Values in parentheses give number of observers using that term, unless used by 1 observer

Observer Group	Positive correlation with Dimension 1	Negative correlation with Dimension 1
Pig farmers	Confident (5), playful (5), aggressive (2), dominant (2), assertive, forceful, rough, bold, fearless, interactive, excited, friendly, relaxed, cheeky	Timid (4), hesitant (3), cautious (2), wary (2), fearful (2), frightened, scared, nervous, watchful, reluctant, shy, bashful, distracted, uninterested, bored, talkative
Veterinarians	Playful (5), confident (4), bold, assertive, aggressive, dominant, vigorous, boisterous, enthusiastic, inquisitive, interested, friendly, comfortable	Cautious (4), apprehensive (3), unsure (2), nervous (2), shy (2), reserved, anxious, avoiding, uncomfortable, hesitant, reluctant, concerned
Animal protectionists	Playful (6), lively (3), confident, bold, boisterous, domineering, frisky, feisty, adventurous, inquisitive, interested, attentive, gregarious	Cautious (6), wary (3), shy (3), timid (2), hesitant, reticent, intimidated, anxious, scared, indecisive
Joined observers	Playful (16), confident (10), dominant (4), aggressive (3), bold (3), lively (3), assertive (2), boisterous (2), inquisitive (2), interested (2), friendly (2), interactive, adventurous, vigorous, enthusiastic, forceful, rough, fearless, excited, frisky, feisty, cheeky, attentive, gregarious, comfortable, relaxed	Cautious (12), timid (6), shy (6), hesitant (5), wary (5), nervous (3), apprehensive (3), unsure (2), reluctant (2), fearful (2), anxious (2), scared (2), frightened, intimidated, uncomfortable, avoiding, watchful, concerned, reticent, reserved, bashful, distracted, uninterested, indecisive, bored, talkative
Observer group	Positive correlation with Dimension 2	Negative correlation with Dimension 2
Pig farmers	Aggressive (4), domineering, playful, boisterous, frisky, persistent, curious, interested, corresponding, enjoyment	Content (2), happy (2), friendly (2), calm, relaxed, pleasant, gentle, docile, placid, casual, exploring, confident
Veterinarians	Nervous (5), agitated, frustrated, unsettled, fearful, wary, timid	Bored (3), shy (2), uninterested, indifferent, quiet, wary
	Active (2), alert (2), aggressive, antagonistic, dominant, tactical, excited, excitable	Relaxed (3), calm, placid, gentle, comfortable, affectionate, content, trusting, affection seeking, happy, confident, exploratory
Animal protectionists	Cautious (2), nervous, agitated, restless, upset, uneasy, unsure, insecure, afraid	Disoriented, lethargic, submissive
	Excited (2), belligerent, alert, boisterous, lively, reactive, interested, determined, persistent	Relaxed (4), laid back, calm, peaceful, equable, docile, ambling, friendly, affectionate, inquisitive, independent
Joined observers	Nervous (2), jumpy (2), skittish (2), tense (2), agitated, unsure	Phlegmatic, tired, passive, disinterested, easily distracted, preoccupied
	Aggressive (5), excited (3), alert (3), boisterous (2), interested (2), dominant (2), persistent (2), active (2), playful, lively, frisky, excitable, reactive, antagonistic, tactical, belligerent, determined, curious, corresponding, enjoyment	Relaxed (8), calm (3), content (3), friendly (3), happy (3), gentle (2), docile (2), placid (2), affectionate (2), confident (2), exploratory (2), pleasant, laid back, ambling, casual, peaceful, quiet, equable, trusting, affection seeking, comfortable, independent, inquisitive
	nervous (8), agitated (3), jumpy (2), skittish (2), tense (2), unsure (2), restless, frustrated, unsettled, insecure, uneasy, wary, timid, upset, afraid, fearful	Bored (3), shy (2), disinterested, uninterested, easily distracted, preoccupied, disoriented, indifferent, wary, passive, phlegmatic, lethargic, tired, submissive

