

The effects of environment, practices, and gear chosen by the horse owner on horse behavior

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Horses (*Equus caballus*), members of the *Equidae* family, are large ungulates with an evolutionary history stretching back 55 million years. Since their domestication around 2000 B.C, modern horses have been going through changes in their immediate surroundings, as they were led to get accustomed to human-controlled environments. As the equestrian community has recently become increasingly concerned with how different environmental conditions impact horses' behavior and interactions with humans, I set a goal to investigate that with an online questionnaire. The questionnaire consisted of two sections: a background information section and a horse personality assessment. The background information section gathered information about human-chosen environmental factors (herd size, time spent in pasture, number of caretakers and riders, relationship length), frequency of practices (riding, groundwork, spending quality time), and headgear used, alongside with horse intrinsic parameters, such as age, sex and breed. In the personality questionnaire, respondents were presented with 52 different adjectives and asked to rate how well each described their horse. The questionnaire gathered 2028 respondents from France and Finland. The results of this study indicate that there is a clear association between human-made choices and horse behavior. Horse personality traits – human sociability, horse sociability, attentiveness, neuroticism – were associated by human-made choices regarding housing conditions, headgear, the number and lengths of interactions with humans, and the frequency of practices. There were also links between personality traits and horses' sex, age and breed. Recognizing and understanding the interactions between human actions and horse behavior provide a valuable foundation for initiating conversations on responsible horse ownership and management practices.

Key words: horse, herd size, headgear, relationship length, riding, groundwork, quality time, owner, rider

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Hevoseläinten (*Equidae*) heimoon kuuluvat hevoset (*Equus caballus*) ovat suurikokoisia kaviokyntisiä, joiden evolutiivinen historia ulottuu 55 miljoonan vuoden taakse. Domestikoitumisestaan (2000 eaa.) lähtien hevoset ovat joutuneet totuttautumaan erilaisiin, ihmisten hallitsemiin elinympäristöihin. Koska hevosharrastajat ovat viime aikoina osoittaneet kiinnostusta siihen, miten erilaiset ympäristötekijät vaikuttavat hevosten käyttäytymiseen ja vuorovaikutukseen ihmisten kanssa, asetin tavoitteekseni tutkia tätä nettikyselyn kautta. Kysely koostui kahdesta osasta: taustatietoja kartoittavasta osiosta ja persoonallisuuskyselystä, jossa kartoitettiin hevosen persoonallisuustekijöitä. Taustatieto-osiossa keräsin tietoa ihmisen tekemistä ympäristöön liittyvistä valinnoista, kuten hevoslauman koosta, laitumella vietetystä ajasta, omistajien ja ratsastajien määrästä, sekä hevosen ja ihmisen välisen vuorovaikutussuhteen kestosta. Lisäksi kyselyssä selvitettiin eri aktiviteettien, kuten ratsastuksen, maastatyöskentelyn ja yhdessä vietetyn laatuajan tiheyttä, sekä hevosella käytettyjen varusteiden käyttöä. Lisäksi otin huomioon hevosten sisäsyntyiset ominaisuudet, kuten iän, sukupuolen ja rodun. Persoonallisuuskyselyssä hevosenomistajille esitettiin 52 erilaista adjektiivia, ja pyydettiin heitä arvioimaan kuinka hyvin kyseiset adjektiivit kuvaavat heidän hevosiaan. Tutkimus keräsi 2028 osallistujaa Ranskasta ja Suomesta. Tutkimuksen tulokset osoittivat, että ihmisen tekemillä valinnoilla on selvä yhteys hevosten käyttäytymiseen. Hevosten persoonallisuuspiirteet – ihmisiin suuntautuva sosiaalisuus, hevosiin suuntautuva sosiaalisuus, tarkkaavaisuus ja neuroottisuus – olivat yhteydessä ihmisen tekemiin päätöksiin, kuten asumisolosuhteisiin, varusteiden valintaan, ihmisten kanssa solmittujen vuorovaikutussuhteiden määrään ja pituuteen, sekä eri aktiviteettien tiheyteen. Myös hevosen sukupuolella, iällä ja rodulla oli vaikutusta persoonallisuuspiirteisiin. Näiden yhteyksien tunnistaminen ja ymmärtäminen tarjoaa arvokkaan lähtökohdan keskusteluille vastuullisesta hevosenpidosta ja hoitokäytännöistä.

Avainsanat: hevonen, lauman koko, varusteet, suhteen kesto, ratsastus, maastatyöskentely, laatu aika, omistaja, ratsastaja

Table of contents

1. Introduction	5
2. Methods	9
2.1 Questionnaire	9
2.2 Participants	12
2.3 Ethics	12
2.4 Horse personality factor analyses	13
2.4.1 Before analyzing	13
2.4.2 An exploratory factor analysis	13
2.4.3 Confirmatory factor analysis	14
2.4.4 Cross-cultural validation	14
2.4.5 Factor scores and hypothesis testing	14
2.4.6 Personality structure	15
2.5. Statistical analyses	17
3. Results	18
3.1 Herd size	18
3.2 Number of previous owners	19
3.3 Number of riders	21
3.4 Relationship length	22
3.5 Practices	23
3.6 Headgear	25
3.7 Horse age	27
3.8 Horse sex	29
3.9 Horse breed	31
4. Discussion	32
4.1 Herd size	33
4.2 The number of owners and riders	34
4.3 Relationship length	36
4.4 Practices	36
4.5 Headgear	38
4.6 Intrinsic factors (horse age, sex and breed)	39
4.7 Limitations of the study	40
4.8 Conclusions	41
5. Acknowledgements	41
References	43
Appendices	52
Appendix 1. Horse Personality Questionnaire	52
Appendix 2. Pairwise Comparison Results (Post Hoc Analyses)	57

1. Introduction

Humans domesticated the first domestic animals around 12 000 years ago (Davis et al., 1978; Larson et al., 2014). During this coevolution, these domesticated species have undergone many changes in their appearance, behavior, and ability to understand human commands (Price 1999; Stafford 2006; Reid 2009; Udell et al., 2010; Wilking et al., 2014). Additionally, their habitats and social aspects have changed radically compared to their original wild environments (Price 1999). The effects of these differences on the welfare of domestic animals have only recently started to be considered (Stafford 2006; Saraiva et al., 2018).

One of those domesticated animals are horses (*Equus caballus*). Horses, members of the *Equidae* family, are large ungulates with an evolutionary history stretching back 55 million years (MacFadden, 2005). These prey animals (Saslow, 2002) naturally form social groups in their native environment (Salter & Hudson, 1982). These social groups, called harems, typically contain mares and one to five stallions (Linklater et al., 1999). Mature females often remain together most of their lives (Krueger, 2008), allowing horses to develop strong, long-lasting bonds. As a grazing animal that prefers open grasslands, horses can spend 12 to 18 hours each day feeding and cover distances of 9 to 16 km daily, indicating that they are a physically active species (Hampson et al., 2010).

