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**Temperament of the Norwegian horse breeds – a questionnaire based study**

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## Research highlights

Revealed major components of the temperament in the Norwegian horse breeds, through an expansion of a Horse Personality Questionnaire (HPQ)

The four Norwegian horse breeds (the Fjord, the Dole, the Nordland/Lyngen and the Norwegian coldblooded trotter) share the same five factors ‘anxiousness’, ‘agreeableness’, ‘conscientiousness’, ‘openness’ and ‘dominance’

The factors ‘agreeableness’ and ‘conscientiousness’ are not earlier identified with a HPQ

In addition, the Norwegian coldblooded trotter had ‘excitability’ as a separate factor

## Abstract

To increase the populations of the Norwegian horse breeds, it is desirable to improve their competitive edge in the market. One of the declared strengths of these populations are their robust temperament, which has not been described sufficiently to be utilized for breeding purposes. A horse personality questionnaire (HPQ), with grading of 43 behaviourally defined adjectives, was analysed with a factor analysis to condense the temperament of the four Norwegian breeds into main temperamental factors. The analysis consisted of 1018 horses and the respondents was in general handlers or owners of the objective horse. The Fjord horse, the Dole horse and the Nordland/Lyngen shared the same five factors in the analysis; ‘anxiousness’, ‘agreeableness’, ‘conscientiousness’, ‘openness’ and ‘dominance’. The Norwegian coldblooded trotter shared the same five factors, but in addition had a factor identified as ‘excitability’. In total, the factors explained a maximum of 44 % of the variance, which is somewhat less than other studies using the HPQ or similar. An expansion of number of adjectives compared to earlier studies, with skewness in which factor they load on to and more non-loading adjectives, could be an explanation of this. The use of HPQ has contributed to simplify the phenotypic landscape, but for future development of assessing temperamental traits for breeding purposes, a horse personality questionnaire is not recommended, as it is probably highly influenced by personal preferences or possible benefits of the owner. The alternative is impartial observers unknown to the horses, demanding a test arena for the horses, where the observers can base their ratings on the horses’ performances.

Key words: Horse personality questionnaire; factor analysis; temperament; Big Five; horse.

## **1. Introduction**

The Dole, the Fjord, the Nordland/Lyngen and the Norwegian coldblooded trotter are ancient Norwegian horse breeds, with a cultural-historical background. The breeds are protected by The UN's convention for biological diversity (UN, 1992). During the last decades these breeds have experienced a rapid decline in number of foals born (Olsen, 2011), resulting in reduced genetic variation (Olsen et al., 2010). A national plan of action for the three smallest breeds (the Dole, the Fjord and the Nordland/Lyngen) states that a clearer defined area of use, strengthened by improvement in breeding as well as intensified marketing, are necessary efforts to sustain the breeds (NHS, 2012). To strengthen the breeds' competitive edge, the plan recommends utilizing the breeds' strengths to develop a unifying sports event, forming a 'signature activity' for these three breeds. One of the stated strengths of these breeds is the robust, cold-headed temperament, which will be well suited for developing a sports event including rough terrain with natural obstacles. A unifying sports event will preferably revitalize both the existing community surrounding the breeds and the general demand in the market. Thus, temperament is preferred to be included as a performance trait in the breeding program.

The main area of use for the three smallest breeds is within the segment for hobby and leisure, but also to some extent for health purposes, tourism and as a working horse (ECON, 1999; ECON, 2000). Since a quite large part of the users in the main market is young, often inexperienced people, quality assessment of temperamental traits is important to ensure safety of the sport. In addition, studies show that temperamental traits are ranked as very important traits by horse riders and horse experts (Gille and Spiller, 2010; Graf et al., 2013a; Teegen et al., 2008; Von Borstel et al., 2013), and thus should be included in the breeding program. Studies from Germany also show that horse owners even are willing to cover additional costs for an objective temperament assessment of their horse (Graf et al., 2013b). This supports the need for more knowledge on horses' temperamental traits.

It is natural to assume that past selection has influenced the horses' temperament, as well as the performance and conformation. Actually, von Borstel et al. (2010) found that show-jumping horses showed lower fear reactions than dressage horses, predominantly due to genetic differences. Further, Lloyd et al. (2008) identified breed differences in personality with horses, where 'anxiousness' and 'excitability' showed the highest variation between breeds, in support of the existence of genetic variation in behaviour. In several studies within non-human species, traits describing different dimensions of the temperament have been shown heritable (e.g. Meyer et al., 2012; Svartberg et al., 2005; Von Borstel et al., 2012; Wolf et al., 2008).

In the current Norwegian horse breeding programs, temperament is scored in a one-day test, on a scale from 1 to 10 without a scale description, and with sub-scores from the team of exterior judges, the performance test judge and from the veterinarian in a health test. In the performance tests additional scores are assigned for the ability to cooperate and willingness in use, but these scores are not defined as a part of the temperamental score. The temperamental score is given from several judges in different activities, and it is tempting to assume that they actually score different dimensions of the temperament, rather than one, unified trait. To be able to reveal these dimensions, and to be able to objectively score them as traits, it is necessary to gain more knowledge of the composition of the horses' temperament. This is in line with von Borstel et al. (2013), who requested objective scoring of personality traits through universally accepted guidelines, taking on a psychological perspective (Haskell et al., 2014).

Several studies have described the temperament of non-human species in terms of the Five Factor Model (FFM), derived from human psychology, from the early start in the 1970's (e.g. Stevenson-Hinde and Zunz, 1978). The FFM is a model describing five broad factors, in which each of them summarizes several minor traits (Gosling and John, 1999). The main factors from the human FFM are 'openness' (O), 'conscientiousness' (C), 'extraversion' (E), 'agreeableness' (A) and 'neuroticism' (N). Further, Gosling and John (1999) suggested that the three last dimensions (E, A, N) are dimensions showing a strong cross-species generality, from their review of 19 studies including a total of 12 species. The O-dimension was not found consistent over species, but was in some species revealed through curiosity

and playfulness, whereas the C-dimension only was found in chimpanzees. The authors also suggested ‘dominance’ and ‘activity’ as two additional factors appearing with non-human species.