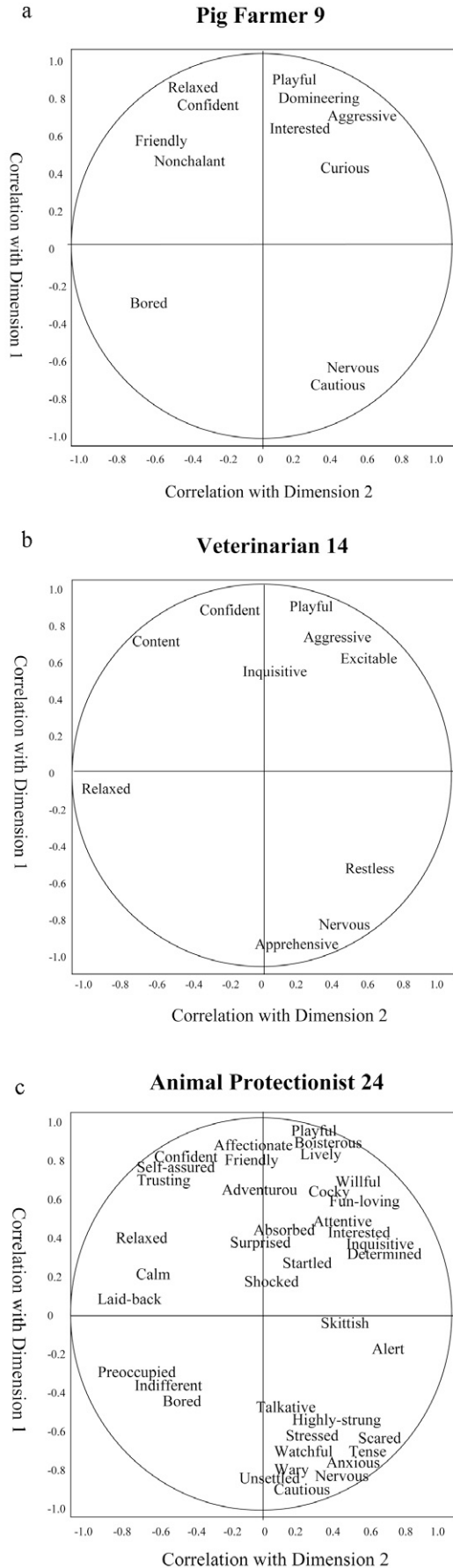


Figure 2. Word charts for different observer groups (1 per group). Axes reflect strength of correlation of the terms of an observer with Dimensions 1 and 2 of the consensus profile of the joined analysis.

of pigs. The 3 observer groups jointly identified 2 main dimensions of pig expression (dim1: playful/confident to cautious/timid; dim2: aggressive/nervous to relaxed/bored), which were similar in semantic tone to those found in a previous study (Wemelsfelder et al., 2001; dim1: confident/playful to timid/wary; dim2: excitable/persistent to relaxed/calm; see this paper for discussion of these dimensions in context of other pig studies). Within this context of high overall agreement, closer examination of the variation from the consensus found that observer groups differed in some aspects of their discrimination between pigs; however, quantitatively these differences were small and did not distort the overall consistency between observer characterizations of individual pigs.

These results further support the internal validity of spontaneous qualitative assessments of pig behavioral expression, as demonstrated by Wemelsfelder et al. (2000, 2001). These earlier studies used graduate animal science students as observers; however, in the present study, observer groups were specifically selected to differ in professional and personal outlook, and were tested separately so as not to contaminate these differences. A questionnaire filled in by observers after the study had ended, indeed found them to differ significantly in daily and lifetime contact with pigs, and in consumption of animal products; additionally, although generally showing positive attitudes toward pigs, they were found to differ in some aspects of affection and empathy for pigs, and in their confidence that qualitative descriptors accurately describe the experience of the pigs (see appendix for details). More differences might have been found had observers been sent the questionnaire before the study began when they were still unaffected