Since their domestication around 2000 B.C (Librado et al., 2021), modern horses have been going through changes in their immediate surroundings, as they were led to get accustomed to human-controlled environments. Since environmental conditions, such as access to food and the amount of space available, significantly impact the time horses spend feeding, resting, and exercising (Auer et al., 2021), it is crucial to create an environment that meets their needs. When the environment does not allow horses to express their natural behaviors, they may be forced to suppress them, resulting in a lower quality of life and the development of stereotypic behaviors (Cooper & Mason, 1998; Cooper, 2007; Lesimple et al., 2019). Hockenhull and Creighton (2014) also point out that housing conditions are among the most significant reasons for behavioral problems and aggression toward humans in leisure horses.

Humans' housing conditions for domestic horses vary in enclosure size and the number of conspecifics they can interact with. While some horses are housed alone in individual stalls, others can spend all their time in pasture groups (Hockenhull & Creighton, 2014; Maisonpierre, 2019; Lesimple et al., 2019; Dai et al., 2023). Living outdoors in pastures most

closely resembles the natural conditions of feral horses (Dai et al., 2023), and since the expression of natural behaviors is regarded as a key indicator of good welfare (Bracke & Hopster, 2006; Regaiolli et al., 2020; Harvey et al., 2022), it is likely that group housing may have a more positive effect on a horse's well-being compared to a single housing (Søndergaard & Ladewig, 2004; Ruet et al., 2020). The horses living in groups in a pasture are more active than their stabled conspecifics (Maisonpierre, 2019) and display fewer aggressive behaviors toward humans (Søndergaard & Ladewig, 2004; Ruet et al., 2020). On the other hand, a single indoor housing environment does not offer the same possibility to move freely or engage in social behaviors, decreasing horses' welfare (McGreevy et al., 2018). Horses kept in isolation lack the security of a herd, which heightens their need for vigilance and disrupts their sleeping patterns (McGreevy et al., 2018). Kiley-Worthington (1990) also points out that isolated housing is linked to heightened aggression, nervousness, and excitability. Still, people might want to keep their horses in individual stalls since they are concerned that outdoor group housing could potentially lead to injuries (Hartmann et al., 2015). The various usage – companion, sport, work - of the horse can also have an impact on the environmental conditions of horses, since depending on countries, up to 58-90% of the sport horses can be stabled in single boxes (Leme et al., 2014; Larsson & Müller., 2018).

Another environmental condition horses can experience is the amount of humans they interact with. They may experience interactions with a diverse number of riders (Hanousek et al., 2020; Neumann et al., 2021) and owners (Clough et al., 2021; Liehrmann et al., 2022), with whom the duration of their relationship may vary (Liehrmann et al., 2022; Liehrmann et al., 2023). These factors were shown to impact horse behavior in the context of interactions with humans, as multiple riders, ownership changes, and a short relationship with the owner were shown to increase the horses' reluctance to face novel objects while handled by humans (Liehrmann et al., 2022). Different people may also engage in their horses' lives with varying frequencies and types of activities—ranging from riding to groundwork (training from the ground without riding) and simply spending quality time together without specific demands (Keaveney, 2008; Jung et al., 2019; Grandgeorge et al., 2024). Owners also use different types of headgear, such as bitted or bitless bridles, when engaging in activities with their horses (Condon et al., 2022). The choice of headgear is significant, as it plays a role in discussions around rider safety, horse welfare, and overall rider satisfaction (VanderHorst et al., 2013; Luke et al., 2023).

As the equestrian community has recently become increasingly concerned with how different environmental conditions impact horses' behavior and interactions with humans (Kelemen et al., 2021; Cerasoli et al., 2022; Ross et al., 2023), I set a goal to investigate this aspect with an online questionnaire. First part of the questionnaire gathered information about human-chosen environmental factors (herd size, time spent in pasture, number of caretakers and riders, relationship length), frequency of practices (riding, groundwork, spending quality time), and headgear used, alongside with horse intrinsic parameters, such as age, sex and breed. Second part of the questionnaire was an adjective-based horse personality evaluation, based on several other questionnaires using the same adjectives to assess horses' behavior (Momozawa et al., 2005; Lloyd et al., 2007; Duberstein & Gilkeson, 2010; Olsen & Klemetsdal, 2017). This questionnaire resulted in four biologically significant personality factors: human sociability, horse sociability, attentiveness, and neuroticism. Human sociability reflects a horse's curiosity and social behavior toward humans, while horse sociability describes its interactions with other horses. Neuroticism represents fearfulness, whereas attentiveness reflects a horse's responsiveness to humans and ability to focus. These four factors for which each horse was attributed a score were used to explore the effects of environment, practices, and gear chosen by the horse owner on their horse behavior.

- I started the investigation by focusing on the human-chosen environmental factors, like herd sizes the horses get to live with. Since horses can read human-made cues (Maros et al., 2008; Krueger et al., 2011), and horses living in herds are better at following human-given cues (Liehrmann et al., 2023), I predict that horses living in herds could be rated as more attentive than horses housed alone.
- While horses perform better in a stable social environment with fewer riders (Neumann et al., 2021) and tend to be more hesitant toward novelty when there are multiple handlers or owners (Liehrmann et al., 2022), I predict horses with multiple owners and/or riders to be rated as more neurotic.
- Additionally, there is evidence that relationship length affects responses in test situations both in Asian elephants (*Elephas maximus*) (Crawley et al., 2021; Liehrmann et al., 2021), and horses (Liehrmann et al., 2022). Because both animals show less fear of novelty when handled by a handler they have known for a longer versus shorter time, I predict that the longer the relationship, the lower the neuroticism levels.

Alongside the environmental factors, I will shed light on how human-horse activity patterns, e.g. how often humans either ride their horses, do groundwork with them, or spend quality time with them, may reflect on the horse behavior.

- Since frequent riding can demand horses to enter and work in novel environments (Hall et al., 2013) and interact with foreign obstacles (McGreevy et al., 2007), I hypothesize that this interaction with new and possibly threatening stimuli might lead to heightened neuroticism and attentiveness levels, at least in newly ridden horses that are not habituated in novel situations. Through this hypothesis, I expect that riders who ride their horses frequently may rate them as more attentive and neurotic than those who ride less often.
- Groundwork differs from riding in that the horse is trained from the ground, without being ridden. Using groundwork methods in horse training has been shown to reduce heart rate and lower horse stress levels (Visser et al., 2009; Kędzierski et al., 2012). It is also described in the literature as “engaging playfully with the horse” (Smith, 2018), suggesting that humans actively foster and encourage positive social interaction during these sessions. So I hypothesize that regularly fostering this contact through groundwork leads humans to rate their horses as more social with humans compared to those who do not engage in groundwork as frequently.
- Spending quality time, e.g., hanging out with the horse without asking it to do anything, is often described similarly as doing groundwork, as people describe quality time spent with the horse as “playing,” “fooling around,” or “just being” with the horse (Koski & Spännäri, 2024). This interaction is seen as very meaningful and pleasant to both of the parties, as people describe that “we seem to enjoy each other’s company” (Keaveney, 2008), implying that the horse seeks human company in the same way that the human seeks horse company. Thus, I expect people spending regular quality time with their horses to rate those horses more social with humans than horses with whom humans do not interact so often.
- Regarding the headgear horse owners use, bitted gear has been linked to mouth pain and injuries (Cook, 2003; Mellor, 2020) and heightened fear levels (Mellor, 2020) in horses. Based on this, I hypothesize that horses ridden with bits will be rated higher in neuroticism.