In horses, Morris et al. (2002a) and Morris et al. (2002b) used the NEO-Personality Inventory-Five Factor Inventory (NEO-PI-FFI), a well-established personality questionnaire for humans, to reveal underlying components of the temperament, stating that cross-species comparability in the factor structure of personality is possible. Further, Momozawa et al. (2005) used a 20-item questionnaire, and later Lloyd et al. (2007) developed a Horse Personality Questionnaire (HPQ), consisting of 30 behaviourally defined adjectives, adapted from Stevenson-Hinde and Zunz (1978), Stevenson-Hinde et al. (1980) and Morris et al. (2002a). The HPQ, as assessment method, showed high reliability between raters and a Principal Component Analysis (PCA) revealed six underlying components; ‘dominance’, ‘anxiousness’, ‘excitability’, ‘protection’, ‘sociability’ and ‘inquisitiveness’ (Lloyd et al., 2007).

The main aim of this study was to gain information on major components of temperament in the Norwegian horse breeds, from sampling data through a questionnaire.

## **2. Material and methods**

### *2.1 The questionnaire*

Information on the temperament in the four Norwegian horse breeds; the Fjord, the Dole, the Nordland/Lyngen and the Norwegian coldblooded trotter were surveyed through a questionnaire accomplished during autumn 2012. The questionnaire was made up of two parts; one demographic part with questions about the owner and the horse, and one non-demographic part with 43 behaviourally defined adjectives (Table 1). The horses were scored individually on each adjective using a 5-point Likert scale, where ‘0’ indicated no expression and ‘4’ indicated full expression of the adjective. For each adjective, the rater could also mark for “don’t know”. Of the 43 BDAs, 25 were adapted from Stevenson-Hinde et al. (1980), three were adapted from Morris et al. (2002a), two from Lloyd et al. (2007), and finally the last 13 BDAs were special to this study, agreed upon by a working group consisting of experienced horsemen. The working group also assisted in the translation of the English

adjectives to suitable Norwegian phrases. The questionnaire was accessed through Questback ([www.questback.no](http://www.questback.no)), and information spread out through websites of horse organisations, their members' magazines, by e-mail and by social networks.

## *2.2 Data material*

In total, 1197 responses were obtained through the questionnaire. Of these, 6 responses were for horses of breeds not included in the study, 28 responses were for non-registered horses, 56 responses were from persons 16 years old or younger and one response was blank. These 91 responses were excluded from the study. Due to the distribution method, the return rate was unidentifiable.

The 1106 responses were made up of data from a total of 1059 unique horses. For animals with duplicate responses the assumed most reliable record was kept, based on the demographic information. Of the remaining responses, 4.1 % scored "Don't know", or 'missing', for more than 10 % of the adjectives, and these were omitted from further analysis. The final data set consisted of 1018 horses; 214 of the Dole horse (8.4 % stallions, 42.1 % geldings and 49.5% mares), 294 of the Fjord horse (9.8 % stallions, 37.1 % geldings and 53.1 % mares), 229 of the Nordland/Lyngen (14.0 % stallions, 33.2 % geldings and 52.8 % mares) and 281 of the Norwegian coldblooded trotter (11.4 % stallions, 38.4 % geldings and 50.2 % mares).

## *2.3 Data analysis*

Initially, missing values were replaced with a mean value for the respective adjective within breed. Further, as a preliminary analysis of variance for all adjectives showed an effect of breed, the subsequent analyses were all accomplished within breed. The standardised data of the 43 adjectives was analysed through a factor analysis, using SAS/STAT® software. Factor analysis is a multivariate method for revealing the covariance structure between variables, to discover possibly underlying, unobservable factors (e.g. Johnson and Wichern, 2002). For the factor analysis, a principal component method was used, where each variable's largest absolute correlation with any other variable were used as the prior

communality estimate. The number of factors was determined by keeping eigenvalues greater than 1. A varimax rotation was chosen to obtain an easier interpretation of the factor loadings.

### 3.0 Results

Of the final 1018 responses, respondents were of ages 17-25 years (28 %), 26-35 years (31 %), 36-55 years (34 %) and >55 years (7 %). As much as 89 % of the respondents were female, and amongst the male respondents, almost 90 % were  $\geq 36$  years old. Respondents were from all the 19 counties in Norway, but the Fjord was dominating to the West of Norway (43 % of the Fjord horses in the study), the Nordland/Lyngen to the North of Norway (38 %), while the Dole and the Norwegian coldblooded trotter was dominating to the East of Norway (63 % and 49 %, respectively). The lowest fulfilled education level across sex was primary school (4 % of the respondents), while the highest was at Ph.D.-level (1 % of the respondents). A major proportion of the respondents had either high school as highest level of education (46 %) or a bachelor degree from college or university (31 %).

A total of 32 % stated that they had an education associated to horses. Only 20 % quoted that they used their horses in professional activities, of which 45 % received agricultural production grants, mainly in the medium order (between NOK 50.000 to NOK 300.000 per year). Most of the respondents (94 %) had been doing horse sport activities for  $\geq 5$  years. Also, most of the respondents were the owner of the horse (85 %). Likewise, 80 % of the respondents had known the horse for more than 2 years, and only 5 % for less than 6 months. As much as 89 % handled the horse on a daily basis, whilst only 3 % less than monthly. Most of the horses were trained and/or worked on a daily (47 %) or weekly (45 %) basis. The majority of the respondents stated that they either liked the horse (12 %) or liked the horse very much (85 %). The birth year of the horses reached from 1978 to 2012, while mean age of the horses was 10 years with a standard deviation of 6.15 years.