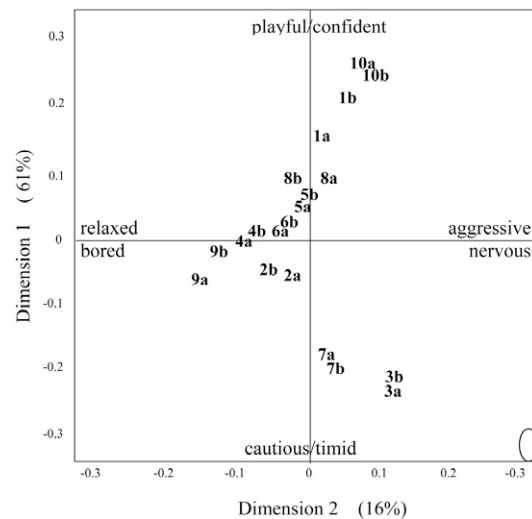


Figure 3. Pig plot for the joined analysis. Axes reflect scaling values for relative sample (pig) distance on dimensions 1 and 2 of the consensus profile. Numbers denote individual pigs. Suffices a and b denote tape 1 and tape 2 repeat assessments of individual pigs. The ellipse represents the SE for the position of each pig in the plot.

by the QBA exercise. We chose not to do this, however, to avoid that filling in the questionnaire might affect the QBA assessments of the observers. In any case, more differences among observers could only have strengthened the main finding of this study, which is that despite any such differences, observer groups achieved excellent interobserver and intraobserver agreement in their qualitative assessments of pig expression.

This finding challenges the assumption that qualitative judgments of animal behavior are inevitably confused by observer-related bias. Concern for anthropomorphism, the illicit projection of human qualities on to animals (Midgley, 1983), has long made scientists reluctant to describe animals in psychological terms (Wynne, 2004). However, this concern has increasingly been put to critical scrutiny by authors who argue that not all psychological qualifications of animals are by necessity based on anthropomorphic projection (Midgley, 1983; Fisher, 1991; Bavidge and Ground, 1994; Crist, 1996; Wemelsfelder, 1997; Costall, 1998; Rees, 2001; Keeley, 2004). Putting this proposition to the test, several companion animal studies report good agreement and consistency in the judgments by observers of the intentions and emotions of observed animals (mainly dogs), which they suggest indicate such judgments to be meaningfully grounded in behavioral observation (Bahlig-Pieren and Turner, 1999; Morris et al., 2000; Tami and Gallagher, 2009). Equally, the finding of the present study that observer groups, notwithstanding their diverging backgrounds, can provide expressive information on individual pigs with strong agreement, consistency, and data resolution suggests that this information is based on systematic behavioral observation, rather than unfounded anthropomorphic projection. Misjudgment of animal expressions can, of course, occur in particular circumstances (Bradshaw and Casey, 2007), but this does not, per se, negate the empirical nature of this type of assessment (Midgley, 1983).

The relevance of this study must be weighed against the fact that it used a relatively small sample of observers from a limited demographic that cannot be considered representative of the larger target populations (e.g., Scottish pig farmers). It will be important to repeat the experiment on a larger scale to see if reported outcomes persist. Free-choice profiling proved an effective method for integrating varying observer perceptions into common constructs and computerization of its procedures would make it easier to include more and larger observer groups. It may then also become possible to let observers view animals against different environmental backgrounds and test how this affects their agreement. If pigs were viewed in intensive farming conditions, for example, pig farmers might judge their expressions more positively than animal protectionists would. Wemelsfelder et al. (2009) tested the effect of environmental background on QBA by digitally

manipulating video footage of 15 individual pigs, so that observers (unaware of the treatment) could view the same pig expressions against indoor and outdoor backgrounds. Results indicated that environmental background (given calculated 95% confidence intervals and indexes for the variability attributable to background effects) is unlikely to distort observer characterizations of pig expression, supporting the robustness of QBA. However, observers in this case were all of the same (veterinary) background. Thus, cross testing the effects of observer background and environmental setting on QBA in larger samples would be an important next step.