- Lastly, as age, sex, and breed may influence horse behavior, I included these intrinsic factors into the statistical analyses to control for their potential association with the horse personality factors.

The aim of this study is to better understand the human-horse relationship by examining how the environment and habits provided by the horse owners reflect on their horse behavior. This information could lead to refined guidelines for horse housing.

2. Methods

2.1 Questionnaire

The questionnaire I made for this study consisted of two sections: a background information section and a horse personality assessment. It was distributed in Finland and France between June 2023 and February 2024 and was available in Finnish, French, and English. Alisa Viitanen provided the Finnish and English translations, while the French translation was completed by Océane Liehrmann.

The first section used 25 questions to assess respondents' interactions with their horses, focusing on the frequency of activities such as riding, groundwork, and spending quality time together. It also collected details about horse housing, including herd size and the amount of time horses spend in pasture. Additionally, it examined the types of headgear used, categorizing headgear as bitless, bit-only, or a combination of them. Information about the horses, such as their sex, age, and breed, was gathered, along with background details about the owners, including their biological sex, age, and country of residence. Lastly, the questionnaire addressed the duration of the owner-horse relationship and the number of horses owned. More detailed descriptions of the predictors can be found in Table 1.

Table 1.
Definitions and sample sizes of the different predictors.

Predictors		Sample size	Additional details	Definitions
Riding Frequency	Ordinal factor	Non broken or retired	240	How often the horse owner rides/drive their horse
		Never	179	
		Rarely	272	

Predictors		Sample size	Additional details	Definitions	
		Once or twice a month	187		
		Once or twice a week	688		
		4 to 7 times a week	462		
Groundwork Frequency	Ordinal factor	Never	119	How often the horse owner trains their horses from the ground (not on the horse)	
		Rarely	287		
		Once or twice a month	405		
		Once or twice a week	954		
		4 to 7 times a week	263		
Quality time Frequency	Ordinal factor	Never	17	How often the respondent spend time with their horse without asking anything from them. (e.g. just being with the horse in the stall, the paddock or the pasture, giving them scratches or treats, or just doing nothing at all)	
		Rarely	76		
		Once or twice a month	146		
		Once or twice a week	631		
		4 to 7 times a week	1158		
Headgear used	Ordinal factor	Horse not ridden/trained	361	The type of headgear used during riding or training. Respondents could choose multiple options and were classified based on whether they selected only bitless headgear, only headgear with bits, or a combination of both.	
		Bitless only	58		The owner only uses bitless options when training or riding the horse (e.g., neck rope, rope, classic halter, bitless bridles).
		Bitless and bit	599		The owner uses both bitless and bit headgear when training/riding the horse
		Bit only	983		The owner only uses headgear with a bit when training/riding the horse
Relationship Length	Ordinal factor	0 to 1 year	215	The duration in years since the respondent knows their horse	
		2 to 5 years	689		
		6 to 10 years	567		
		more than 10 years	542		
Previous	Factor	Horse is with breeder	258	The respondent and owner of the horse is also its breeder	

Predictors			Sample size	Additional details	Definitions
		Horse is bought from the breeder	749		The number of ownership changes the horse has had, varying from living with the breeder to multiple ownership changes.
		Multiple	1021		
Number of riders		Not ridden	384	The horse is not ridden.	The number and the type of riders the horse has - whether it is ridden with a small circle of familiar riders or with several, possibly unfamiliar riders
		Exclusive rider	1026	The horse has one rider.	
		Friends/family	395	Friends and family also ride the horse.	
		Shared with others	223	The horse is ridden by several people, outside of friends and family.	
Herd size	Factor	Alone	479	The horse lives alone	The number of other horses the horse lives with.
		Dyad	525	The horse lives with one other horse	
		Herd	983	The horse lives with several other horses	
Horse sex	Factor	Mare	900	Female	Sex of the horse. Males are categorised according to their sterilisation status. Females are usually not sterilised.
		Gelded	1038	Sterilised male	
		Stallion	90	Non sterilised male	
Horse age		Continuous	2028	min = 0.5; Max = 35; Mean = 13; SD = 6	Age of the horse in years
Breed		Draught horse	112	E.g. Friesians, Irish cob	Horse breeds divided into 5 different categories based on their genetics (Leroy et al., 2009; Petersen et al., 2013)
		Nordic	440	E.g. Finnish coldblood, Fjord	
		Pony	131	E.g. Connemara, British pony	
		Warm-blooded	1091	E.g. American trotter, Anglo-arabian	
		Unknown	254	E.g. Crossbreeds	
Random Factors			Sample size		
Location	Factor	Finland	912		Geographical location of the respondent.
		France	1116		
Human age	Ordinal factor	18 - 24	120		Human age in categories. Respondents under 18 years old were not allowed to answer the survey.
		25 - 34	487		
		35 - 44	561		
		45 - 54	478		
		55 - 64	302		
		65 and over	80		

Predictors		Sample size	Additional details	Definitions
Human sex	Factor	Female	1915	Human biological sex
		Male	96	
		Other	17	
Human ID	Factor		2028	The ID number given to the respondent.

The second section of the questionnaire consisted of a personality questionnaire featuring 52 adjectives, adapted from previous studies that used the same descriptors to evaluate horse behavior (Momozawa et al., 2005; Duberstein & Gilkeson, 2010; Lloyd et al., 2007; Olsen & Klemetsdal, 2017). One adjective presented to respondents can, for example, be ‘activity,’ which measures how the horse moves around and if it dislikes standing still for long. Respondents were asked to indicate their level of agreement with each adjective using a six-point scale: "strongly disagree," "disagree," "neutral," "agree," "strongly agree," and "I don't know." Details of the adjectives are provided in Appendix 1.

2.2 Participants

A total of 2028 individuals took part in this research. Recruitment was done through social media, online, and publications in equestrian paper and online press, and by directly reaching out to horse stables in France and Finland. The most common age group among participants was 35-44 years. Of the respondents, 1915 were women (94.4 %), 96 were men (4,7 %), and 17 identified as intersex or preferred not to disclose their gender (0.8 %). The majority of participants were from France (55.0 %) and then Finland (45.0 %). Only individuals aged 18 or older were eligible to participate in the survey. Participants could fill out the horse personality part of the questionnaire multiple times if they had more than one horse.

2.3 Ethics

The Ethics Committee for Human Sciences at the University of Turku (Humanities and Social Sciences Division) approved the informed consent and the research protocol (approval number 36/2023). Before starting the questionnaire, participants were asked for consent to use their information in research, with the knowledge that they could remove their consent at any point.

2.4 Horse personality factor analyses

The factor analysis was performed to reduce the questionnaire items into a smaller number of biologically meaningful traits, which is usually done in personality research (Mikkonen et al., 2021; Salonen et al., 2021). The factor analyses thus created a cluster of factors representing a personality dimension.

2.4.1 Before analyzing

Before the analysis, the adjective "protective" ("My horse is protective and prevents harm or possible harm to other horses") was removed because 21.1% of respondents answered "I don't know/can't say." The data was then split into train and test sets to allow for an assessment of dimensionality using cross-validation.