#### 3.1 Factor analysis

For both the Dole, the Fjord and the Nordland/Lyngen, five factors had eigenvalues above 1 (Tables 2-4). Correspondingly, for the Norwegian coldblooded trotter, six factors remained (Table 5). For all the



breeds, factor 1 explained the largest part of the total sample variance, ranging from 12 % (the Norwegian coldblooded trotter) to 18 % (the Nordland/Lyngen), and the cumulated variance accounted for by all factors ranged from 38 % (the Dole) to 44 % (the Nordland/Lyngen) (Table 6). In correspondence, a total of 11-16 adjectives had loadings above |0.4| on factor 1 in the four breeds, while the corresponding numbers of adjectives for factor 2-6 were 8-10 (factor 2), 5-7 (factor 3), 4-5 (factor 4), 3-4 (factor 5) and 3 (factor 6) (Tables 2-5).

The Norwegian coldblooded trotter had one more factor than the other breeds; its factor 5 (Table 5). Otherwise, factors 1-4 were compounded by many common adjectives across all breeds; 11, 6, 5 and 4, respectively. Factor 5 in the Fjord and the Nordland/Lyngen had three adjectives in common with factor 6 in the Norwegian coldblooded trotter, while these breeds for this factor shared only one common adjective with the Dole. Actually, factor 5 in the Dole contained two adjectives that mapped on factor 2 in the Fjord and the Nordland/Lyngen.

#### **4.0 Discussion**

The demographic part of the questionnaire showed that the respondents were rather evenly spread out over the age classes, but overrepresented by females, especially amongst the younger respondents. According to the Central Bureau of Statistics in Norway (Statistics Norway, 2015), the education level was somewhat higher amongst the respondents of this study, compared to the average for the Norwegian society, as there were fewer with primary school as highest fulfilled education, and more with short (bachelor) or long (e.g. master) university grades. One explanation can be that younger females on average have the highest education level in Norway (Statistics Norway, 2015). Another explanation may be that owning a horse in Norway is rather expensive, and income is somewhat correlated to education level (Statistics Norway, 2010). Geographically, all the counties in Norway were represented, but the breeds dispersed somewhat skewed. However, the skewed dispersion reflects the areas of origin of the breeds, and the responses should as such be representative.

Overall, the respondents have stated that they were experienced within horse activities and that they were well known with the horse for which they responded. One third had even a horse-related education and one fifth was running a professional business with horses. The high level of horse experience amongst the respondents, and that they had known the horse for a long time, gives a good foundation for reliable results. The age distribution of the horses was quite wide with a long tail towards older horses, reflecting rather well the common age pattern of the adult population of horses of the National breeds.

Because temperament is an important trait in the horse, interest in revealing dimensions of their personality is increasing. The purpose of the factor analysis was mainly to identify possible underlying, unobservable, dimensions or factors in the covariance among a large number of variables or adjectives, and varimax-rotated factor scores were used to give insight to which adjectives that likely make up some important dimensions of the horse temperament.

The factor analysis revealed five common factors for all the breeds and one additional factor for the Norwegian coldblooded trotter (factor 5 in that breed). The first factor explained approximately 40 % of the total variation over breeds. This factor consisted of adjectives linked to fear and reactivity, with the most expressed loadings for ‘apprehensive’, ‘unequable’, ‘visually sensitive’ and ‘sound sensitive’, while ‘flighty’ had higher scores in the three draught breeds than in the trotter. This factor corresponds well to the factor ‘neuroticism’ from the Big Five (McGrogan et al., 2008; Morris et al., 2002a) or the equivalent factor ‘anxiousness’ as used by e.g. Lloyd et al. (2007) and Lloyd et al. (2008). As the horse is a prey animal with flight as an obvious strategy of survival, it is natural that traits connected to fear and reactivity are core elements evolved in horse temperament.

The second factor was compounded of adjectives like ‘friendly’, ‘non-aggressive’, ‘considerate’, ‘popular’ and ‘social with humans’, which indicates a structure dealing with attitude against humans and response to handling. This corresponds well to the factor ‘agreeableness’ from the Big Five, related to being ‘sympathetic’, ‘considerate’, ‘warm’ and having ‘lack of aggression’ (Costa and McCrae, 1992;

Gosling and John, 1999). This is an important trait as it determines among other things the interactions between horse and human through handling.

The adjectives ‘cooperative’, ‘non-stubborn’, ‘hardworking’ and ‘willing to learn’ mainly constituted the third factor, which indicates a temperamental dimension associated with work and use of the horses. This assembles well with the factor ‘conscientiousness’, as described as part of the Big Five in humans with traits like ‘productive’, ‘dependable’, ‘responsible’ (Costa and McCrae, 1992). Morris et al. (2002b) identified ‘conscientiousness’ in horses, through ratings given by primary carers of the horses, and also found that the horses became progressively more conscientious the higher the level of skills of the horse. Lloyd et al. (2007) did not get a match between the Big Five component ‘conscientiousness’ and any of the horse personality components, but explains this as a result of different assessment criteria used.

The fourth factor consisted of adjectives like ‘sociable’, ‘playful’, ‘curious’ and ‘social with humans’, which is comparable with the factor ‘openness’ from the Five Factor Model (John, 1990), which in Gosling & John (1999) is characterized by traits like ‘curiosity-exploration’ and ‘playfulness’. The fourth factor is also comparable with the factor ‘sociability’, as described by e.g. Lloyd et al. (2007), which includes traits like ‘sociable’, ‘playful’ and ‘popular’. Others place ‘sociability’ as a sub-trait under ‘extraversion’, together with e.g. ‘activity’ (Costa and McCrae, 1992). This factor is nevertheless important for interplay with both humans and other horses.

The fifth common factor (corresponding to factor six for the trotter) included adjectives like ‘dominant to horses’, ‘non-subordinate’ and ‘protective’, whilst for the Dole also ‘dominant to humans’ and ‘irritable’ had high loadings, indicating a separate factor for ‘dominance’, as also suggested by e.g. Gosling and John (1999) and by Lloyd et al. (2007) for horses. A horse scoring high for dominance will probably spend much time herding, giving head threats and kicks towards other horses (McDonnell and Haviland, 1995) and thus make a practical problem for joint management and stabling of several individuals.