The expressive information that qualitative observer judgments provide has mostly been taken to describe behavioral style, temperament, or personality in individual animals (Stevenson-Hinde, 1983; Feaver et al., 1986; Gosling, 2001). However, given the apparent reference of many qualitative descriptors to the affective experience of an animal (e.g., content, anxious), interest in exploring their potential as indicators of animal welfare (used in conjunction with other indicators) is also growing (Morton and Griffiths, 1985; Carlstead et al., 2000; Wemelsfelder, 2005, 2007; Weiss et al., 2006; Wiseman-Orr et al., 2006). The integrative nature and sensitivity of such terms to subtle shifts in expression may make them an effective diagnostic tool aimed at detecting early signs of declining or improving welfare (Spooler et al., 2003; Napolitano et al., 2009; Whitham and Wielebnowski, 2009). Farmers, in particular, may take interest in participating as stakeholders in developing such a tool (see, for example, Wiseman-Orr et al., 2011). To develop and test this potential use, QBA should be incorporated into multidisciplinary studies of animal health and welfare, and be cross validated against other measures on different types of organization. The report by Stockman et al. (2011) of significant correlations between QBA and physiological stress indicators in cattle during transport, for example, is highly relevant in this respect.

Generally, QBA, particularly when facilitated by FCP, seems well suited as a method for investigating whether and how the backgrounds and dispositions of observers affect their judgments of behavior and welfare. Such application has the potential to interconnect social and natural science questions (e.g., testing the role of empathy in judging animal behavior; Hills, 1995), and may stimulate further development of experimentally validated, interdisciplinary approaches to animal behavior and welfare research.

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APPENDIX: OBSERVER QUESTIONNAIRE**Part 1: Looking back at your description of the pigs**

Please take a moment to think back to those evenings during the study when you were watching the pig videos. You were asked to watch the pigs interact with a person and create your own terms to describe the pigs' behavioral expressions. In the next session, you were asked to use your personal terms to score the pigs' expressions. Now that this is finished, we would like to get a better idea of how, looking back, you interpret the terms you used.

Do you:

1. See your terms as realistically and accurately describing the pigs and their experiences?
2. See your terms as describing the pigs but feel you could never be sure of what the pigs themselves really experienced?
3. See your terms as essentially words for describing human experience and therefore their relevance to pigs is completely unclear?

Which of these views would you say is closest to your own (tick one box only)?

(1) (2) (3)

Part 2: About you

1. **Age:** 19 or under 40-49 70+
20-29 50-59
30-39 60-69
2. **Brief job/activity description:** _____

3. **Currently, how often would you say you come into contact with pigs (tick one box):**
most days once or twice a week a few times a month
a few times a year less than once a year never
4. **If you were to add up the total amount of time you have spent in contact with pigs in your lifetime, how much would you say it was (tick one box):**
never a few occasions a few days
a few weeks a month or more a year or more
5. **Do you currently keep any (tick any box which applies):**
indoor/pet dogs cats other pets
outdoor/working dogs horses
6. **In the past, have you ever kept any (tick any box which applies):**
indoor/pet dogs cats other pets
outdoor/working dogs horses
7. **Do you eat (tick any box which applies):**
meat fish eggs dairy products None of these

Part 3: How you view pigs

To indicate your view on the questions below, please mark the line at the appropriate place between “not at all” and “very much”.