2.4.2 An exploratory factor analysis

An exploratory factor analysis was conducted on the train data (N = 1010). The suitability of the data for factor analysis was first verified using the Kaiser-Meyer-Olkin (KMO) test, which yielded a value of 0.91, indicating excellent factorability. Next, the number of factors was visually assessed using a scree test, which suggested a possible solution with either three or six factors. Additionally, Velicer's minimum average partial (MAP) test was used to estimate the number of factors, with the lowest MAP value indicating nine factors.

The decision on the number of factors was made by extracting all factor solutions ranging from 1 to 10 factors and comparing them. I based the comparison both on the content of the factors (i.e., which variables load onto each factor) and on fit indices, particularly the Tucker-Lewis Index and the Root Mean Square Error of Approximation (RMSEA). All factor analyses were conducted using polychoric correlations and mean imputation for missing values.

A Heywood case occurred in factor solutions with 7 to 10 factors, where more than 100% of a variable's variance was explained by the factors—resulting in negative residual variance. Due to this issue, these factor configurations were excluded from further analysis. One- and two-factor models proved difficult to interpret and were therefore also excluded. For the remaining models, various rotation methods were compared, and the number of factors that did not load onto any factors and those with cross-loadings (loading onto two or more factors simultaneously) were calculated.

The different factor structures were compared, and from the models that best fit the data, preference was given to models offering the greatest biological relevance—that is, those best capturing meaningful behavioral variation among horses. Based on this criterion, a four-factor solution was selected, with each factor named according to the types of adjectives it included. Adjectives that did not load onto any factors were excluded from the final analysis. The final analysis used a Varimax rotation with four factors. Internal consistency for these factors was assessed using Cronbach's alpha and Guttman's lambda.

All analyses were conducted using the R package psych (v. 2.4.6.26; William Revelle, 2024).

2.4.3 Confirmatory factor analysis

To assess the stability of the four-factor structure identified in the EFA (exploratory factor analysis), a confirmatory factor analysis (CFA) was applied to the test data (N = 1018) using the cfa-function from the lavaan- package (v.0.6.19; Yves Rosseel 2012). In addition to default settings, the residual variances of the latent factors were constrained to one.

When evaluating the CFA's four-factor structure, the standardized estimates (equivalent to loadings in the EFA) and model fit indices were examined. The relative fit indices indicated a poor fit (TLI = 0.721, CFI = 0.738), while the absolute fit index showed an acceptable fit (RMSEA = 0.078 [0.076, 0.080]).

Finally, Cronbach's alpha and Guttman's lambda were calculated for this dataset to assess the reliability of survey items and to help determine whether a collection of items consistently measures the same characteristic.

2.4.4 Cross-cultural validation

CFA models were applied separately to both the Finnish and French datasets, as described above, to confirm the suitability of the four-factor model across different cultures. In this comparison, particular attention was given to standardized estimates for factors and model fit indices.

2.4.5 Factor scores and hypothesis testing

Based on the EFA conducted on the train data, factor scores were calculated for each horse using the "tenBerge" method from the psych-package (v. 2.4.6.26; William Revelle, 2024),

with mean imputation for missing values. The relevance of the personality survey was further validated by comparing the factor scores with previous research findings and existing literature.

2.4.6 Personality structure

The factor analysis identified four distinct personality traits that I named as: human sociability, horse sociability, neuroticism, and attentiveness. Human sociability reflects a horse's social behavior and curiosity toward humans, while horse sociability describes its interactions with other horses. Neuroticism represents fearfulness, and attentiveness captures a horse's responsiveness to humans and ability to focus.

Table 2.

Loadings of personality factors. Significant loadings for each personality trait are marked in bold (over 0.4 or below -0.4).

Adjective	Human sociability	Horse sociability	Neuroticism	Attentiveness
Curious with humans	0,77	0,05	-0,13	0,01
Affectionate with strangers	0,74	0,04	-0,16	0,02
Outreaching	0,69	0,05	-0,24	0,31
Affectionate with familiar	0,67	0,07	-0,04	0,11
Playful with humans	0,51	0	-0,13	-0,05
Easily approached	0,47	0	-0,15	0,16
Playful with horses	0,44	0,17	-0,01	-0,16
Curious	0,42	0,06	-0,51	-0,04
Kind	0,42	0,33	-0,11	0,54
Sociable	0,41	0,36	0,13	-0,04
Distrustful with horses	-0,41	-0,34	0,19	-0,05
Distrustful with humans	-0,56	-0,04	0,35	-0,24
Avoidant of strangers	-0,62	-0,05	0,3	-0,18
Solitary with humans	-0,76	-0,11	0,12	-0,06
Caring	0,2	0,64	-0,14	0,25

Adjective	Human sociability	Horse sociability	Neuroticism	Attentiveness
Permissive	-0,02	0,53	-0,09	0,16
Equable	0,08	0,52	-0,34	0,21
Submissive	-0,03	0,5	0,14	-0,02
Popular	0,25	0,46	-0,05	0,1
Controlling	0,06	-0,48	-0,09	-0,05
Pushy with horses	0,07	-0,64	0,09	-0,42
Aggressive with horses	-0,12	-0,85	0,13	-0,19
Anxious	-0,14	-0,06	0,86	-0,11
Fearful	-0,2	-0,08	0,83	-0,08
Insecure	-0,06	-0,01	0,8	-0,13
Excitable	-0,01	-0,15	0,64	-0,26
Reliable	0,06	0,17	-0,44	0,59
Confident	0,2	0,08	-0,82	0,17
Respectful	-0,11	0,11	-0,03	0,65
Responding	0,33	0,06	-0,14	0,62
Concentrated	0,07	0,05	-0,19	0,61
Obedient	0,14	0,1	-0,13	0,59
Consistent	0,11	0,17	-0,32	0,57
Attentive	0,26	0,06	0,02	0,55
Irritable	-0,19	-0,33	0,3	-0,46
Distracted	0,11	-0,05	0,33	-0,51
Stubborn	-0,11	-0,14	0,1	-0,57
Erratic	-0,16	-0,19	0,37	-0,57
Aggressive with humans	-0,23	-0,36	0,08	-0,58
Frustrated with constraint	-0,01	-0,19	0,21	-0,57
Pushy with humans	0	-0,22	0,08	-0,72

According to Table 2, horses scoring high in human sociability are curious about humans, affectionate with strangers, and outreaching, while horses scoring low in human sociability are solitary, avoidant of strangers, and distrustful of humans.

Horses scoring high in horse sociability are caring, permissive, and equable, while horses scoring low are controlling, aggressive, and pushy with horses.

Horses high in neuroticism tend to be anxious, fearful, and insecure, whereas those low in neuroticism are generally confident and reliable.

Horses scoring high in attentiveness are respectful, responsive, and concentrated, while horses scoring low are stubborn, erratic, and pushy with humans.

2.5. Statistical analyses

All analyses and data handling were conducted on R version 4.4.1, and figures were created using the ggplot2 package (v.3.5.1; H. Wickham, 2016).