The factor that were special for the Norwegian coldblooded trotter contained the adjectives ‘speedy’, ‘not slow’, ‘tense’ and ‘excitable’. Although ‘excitable’ also mapped on the first factor associated with fear and reactivity, this fifth factor in the trotter seem to correspond to the factor ‘excitability’ as described by Lloyd et al. (2007), containing ‘active’, ‘not slow’, ‘intelligent’ and ‘excitable’. The Norwegian coldblooded trotter is a specialized breed for trotting performance, and it is obvious reasons to compare this factor to a kind of “ignition state” or as a speed trait measuring the powers of reaction.

In total, the factors explained a maximum of 44 % of the variance, which is somewhat less than other studies using the HPQ or similar. Lloyd et al. (2007) used a principal component analysis (PCA) to reveal the components based on results from only 44 horses, where six components together explained 79,3 % of the total variance. McGrogan et al. (2008) also used a PCA and found three factors accounting for 59 % of the total variance. Compared to the originally HPQ as used in Lloyd et al. (2007), we expanded the number of behaviourally defined adjectives from 30 to 43 and this expansion is one reason for less variance explained, as the proportion of the variance explained due to the  $j$ -th factor is the summed, squared value of the loadings divided by the number of adjectives. So, the more non-loading adjectives that are added, the less the total variance explained.

Of the 13 adjectives added, ten adjectives spread out mainly on the factors 1-3, mostly so on the first factor. Remarkably, ‘easily recovered’ and ‘tactile sensitive’ did not load into any of the factors for any of the breeds, even though experienced practitioners in the preliminary work outlined especially ‘easily recovered’ as a very important trait. It is though possible that the ability to recover is such a situational trait that many respondents do not have the required experience with the horse to be able to assess the trait. As a total of five adjectives mapped on factor 1 for all breeds, it generally contributed to factor 1 explaining most of the total variance. However, this was a consequence of the large number of adjectives added that mapped on factor 1, rather than this factor necessarily being the most pivotal for horses’ temperament.

Our modification of the original version of the HPQ was thoroughly discussed with experienced practitioners through working groups, and the modification seem to be supplementary information as to break out factors 2 and 3, with the adjectives ‘friendly’ and ‘cooperative’, having the highest loadings for the respective factors, except for the Dole. This illustrates that the HPQ can be improved upon by a judicious choice of additional behaviourally defined adjectives. Priority should be to adjectives identifying underlying factors or dimensions of temperament rather than to add more adjectives for already identified factors, as mentioned for factor 1. Further, an adaption of local terminology was important to identify additional factors that aid in better understanding horses’ temperament. However, our choice of adjectives was unable to break out ‘protection’ and ‘inquisitiveness’ as separate factors of a horses’ temperament. The low number of animals in the study of Lloyd et al. (2007), might rather cause revealing the sub-traits of larger factors, such as for instance ‘inquisitiveness’ rather is a sub-trait under the factor ‘openness’, as described in Gosling and John (1999).

The adjectives mapping on the different factors were rather similar for the different draught breeds although some differences was seen, mostly for the Dole. The largest difference, however, was showed for the trotter, where even a separate factor was found (factor 5 in that breed). This could be a consequence of the respondents requiring different temperament in that breed, and thus have a different perception of the rating scales, rather than the temperament being different in this breed. The Norwegian coldblooded trotter and the Dole were actually one breed until the middle of the 19<sup>th</sup> century, when the breed was officially split up and selected for two different purposes; the coldblooded trotter for racing purposes, and the Dole for draught purposes. There are still some genetic exchange between the two breeds, as some cross-breeding occurs from time to another.

In this study, and according to Meagher (2009), subjectivity was minimized by providing clarity of the terminology and use of explicit criteria for each value on the scale. Actually, each adjective in the HPQ was followed by an explanation of the item and of the scale, which is expected to reduce the variance of the understanding and interpretation of the items. Further, our observer ratings were made by respondents who knew the object animals well. This allowed the rater to utilize lifelong knowledge of

the animal which by Meagher (2009) has been considered preferential rather than to rely rating in a one-time event. However, observer ratings can be systematically biased due to dishonest rating, if the respondent has a personal interest in the results (Meagher, 2009). As this study aimed at obtaining knowledge on the population level, and the respondents were well informed of this, as well as the respondents being anonymous, not gaining personal profit or receiving any information on individual animals, ratings done by the respondents are considered to be their honest perception of the objective horses. In general, as summarized by Gosling and Vazire (2002), personality ratings of animals show high level of agreement between observers, validity through accordance between predicted behaviours and real-world outcomes and low degree of anthropomorphism.

The reliability of behaviourally defined adjectives was studied by Lloyd et al. (2007) by looking at the variance and the bias of the ratings, assessed from three independent observers. This, however, could not be calculated in our material as only 43 horses was rated by two or more observers, with different observers between the horses (not a set of 2-3 observers rating several horses). Lloyd et al. (2007), however, concluded that the assessment method through the horse personality questionnaire showed reliable measures of horse personality. Morris et al. (2002a) also obtained high inter-correlations in ranking of the horses' personality, by using an equivalent questionnaire. Other studies investigating the reliability of rating scales based on temperament or behaviour in non-equine species also show positive results of inter-rater reliability (e.g. Diesel et al., 2008; Wemelsfelder et al., 2001). In addition, Costa and McRae (1992) claims that the five factor model reliably represent basic dimensions of personality, based on studies showing stability of the assessment method over i.a. species, time and inter-observer ratings.

The factor structure from the HPQ helps us to phenotypically better understand the temperamental traits at another level than just to score temperament as a common trait in a one-day test, as done today. The knowledge is an incitement to evaluate the current test system and suggest an appropriate test through a validation procedure. Knowledge of the temperamental traits will also be of most importance for developing the breeds' competitive edge through establishing a signature activity for these breeds, where

these breeds' temperamental traits can be fully utilized, as they are described as cold-headed and well suited for outdoor use in rough terrain (NHS, 2012). Knowledge of expression of the traits in individuals also is useful for marketing these breeds in market segments that represents a growth potential for the populations, such as tourism and health services (ECON, 1999; ECON, 2000).