Example:

not at all _____ *very much*

1. I like pigs:

not at all _____ *very much*

2. I think pigs are fascinating animals:

not at all _____ *very much*

3. I think pigs are handsome animals:

not at all _____ *very much*

4. I think piglets are cute:

not at all _____ *very much*

If you were standing in a pen with about 10 female pigs (of \pm 60 kg, the size of a large dog), who were busy rooting in straw but looked up when you came in,

1. Would you feel frightened?

not at all _____ *very much*

2. Would you be bothered by their smell or dirtiness?

not at all _____ *very much*

3. Would you feel like going up to them and stroking or patting them?

not at all _____ *very much*

4. Would you feel like talking to them?

not at all _____ *very much*

5. Would you feel that you could communicate with them in some way?

not at all _____ *very much*

6. Would you feel that they could communicate with you in some way?

not at all _____ *very much*

Part 4: Situations involving pigs

Please indicate:

- what you think the pig described would be feeling like in the following situations;
- what you think you would be feeling like as a result of seeing the pig in those situations.

To indicate your view on the questions below, please tick the line at the appropriate place between “nothing” and “very bad/good”.

Example:

not at all _____ *very much*

1. You see a pig lying in a corner, its skin badly scratched after losing a fight with another unfamiliar pig

- a. The pig would be feeling:

not at all _____ *very bad*

- b. You would be feeling:

not at all _____ *very bad*

2. You see a pig rolling about in a wallow of mud on a hot sunny day

- a. The pig would be feeling:

not at all _____ *very good*

- b. You would be feeling:

not at all _____ *very good*

3. You see a young pig unable to feed because other pigs are blocking its way to the feeder

- a. The pig would be feeling:

not at all _____ *very bad*

- b. You would be feeling:

not at all _____ *very bad*

4. You see a group of piglets scampering about together in fresh straw

- a. The pig would be feeling:

not at all _____ *very good*

- b. You would be feeling:

not at all _____ *very good*

5. You see a piglet squealing as it is castrated

- a. The pig would be feeling:

not at all _____ *very bad*

- b. You would be feeling:

not at all _____ *very bad*

Part 5: What you think pigs can do

Please tick one box for each question

Do you think that pigs can:

1. **Remember something that happened yesterday.**

————— ————— ————— —————

Yes (very sure) Yes (probably) Not sure No (probably) No (very sure)

2. **Actively think about something that happened yesterday.**

————— ————— ————— —————

Yes (very sure) Yes (probably) Not sure No (probably) No (very sure)

3. **Anticipate something that might happen tomorrow.**

————— ————— ————— —————

Yes (very sure) Yes (probably) Not sure No (probably) No (very sure)

4. **Actively think about something that might happen tomorrow.**

————— ————— ————— —————

Yes (very sure) Yes (probably) Not sure No (probably) No (very sure)

5. **Recognize a particular stockperson.**

————— ————— ————— —————

Yes (very sure) Yes (probably) Not sure No (probably) No (very sure)

6. **Prefer to be handled by a particular stockperson out of a group of familiar stockpeople.**

————— ————— ————— —————

Yes (very sure) Yes (probably) Not sure No (probably) No (very sure)

7. **Recognize an object they saw 2 or 3 months ago.**

————— ————— ————— —————

Yes (very sure) Yes (probably) Not sure No (probably) No (very sure)

8. **Like particular individual pigs but dislike others.**

————— ————— ————— —————

Yes (very sure) Yes (probably) Not sure No (probably) No (very sure)

9. **Deceive another pig.**

————— ————— ————— —————

Yes (very sure) Yes (probably) Not sure No (probably) No (very sure)

10. **Go to the aid of another unrelated adult pig.**

————— ————— ————— —————

Yes (very sure) Yes (probably) Not sure No (probably) No (very sure)

11. **Form a picture in their mind of where things are in the area in which they live.**

————— ————— ————— —————

Yes (very sure) Yes (probably) Not sure No (probably) No (very sure)

Questionnaire Statistical Analysis

Data were analyzed using a variety of statistical methods. In Parts 1 and 2, ticks given to different options in a question were counted for each observer group and ensuing data matrices analyzed with a χ^2 test. In Parts 3 and 4, the distance between the left end of the scale and the tick of the observer was measured in millimeters, and the effect of observer group analyzed using parametric 1-way ANOVA. In Part 5, observer scores (1 to 5) were recorded and analyzed using nonparametric Kruskal-Wallis 1-way ANOVA.