Generalized linear mixed models (GLMMs) from the package glmmTMB (v.1.1.10; Mollie E. Brooks 2017) were used to assess how predictors, from Table 3, are associated with horse personality factors (human sociability, horse sociability, neuroticism, attentiveness). A normal distribution was used, and the DHARMA package (v.0.4.6; Hartig F 2022) was utilized to evaluate model dispersion, deviations, and overall fit. Human-related factors, such as age group, sex, and location, were incorporated as random effects to account for potential sociodemographic biases. To decide which models to select, the buildglmmTMB function from the buildmer package (v.2.11; Voeten CC 2023) was used to conduct stepwise backward elimination on glmmTMB models. A post hoc analysis (Tukey method) was then performed using the emmeans package (v.1.10.4; Lenth R 2024) to obtain the estimated marginal means and pairwise differences between groups.

Regarding the model for the personality factor “horse sociability,” certain human-related parameters, such as riding frequency, groundwork frequency, quality time frequency, head tack, other riders, and relationship length, were removed from the initial model, as this personality factor is based on adjectives involving horse-on-horse interaction and not human-horse interaction. Thus there was no biological reasons to formulate valid hypothesis to supporting potential association between horses to horse social behavior and the human related parameters I explore in this thesis.

Table 3.

A summary of selected predictors from the stepwise models. The marks indicate that a significant result was found. The dark gray areas represent predictor-personality factor combinations that were not rational to study.

Personality factors	Independent variables										Random factors				
	Riding Freq.	Groundwork Freq.	Quality time Freq.	Headgear	Previous owners	Other riders	Herd size	Relationship Length	Horse sex	Horse age	Breed	Human ID	Country	Human age	Human sex
Human sociability					✓	✓		✓	✓	✓				✓	✓
Horse sociability							✓		✓	✓			✓		
Attentiveness	✓			✓						✓		✓			
Neuroticism	✓			✓	✓				✓		✓		✓		

3. Results

Specific objectives of this research were to assess the impact of (1) environmental factors (herd size, number of owners and riders, relationship length), (2) practices (riding, groundwork, spending quality time), and (3) headgear chosen on horse behavior. Also, intrinsic factors (age, sex, and breed) were controlled.

3.1 Herd size

The herd size was associated with horse sociability levels, as horses living alone scored significantly lower in horse sociability than horses living in dyads ($df = 1916$, $t = -4.221$, $p = 0.0001$) or herds ($df = 1916$, $t = -4.515$, $p < 0.0001$) (Fig. 1, Appendix 2). Herd size wasn't associated with any other personality trait.

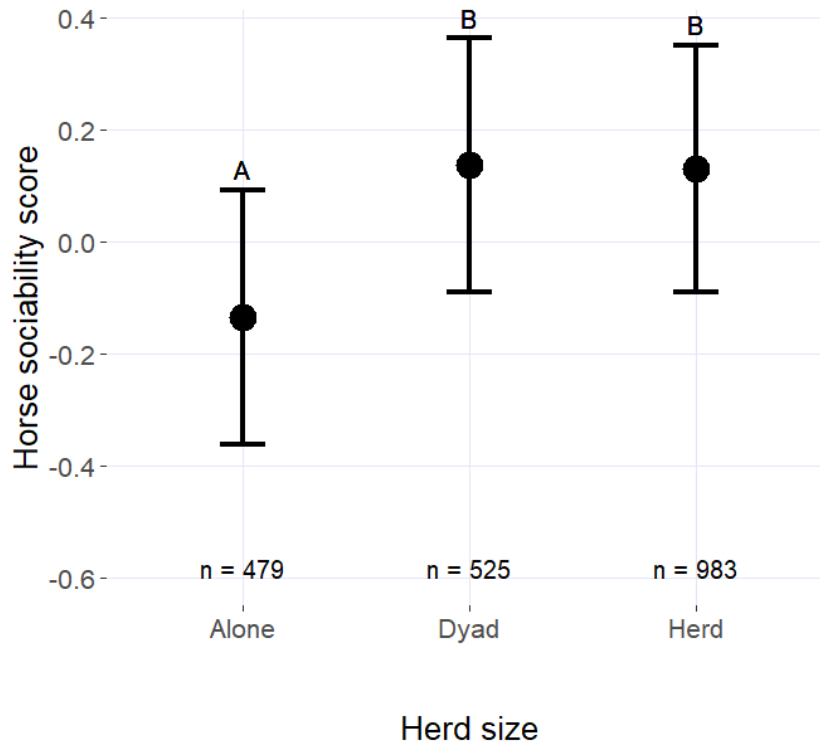
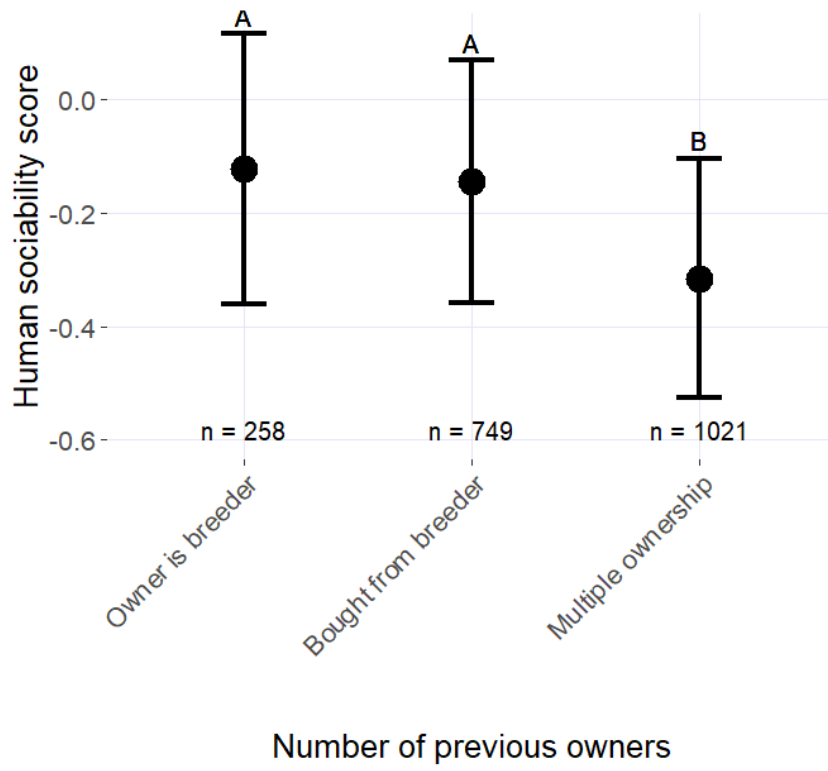


Figure 1. Association of horse sociability score with the herd size. Distinct letters signify statistically significant differences among the groups. The means and their associated 95% confidence intervals (error bars) were extracted from the corresponding model using the function `emmeans` from the “`emmeans`” package in R.