Although observer ratings through a HPQ can be used to identify important, underlying dimensions of horse temperament, they are useless in breeding, as observers who gain personal profit from horses described in very positive terms, will most likely give ratings reflecting this through the HPQ (Meagher, 2009). The alternative is impartial observers unknown to the horses, which demands a test arena for the horses, such that the observers can base their ratings on the horses' performance. A naïve approach would be e.g. for factor 1 to put up a test to measure 'apprehensive', that had the highest loadings for this factor, with the risk that this specific trait will be changed whilst other traits mapping on the same factor remain unchanged, as the internal genetic correlation structure might be low. Further, other traits mapping on other factors might also change as the genetic pattern might be different from the phenotypic one, studied herein. So, although the five factor model might help to simplify the phenotypic landscape, it might still have value in focusing the sub-landscape in a genetic context.

## **6.0 Conclusion**

This study demonstrates that the Horse Personality Questionnaire of Lloyd et al. (2007), known to identify the following six underlying components of temperament; 'dominance', 'anxiousness', 'excitability', 'protection', 'sociability' and 'inquisitiveness', can be improved by adding several adjectives. By doing so, we were able to identify two additional structures interpreted as 'agreeableness' and 'conscientiousness', both contained in the Big Five. However, our choice of adjectives was unable to break out 'protection' and 'inquisitiveness' as separate factors of a horses' temperament.

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Table 1: The adjectives and corresponding descriptions in the non-demographic part of the questionnaire, in the order they appeared. To each adjective, a belonging 5-point Likert scale was used.

No.	Adjectives	Description
1	Willing to learn <sup>c</sup>	Easy learner, accomplish easily new tasks, likes challenges
2	Confident <sup>a</sup>	Behaves in a confident and assured manner, not restrained or tentative
3	Curious <sup>a</sup>	Exploratory in new surroundings and situations
4	Robust <sup>c</sup>	Sturdy, tough, steady
5	Aggressive <sup>a</sup>	Respond quickly in aggressive manner (bite, hit, kick) towards humans. Easily causes harm and damage.
6	Permissive <sup>a</sup>	Rarely responds negatively to external stimuli or demands from either horses or humans
7	Apprehensive <sup>a</sup>	Afraid of everything, flees from or avoids risky situations or obstacles
8	Stereotypic <sup>a, d</sup>	Shows stereotypic behaviour (abnormal, repetitive behaviour with lack of function)
9	Independent <sup>a, d</sup>	Self-controlled, active by himself, not overly bonded to others (horse/humans)
10	Dominant to horses <sup>a, d</sup>	Controls other horses, gets own way, fairly dominant
11	Dominant to humans <sup>c</sup>	Not easy to handle, wilful, quarrelsome when handled and made demands upon
12	Flighty <sup>c</sup>	Panic easily, uncontrolled reactions to external stimuli, uncontrollable by handler
13	Equable <sup>a</sup>	Responds in even, calm way, not easily disturbed
14	Tactile sensitive <sup>c</sup>	Sensitive to touch, responds quickly with physical response (e.g. shaking of the fur, step aside, startle)
15	Considerate <sup>a, d</sup>	Shows care and consideration, protects and adjusts to handler
16	Sound sensitive <sup>c</sup>	Sensitive to (sudden) sounds, responds quickly with physical response (e.g. startle, flight response)
17	Visually sensitive <sup>c</sup>	Sensitive to (sudden) visual stimuli, responds quickly with physical response (e.g. startle, flight response)
18	Social with humans <sup>c</sup>	Outreaching, co-operative when approached by human, confident with humans
19	Excitable <sup>a</sup>	Over-reacts to any change, easily excited, highly strung
20	Restless <sup>a, d</sup>	Does not like standing still for long, hard to settle down
21	Fearful <sup>a</sup>	Sceptical, nervous, shy, retreats readily from others or external disturbances, not readily approaching
22	Socially intelligent <sup>a, d</sup>	Adapts easily to herd structure, respond in discriminative and appropriate manner to the behaviour of others
23	Opportunistic <sup>a</sup>	Creative, seizes a chance as soon as it arises (e.g. breaking through fences, if possible)
24	Speedy <sup>c</sup>	Hot tempered, can come out of control in situations with high tempo or large demands
25	Insecure <sup>a</sup>	Hesitates to act alone, seeks reassurance from others (horse/human)
26	Playful <sup>a</sup>	Initiates play and joins in when play is solicited
27	Irritable <sup>a</sup>	Responds to (even) little provocation with negative body language (e.g. ear position, puckering of nostrils)
28	Popular <sup>a</sup>	Attractive, sought out as a companion by others
29	Protective <sup>a</sup>	Prevents harm or possible harm to others
30	Slow <sup>a</sup>	Moves slowly and deliberately, not easily hurried, often interpreted as lazy
31	Sociable <sup>a</sup>	Seeks and enjoy company of others

32	Easily recovered <sup>e</sup>	Quickly recovered after sudden/unexpected situations, independent of immediate reaction
33	Solitary <sup>a</sup>	Spends a lot of time alone by choice
34	Cooperative <sup>e</sup>	Responds well to handler/rider, attentive, easy to correct
35	Hardworking <sup>b</sup>	Keen to do well, behaves well during "work", concentrates on what is being asked to do, not easily disturbed
36	Subordinate <sup>a</sup>	Gives in readily to others, submits easily and does not put up a fight to defend itself, makes no demands
37	Tense <sup>a</sup>	Shows restraint in posture and movement
38	Friendly <sup>c</sup>	Interpreted as a nice, kind and co-operative horse (by humans), responds in a friendly manner to external stimuli
39	Reliable <sup>b</sup>	Can be trusted to do things or behaves well; might also be considered a safe horse to be with
40	Suspicious <sup>b</sup>	Distrustful, sceptical, does not trust others readily (human and horse), trusts few individuals
41	Stubborn <sup>c</sup>	Does not give in easily, not very cooperative
42	Intelligent <sup>c</sup>	Learns new things easily/fast, likes to be challenged, benefits from mental stimulation
43	Reactive against items from behind <sup>e</sup>	Every action behind the horse (e.g. horse driver, movements) startles the horse, responds quickly with physical response (e.g. startle, flight response)

<sup>a</sup> Adapted from Stevenson-Hinde et al. (1980).