Questionnaire Outcomes

Of 32 observers, 1 veterinarian and 1 animal protectionist did not return their questionnaire. One animal protectionist did not fill in Part 3 and some respondents skipped particular questions, causing reduced sample size in these cases. Analysis of 30 completed responses (29 in Part 3) showed the following outcomes.

Part 1. Observer groups differed in how they gauged the validity of their personal qualitative terminologies for pig behavioral expression ($\chi^2 = 12.73$, $df = 4$, $P < 0.02$). Pig farmers mostly believed their terms accurately and realistically described the experiences of the pigs, whereas most veterinarians and animal protectionists saw their terms as describing the pigs but felt they could not be sure of the actual experience of the pigs. Some veterinarians felt their terms were basically human projections, of which the relevance to pigs was entirely uncertain. Thus, pig farmers were most confident regarding their spontaneous qualitative assessments of the pigs.

Part 2. The 3 observer groups differed in these traits: 1) Age range ($\chi^2 = 22.36$, $df = 12$, $P < 0.03$), pig farmers: 30 to 70 yr old; veterinarians: 20 to 50 yr old; animal protectionists: 15 to 40 yr old (1 person in 60s). 2) Daily contact with pigs ($\chi^2 = 41.11$, $df = 10$, $P < 0.001$), pig farmers had contact with pigs on most days, veterinarians ranging from once or twice a week to never, and animal protectionists about once a year or never. 3) Lifetime contact with pigs ($\chi^2 = 33.20$, $df = 4$, $P < 0.001$), pig farmers: 1 yr or more, veterinarians: a few weeks/months, animal protectionists: a few occasions/a few days. 4) Other companion animals ($\chi^2 = 7.65$, $df = 2$, $P < 0.02$), pig farmers kept cats more than the other 2 groups. 5) Consumption of animal products ($\chi^2 = 38.64$, $df = 8$, $P < 0.001$), all animal protectionists were vegetarian and did not consume any fish or meat; 5 out of 9 were also vegan and did not consume any meat, fish, dairy products, or eggs. By contrast, all pig farmers and veterinarians ate meat, fish, dairy products, and eggs.

Part 3. Observers generally displayed a positive affectionate attitude towards pigs, indicating they were inclined to approach pigs and communicate with them. Within this general trend differences were that pig farmers liked pigs more than other groups ($F_{2,26} = 3.36$, $P < 0.05$), whereas animal protectionists were more frightened of them ($F_{2,26} = 17.28$, $P < 0.001$).

Part 4. Observers basically showed positive empathy with pigs, feeling bad when they assumed pigs to feel bad and good when they assumed pigs to feel good. However, some differences occurred. Pig farmers rated the effect of "being blocked from feeding" on pigs more negatively ($F_{2,26} = 5.0$, $P < 0.05$) and "scampering in straw" more positively ($F_{2,26} = 3.31$, $P < 0.05$) than the other groups. This, in turn, made them feel respectively worse ($F_{2,27} = 4.70$, $P < 0.05$) and better ($F_{2,26} = 5.22$, $P < 0.01$) than the other groups. There was no difference in how observers rated the effect of castration on pigs, but it made animal protectionists feel worse than other groups ($F_{2,27} = 4.40$, $P < 0.05$).

Part 5. Observers generally displayed a positive attitude toward the cognitive abilities of pigs, believing that pigs can remember persons and objects for months, form an image of their environment, and hold preferences for particular individual pigs and people. They were, however, uncertain about the ability of pigs to think about past events and anticipate future events, and about higher cognitive abilities, such as altruism and deception.

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