3.2 Number of previous owners

The number of previous owners was associated with human sociability and neuroticism levels. Horses with multiple owners were rated significantly less social with humans than those that live with their breeder ($df = 1909$, $t = 2.412$, $p = 0.0422$), or were bought from the breeder ($df = 1909$, $t = 3.248$, $p = 0.0034$) (Fig. 2, Appendix 2). Similarly, horses that have multiple owners also scored significantly higher on neuroticism than those that have been bought directly from the breeder ($df = 1902$, $t = -3.939$, $p = 0.0002$) or those horses living with their breeder and bought from the breeder ($df = 1902$, $t = -1.911$, $p = 0.1358$) (Fig. 2, Appendix 2)

a)



b)

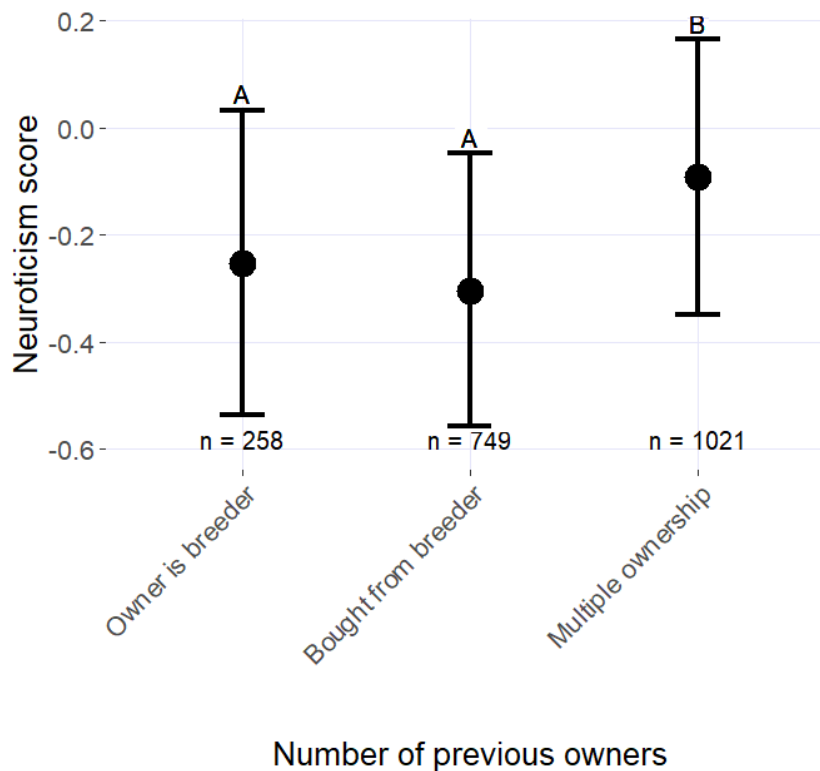


Figure 2. Association of A) human sociability score and B) neuroticism score with the number of previous owners. Distinct letters signify statistically significant differences among the groups. The means and their associated 95% confidence intervals (error bars) were extracted from the corresponding model using the function `emmeans` from the “`emmeans`” package in R.

3.3 Number of riders

The number of riders was associated with human sociability levels, as horses that were not ridden were associated with significantly lower human sociability scores than horses that were also ridden by friends and family ($df = 1909$, $t = -3.079$, $p = 0.0113$) (Fig. 3, Appendix 2).

Non-ridden horses also tended to be rated as less sociable compared to horses ridden exclusively by their owner ($df = 1909$, $t = -2.522$, $p = 0.0590$) and those shared with other riders (non relatives or friends) ($df = 1909$, $t = -2.522$, $p = 0.0569$).

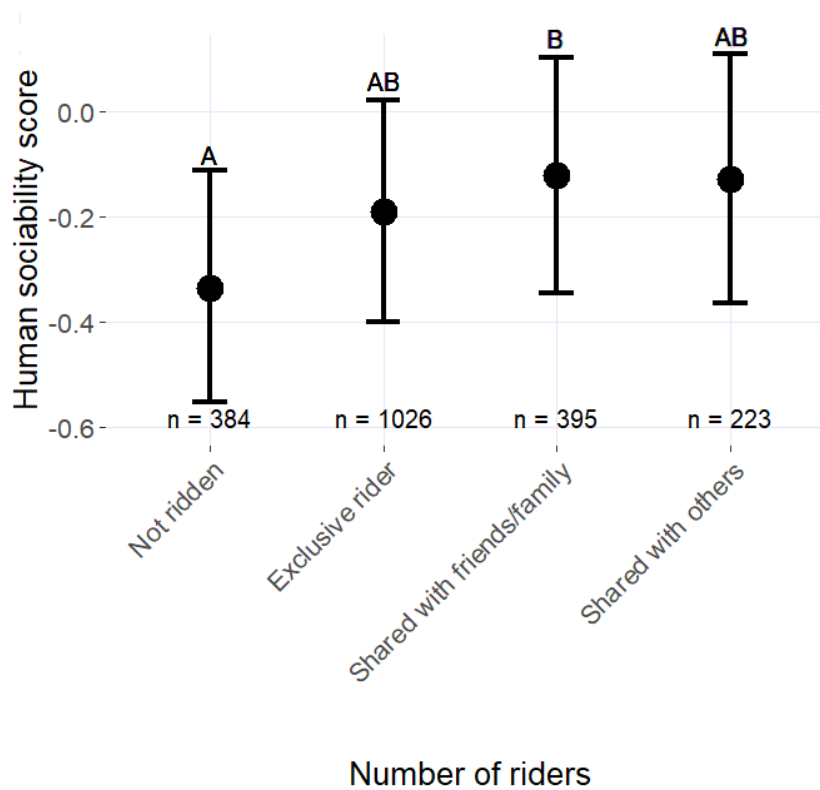


Figure 3. Association of human sociability score with the number of riders. Distinct letters signify statistically significant differences among the groups. The means and their associated 95% confidence intervals (error bars) were extracted from the corresponding model using the function emmeans from the “emmeans” package in R.

3.4 Relationship length

Horses that were reported to know their owner for over 10 years scored significantly higher in human sociability than horses that have known their owner for shorter times; 6-10 years ($df = 1909$, $t = -2.753$, $p = 0.0303$), 2-5 years ($df = 1909$, $t = -3.207$, $p = 0.0074$), or 0-1 year ($df = 1909$, $t = -3.340$, $p = 0.0047$) (Fig 4, Appendix 2).