<sup>b</sup> Adapted from Morris et al. (2002).

<sup>c</sup> Adapted from Lloyd et al. (2007).

<sup>d</sup> Modified to suitable Norwegian phrasing.

<sup>e</sup> added by the author.

Table 2: Factor loadings of the 43 questionnaire items, for the Fjord, on five varimax-rotated principal component estimates with eigenvalues &gt;1.

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Willing to learn	-0.025	0.105	<b><u>0.626</u></b>	0.253	-0.058
Confident	<b><u>-0.705</u></b>	0.030	0.156	0.036	0.177
Curious	-0.055	-0.025	0.081	<b><u>0.524</u></b>	0.091
Robust	<b><u>-0.575</u></b>	0.084	-0.079	0.020	0.071
Aggressive	0.099	<b><u>-0.710</u></b>	0.017	-0.154	0.058
Permissive	-0.259	<b><u>0.439</u></b>	0.125	0.178	-0.176
Apprehensive	<b><u>0.754</u></b>	-0.037	0.076	-0.001	0.112
Stereotypic	0.207	0.010	-0.125	-0.022	0.147
Independent	-0.286	0.008	0.286	-0.004	0.162
Dominant to horses	0.007	-0.087	0.021	-0.031	<b><u>0.670</u></b>
Dominant to humans	0.110	<b><u>-0.554</u></b>	-0.389	0.051	0.124
Flighty	<b><u>0.722</u></b>	-0.162	0.013	-0.003	0.023
Equable	<b><u>-0.724</u></b>	0.076	0.079	-0.052	-0.084
Tactile sensitive	0.355	-0.113	0.267	-0.075	0.112
Considerate	-0.086	<b><u>0.575</u></b>	0.319	-0.057	0.128
Sound sensitive	<b><u>0.709</u></b>	-0.045	0.121	-0.022	0.085
Visually sensitive	<b><u>0.696</u></b>	-0.031	0.017	-0.024	0.101
Social with humans	-0.139	<b><u>0.532</u></b>	-0.102	<b><u>0.480</u></b>	0.007
Excitable	<b><u>0.564</u></b>	-0.192	-0.078	0.046	0.192
Restless	<b><u>0.413</u></b>	-0.240	-0.185	0.329	0.132
Fearful	<b><u>0.642</u></b>	-0.024	0.046	-0.041	-0.095
Socially intelligent	-0.224	0.180	0.116	0.089	-0.096
Opportunistic	0.188	-0.244	0.004	0.148	0.120
Speedy	<b><u>0.469</u></b>	-0.214	0.018	0.112	0.326
Insecure	<b><u>0.654</u></b>	-0.082	-0.223	0.119	-0.176
Playful	0.031	0.028	0.124	<b><u>0.627</u></b>	0.076
Irritable	0.132	<b><u>-0.483</u></b>	-0.026	-0.178	0.141
Popular	-0.079	<b><u>0.529</u></b>	0.222	-0.061	-0.074
Protective	0.190	0.080	0.083	0.124	<b><u>0.405</u></b>
Slow	-0.323	0.046	-0.381	-0.167	-0.127
Sociable	-0.045	0.206	0.005	<b><u>0.685</u></b>	-0.053
Abreactive	-0.144	0.098	0.063	0.036	0.034
Solitary	0.038	-0.065	-0.006	<b><u>-0.590</u></b>	0.032
Cooperative	0.049	0.240	<b><u>0.765</u></b>	0.014	0.055
Hardworking	-0.087	0.191	<b><u>0.696</u></b>	-0.091	-0.062
Subordinate	0.123	0.264	-0.022	-0.053	<b><u>-0.619</u></b>
Tense	<b><u>0.498</u></b>	-0.125	-0.157	-0.045	0.126
Friendly	-0.064	<b><u>0.771</u></b>	0.047	0.089	0.045
Reliable	<b><u>-0.463</u></b>	<b><u>0.500</u></b>	0.133	-0.210	-0.037
Suspicious	<b><u>0.571</u></b>	-0.356	0.031	-0.140	0.024
Stubborn	0.038	-0.266	<b><u>-0.639</u></b>	0.119	0.024
Intelligent	0.006	-0.049	<b><u>0.487</u></b>	0.267	0.096
Reactive against items from behind	<b><u>0.515</u></b>	-0.111	0.128	-0.108	-0.009

Bold and underlined indicates factor loading > |0.4|.

Table 3: Factor loadings of the 43 questionnaire items, for the Nordland/Lyngen, on five varimax-rotated principal component estimates with eigenvalues &gt;1.

	<b>Factor 1</b>	<b>Factor 2</b>	<b>Factor 3</b>	<b>Factor 4</b>	<b>Factor 5</b>
Willing to learn	-0.120	0.218	<b><u>0.653</u></b>	0.271	-0.009
Confident	<b><u>-0.685</u></b>	0.143	0.092	0.083	0.348
Curious	-0.066	-0.007	0.068	<b><u>0.639</u></b>	0.224
Robust	<b><u>-0.634</u></b>	-0.021	0.066	0.035	0.226
Aggressive	0.071	<b><u>-0.622</u></b>	0.038	0.043	0.162
Permissive	-0.347	<b><u>0.506</u></b>	0.227	-0.069	-0.029
Apprehensive	<b><u>0.798</u></b>	-0.023	-0.041	0.078	0.006
Stereotypic	0.060	0.034	-0.066	0.103	-0.071
Independent	<b><u>-0.514</u></b>	-0.057	0.229	0.070	0.311
Dominant to horses	0.052	-0.073	-0.052	-0.034	<b><u>0.605</u></b>
Dominant to humans	0.076	<b><u>-0.502</u></b>	-0.399	0.093	0.283
Flighty	<b><u>0.788</u></b>	-0.163	-0.016	-0.030	0.053
Equable	<b><u>-0.787</u></b>	0.086	0.066	-0.059	-0.004
Tactile sensitive	0.328	-0.091	0.109	0.208	0.126
Considerate	-0.145	<b><u>0.568</u></b>	0.295	-0.074	0.112
Sound sensitive	<b><u>0.735</u></b>	-0.063	-0.033	0.129	0.116
Visually sensitive	<b><u>0.733</u></b>	-0.135	-0.052	0.149	0.155
Social with humans	-0.124	<b><u>0.532</u></b>	0.074	0.359	0.011
Excitable	<b><u>0.700</u></b>	-0.165	-0.016	0.105	0.024
Restless	0.371	-0.162	-0.075	0.279	-0.057
Fearful	<b><u>0.650</u></b>	-0.208	-0.057	-0.125	-0.177
Socially intelligent	-0.204	0.316	0.142	0.296	-0.193
Opportunistic	0.001	-0.147	0.028	0.339	0.049
Speedy	0.398	-0.018	0.154	0.064	0.159
Insecure	<b><u>0.696</u></b>	-0.027	-0.161	0.032	-0.248
Playful	0.029	0.025	0.092	<b><u>0.640</u></b>	-0.077
Irritable	0.057	<b><u>-0.610</u></b>	-0.216	-0.003	0.143
Popular	-0.210	<b><u>0.660</u></b>	0.230	0.130	-0.032
Protective	0.026	-0.079	0.071	0.077	<b><u>0.474</u></b>
Slow	-0.220	-0.041	<b><u>-0.484</u></b>	-0.082	-0.058
Sociable	0.086	0.239	0.036	<b><u>0.667</u></b>	-0.007
Abreactive	-0.359	0.075	0.125	0.024	0.021
Solitary	-0.173	-0.175	-0.101	<b><u>-0.457</u></b>	0.119
Cooperative	-0.130	0.216	<b><u>0.750</u></b>	0.055	0.050
Hardworking	-0.169	0.250	<b><u>0.662</u></b>	0.001	0.084
Subordinate	0.130	0.049	0.011	0.078	<b><u>-0.541</u></b>
Tense	<b><u>0.597</u></b>	-0.230	0.065	-0.112	-0.093
Friendly	-0.134	<b><u>0.771</u></b>	0.082	0.101	-0.022
Reliable	<b><u>-0.527</u></b>	<b><u>0.460</u></b>	0.109	-0.111	0.034
Suspicious	<b><u>0.469</u></b>	<b><u>-0.471</u></b>	0.045	-0.174	0.044
Stubborn	0.026	-0.264	<b><u>-0.678</u></b>	0.123	0.136
Intelligent	-0.196	-0.056	<b><u>0.555</u></b>	0.351	0.050
Reactive against items from behind	<b><u>0.549</u></b>	-0.140	-0.061	-0.014	0.208

Bold and underlined indicates factor loading > |0.4|.



Table 4: Factor loadings of the 43 questionnaire items, for the Dole, on five varimax-rotated principal component estimates with eigenvalues >1.

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Willing to learn	-0.237	0.045	<b><u>0.653</u></b>	0.134	-0.026
Confident	<b><u>-0.686</u></b>	0.028	0.243	-0.026	0.169
Curious	-0.177	-0.038	0.073	<b><u>0.498</u></b>	-0.049
Robust	<b><u>-0.554</u></b>	0.255	-0.022	0.099	0.270
Aggressive	0.134	<b><u>-0.597</u></b>	-0.042	-0.100	0.023
Permissive	-0.300	0.350	0.046	0.017	-0.160
Apprehensive	<b><u>0.747</u></b>	0.054	-0.039	0.053	0.076
Stereotypic	0.143	<b><u>-0.409</u></b>	0.101	-0.047	0.111
Independent	-0.298	0.058	0.301	-0.049	0.069
Dominant to horses	0.052	0.004	-0.011	-0.109	<b><u>0.436</u></b>
Dominant to humans	0.233	-0.283	<b><u>-0.426</u></b>	0.170	<b><u>0.519</u></b>
Flighty	<b><u>0.728</u></b>	-0.282	-0.094	-0.093	0.134
Equable	<b><u>-0.730</u></b>	0.157	0.119	0.082	0.028
Tactile sensitive	0.263	-0.227	0.155	0.123	-0.017
Considerate	-0.077	<b><u>0.565</u></b>	0.296	-0.007	-0.018
Sound sensitive	<b><u>0.652</u></b>	-0.104	0.051	0.050	0.158
Visually sensitive	<b><u>0.698</u></b>	-0.189	-0.061	-0.028	0.147
Social with humans	-0.130	<b><u>0.421</u></b>	0.099	<b><u>0.428</u></b>	-0.028
Excitable	<b><u>0.595</u></b>	-0.086	-0.087	0.013	0.263
Restless	0.183	<b><u>-0.421</u></b>	-0.083	0.281	0.162
Fearful	<b><u>0.511</u></b>	-0.330	-0.089	-0.166	0.046
Socially intelligent	-0.186	<b><u>0.403</u></b>	0.130	0.044	-0.028
Opportunistic	-0.027	-0.155	-0.174	0.350	0.091
Speedy	<b><u>0.413</u></b>	-0.150	0.111	-0.006	0.349
Insecure	<b><u>0.626</u></b>	-0.017	-0.196	0.091	-0.196
Playful	0.009	0.157	-0.006	<b><u>0.513</u></b>	0.038
Irritable	0.108	-0.375	-0.156	0.138	<b><u>0.481</u></b>
Popular	-0.267	<b><u>0.517</u></b>	0.192	0.156	-0.039
Protective	0.108	0.200	0.129	0.083	0.221
Slow	-0.133	0.085	<b><u>-0.536</u></b>	-0.005	-0.096
Sociable	0.016	0.236	-0.009	<b><u>0.609</u></b>	-0.122
Abreactive	0.002	0.143	-0.006	0.136	0.012
Solitary	-0.069	-0.079	-0.068	<b><u>-0.405</u></b>	0.332
Cooperative	-0.098	0.392	<b><u>0.609</u></b>	-0.005	-0.211
Hardworking	-0.144	0.324	<b><u>0.607</u></b>	-0.109	-0.089
Subordinate	0.193	-0.002	0.018	0.278	-0.322
Tense	<b><u>0.493</u></b>	-0.226	-0.140	-0.066	0.291
Friendly	-0.047	<b><u>0.563</u></b>	0.109	0.239	0.017
Reliable	<b><u>-0.474</u></b>	<b><u>0.511</u></b>	0.180	0.003	-0.027
Suspicious	<b><u>0.416</u></b>	-0.134	-0.115	-0.071	0.248
Stubborn	0.144	-0.167	<b><u>-0.649</u></b>	0.119	<b><u>0.402</u></b>
Intelligent	-0.189	0.196	<b><u>0.456</u></b>	0.342	0.060
Reactive against items from behind	<b><u>0.508</u></b>	-0.091	0.029	-0.068	-0.008

Bold and underlined indicates factor loading > |0.4|.