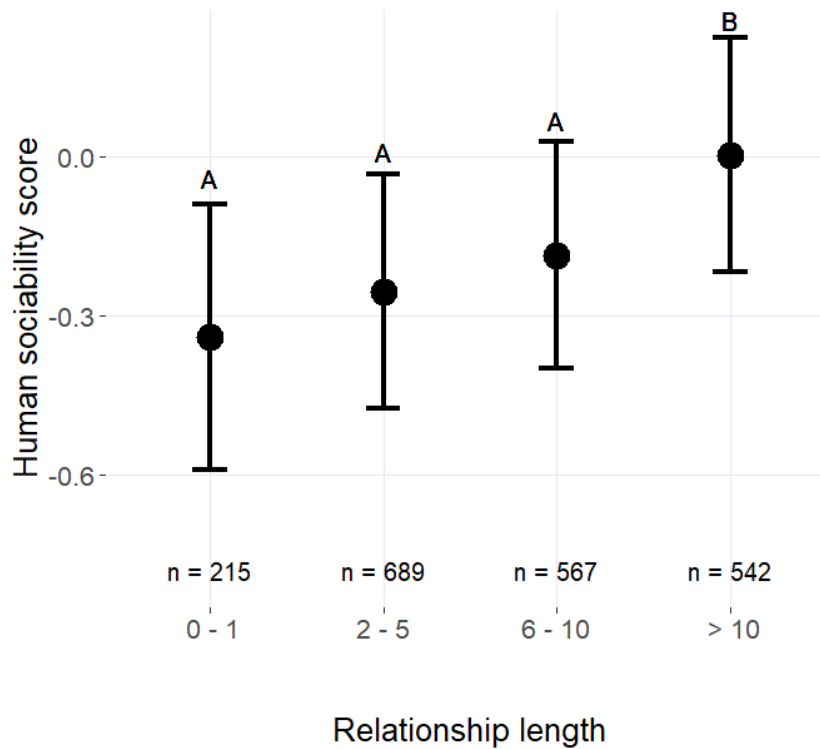
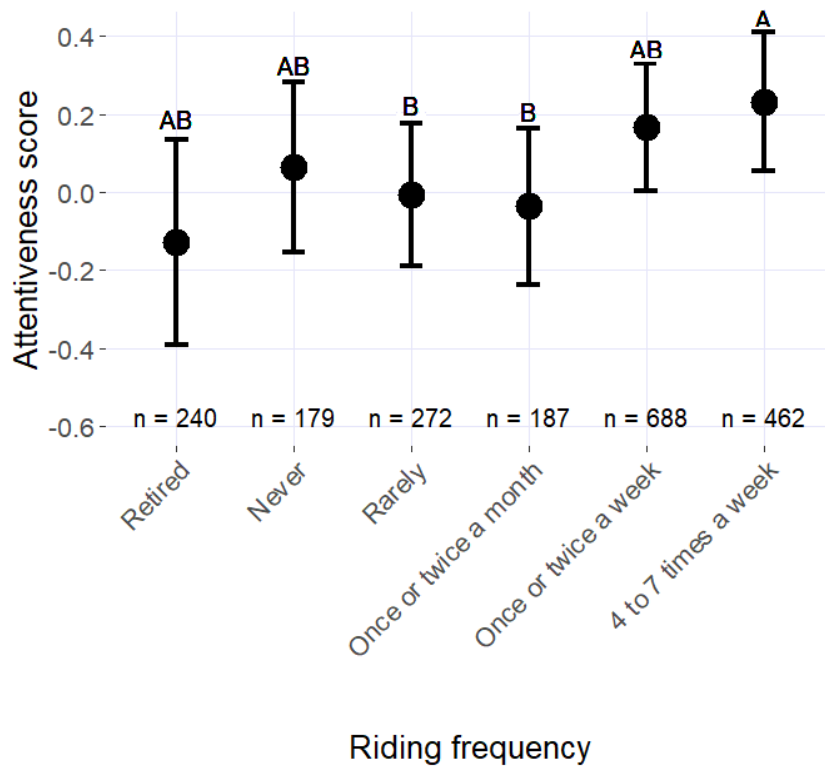


Figure 4. Association of human sociability score with the length of the relationship between a human and a horse. Distinct letters signify statistically significant differences among the groups. The means and their associated 95% confidence intervals (error bars) were extracted from the corresponding model using the function `emmeans` from the “`emmeans`” package in R.

3.5 Practices

Personality traits were not associated with the amount of groundwork or quality time spent with horses, but instead, there was an association between riding frequency and personality traits. Both the neuroticism and attentiveness scores increased with the frequency of riding: horses ridden 4 to 7 times a week were rated significantly more attentive than those ridden rarely ($df = 1909$, $t = -2.968$, $p = 0.0359$) or once or twice a month ($df = 1909$, $t = -3.034$, $p = 0.0295$) (Fig. 5, Appendix 2). Similarly, non-ridden horses were rated significantly less neurotic than horses ridden rarely ($df = 1902$, $t = 3.658$, $p = 0.0036$), once or twice a week ($df = 1902$, $t = -2.898$, $p = 0.0439$), or once or twice a month ($df = 1902$, $t = -3.083$, $p = 0.0253$) (Fig. 5, Appendix 2). Human and horse sociability didn't have an association with riding frequency.

a)



b)

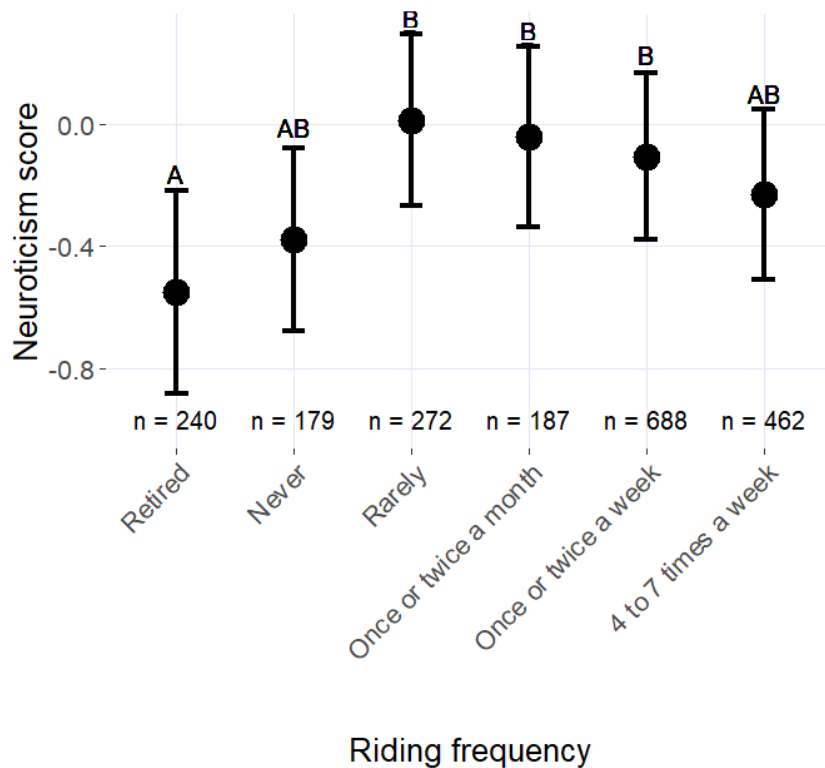
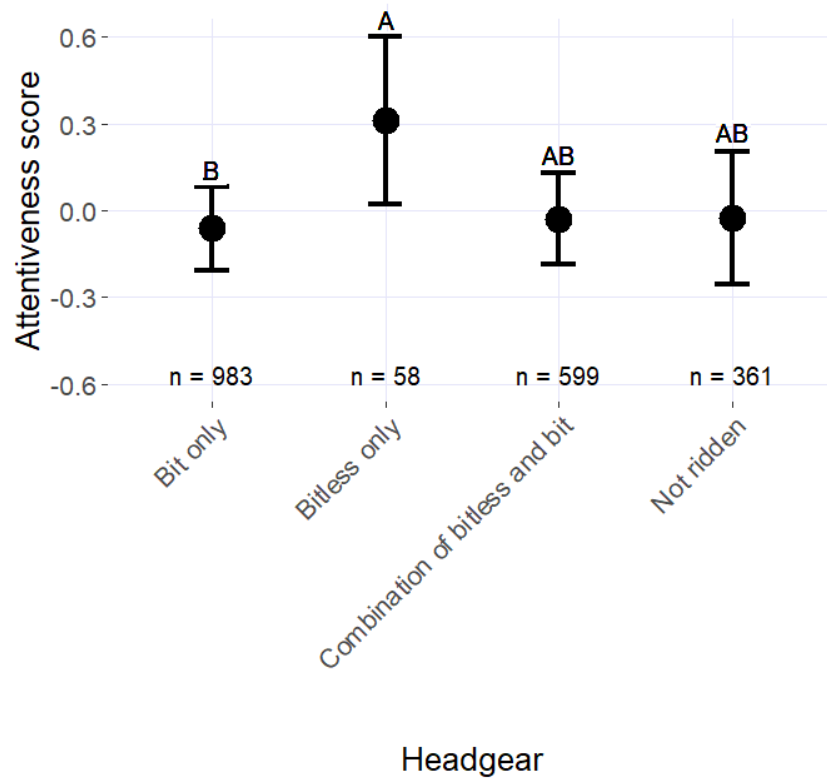