Table 5: Factor loadings of the 43 questionnaire items, for the Norwegian coldblooded trotter, on five varimax-rotated principal component estimates with eigenvalues >1.

	<b>Factor 1</b>	<b>Factor 2</b>	<b>Factor 3</b>	<b>Factor 4</b>	<b>Factor 5</b>	<b>Factor 6</b>
Willing to learn	-0.242	0.102	<b>0.509</b>	0.320	-0.084	0.043
Confident	<b>-0.677</b>	0.102	0.057	0.137	-0.131	0.380
Curious	-0.160	0.059	0.041	<b>0.519</b>	0.034	0.092
Robust	<b>-0.511</b>	0.178	0.117	0.183	-0.048	0.245
Aggressive	0.112	<b>-0.578</b>	-0.005	0.060	0.053	0.117
Permissive	-0.247	<b>0.483</b>	0.273	0.139	-0.116	-0.071
Apprehensive	<b>0.815</b>	-0.030	0.015	-0.052	0.034	0.016
Stereotypic	0.245	-0.171	-0.108	-0.021	0.058	-0.003
Independent	-0.366	-0.072	0.224	-0.049	-0.259	0.397
Dominant to horses	0.013	-0.208	-0.022	-0.093	0.087	<b>0.606</b>
Dominant to humans	0.072	-0.255	<b>-0.508</b>	0.187	0.073	0.316
Flighty	<b>0.602</b>	-0.125	-0.182	-0.156	0.132	0.032
Equable	<b>-0.698</b>	0.189	0.167	0.035	-0.243	0.110
Tactile sensitive	0.153	-0.168	0.076	-0.177	0.377	0.068
Considerate	-0.089	<b>0.516</b>	0.373	0.083	0.100	0.091
Sound sensitive	<b>0.711</b>	0.021	0.008	0.050	0.116	0.050
Visually sensitive	<b>0.712</b>	0.014	-0.063	0.055	0.054	0.015
Social with humans	-0.035	<b>0.518</b>	0.030	<b>0.528</b>	-0.083	-0.150
Excitable	<b>0.448</b>	-0.173	-0.188	-0.061	<b>0.452</b>	-0.089
Restless	0.098	-0.344	-0.191	0.149	0.394	-0.161
Fearful	<b>0.556</b>	-0.044	-0.038	-0.301	0.271	-0.043
Socially intelligent	-0.067	0.322	0.139	0.138	-0.116	0.056
Opportunistic	-0.125	0.031	0.019	0.310	-0.052	0.231
Speedy	0.143	-0.027	-0.193	-0.049	<b>0.645</b>	0.184
Insecure	<b>0.497</b>	-0.088	-0.078	0.004	0.304	-0.356
Playful	0.017	0.061	0.073	<b>0.641</b>	-0.057	0.099
Irritable	0.077	<b>-0.469</b>	-0.091	-0.137	0.199	0.102
Popular	0.008	<b>0.536</b>	0.382	0.197	-0.104	0.071
Protective	0.013	0.063	0.023	0.018	0.141	<b>0.433</b>
Slow	-0.120	0.073	-0.073	-0.073	<b>-0.539</b>	-0.022
Sociable	0.046	0.228	0.037	<b>0.711</b>	-0.014	-0.132
Abreactive	-0.137	0.160	0.029	0.166	0.093	0.120
Solitary	-0.080	-0.042	-0.108	<b>-0.557</b>	-0.033	0.119
Cooperative	-0.087	0.153	<b>0.689</b>	0.068	-0.074	0.026
Hardworking	-0.111	0.131	<b>0.620</b>	0.124	0.003	0.181
Subordinate	0.214	0.202	0.008	-0.078	0.107	<b>-0.575</b>
Tense	0.383	-0.213	-0.221	-0.015	<b>0.505</b>	-0.109
Friendly	0.019	<b>0.723</b>	0.122	0.262	-0.088	-0.181
Reliable	-0.399	<b>0.510</b>	0.364	-0.047	-0.098	0.022
Suspicious	0.378	-0.312	-0.062	-0.222	0.259	0.128
Stubborn	0.049	-0.152	<b>-0.663</b>	-0.003	0.047	0.105
Intelligent	-0.239	0.144	<b>0.401</b>	0.268	-0.034	0.208
Reactive against items from behind	<b>0.494</b>	-0.071	-0.073	0.089	-0.002	-0.051

Bold and underlined indicates factor loading > |0.4|.

Table 6: Total sample variance explained by each factor as well as the cumulated variance explained by all factors for the four breeds.

<b>Breed</b>	<b>Factor 1</b>	<b>Factor 2</b>	<b>Factor 3</b>	<b>Factor 4</b>	<b>Factor 5</b>	<b>Factor 6</b>	<b>Total</b>
Fjord horse	0.1559	0.0872	0.0700	0.0531	0.0353	-	0.4015
Nordland/Lyngen horse	0.1782	0.0943	0.0717	0.0550	0.0390	-	0.4382
Dole horse	0.1431	0.0824	0.0666	0.0453	0.0426	-	0.3800
Coldblooded trotter	0.1235	0.0767	0.0666	0.0610	0.0482	0.0443	0.4203