Figure 5. Association of A) attentiveness score and B) neuroticism score with the riding frequency. Distinct letters signify notable differences among the groups. The means and their associated 95% confidence intervals (error bars) were extracted from the corresponding model using the function `emmeans` from the “`emmeans`” package in R.

3.6 Headgear

The gear type used in horses was associated with attentiveness and neuroticism levels. Non-ridden horses scored significantly higher on neuroticism levels than horses ridden or trained with only bits ($df = 1902$, $t = -2.542$, $p = 0.0540$) (Fig.6, Appendix 2). The horses ridden with only bitless tack also tended to score lower neuroticism levels ($df = 1902$, $t = -2.455$, $p = 0.0675$) than the non-ridden group. In addition, the horses ridden with only bitless head tacks were stated to be significantly more attentive than those ridden with only bits ($df = 1909$, $t = 2.732$, $p = 0.0322$) (Fig.6, Appendix 2).

a)



b)

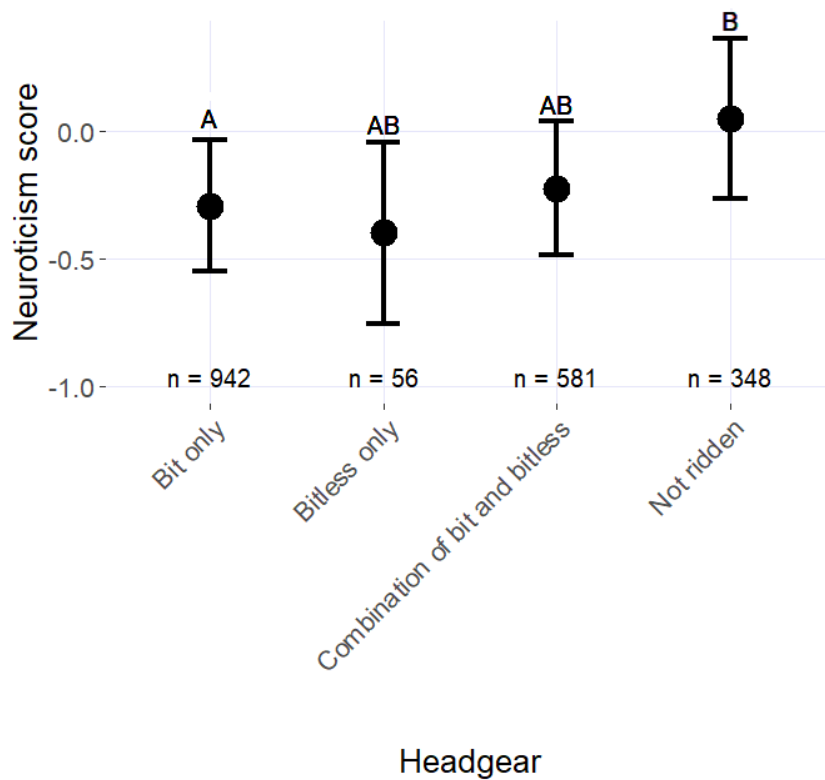
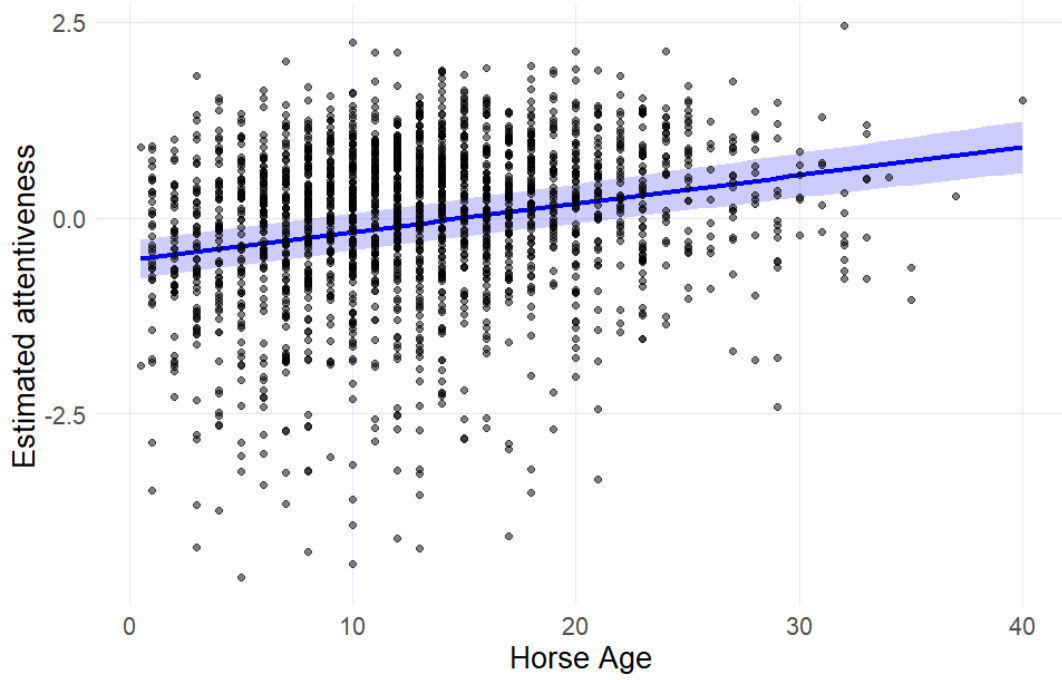


Figure 6. Association of A) attentiveness score and B) neuroticism score with the type of headgear used. Distinct letters signify notable differences among the groups. The means and their associated 95% confidence intervals (error bars) were extracted from the corresponding model using the function emmeans from the “emmeans” package in R.

3.7 Horse age

Horses' age was associated with attentiveness and human sociability levels (Fig. 7). The attentiveness levels decreased with age ($z = 9.977$, $p = < 2e-16$), while the human sociability levels decreased with age ($z = -11.033$, $p = < 2e-16$).

a)



b)

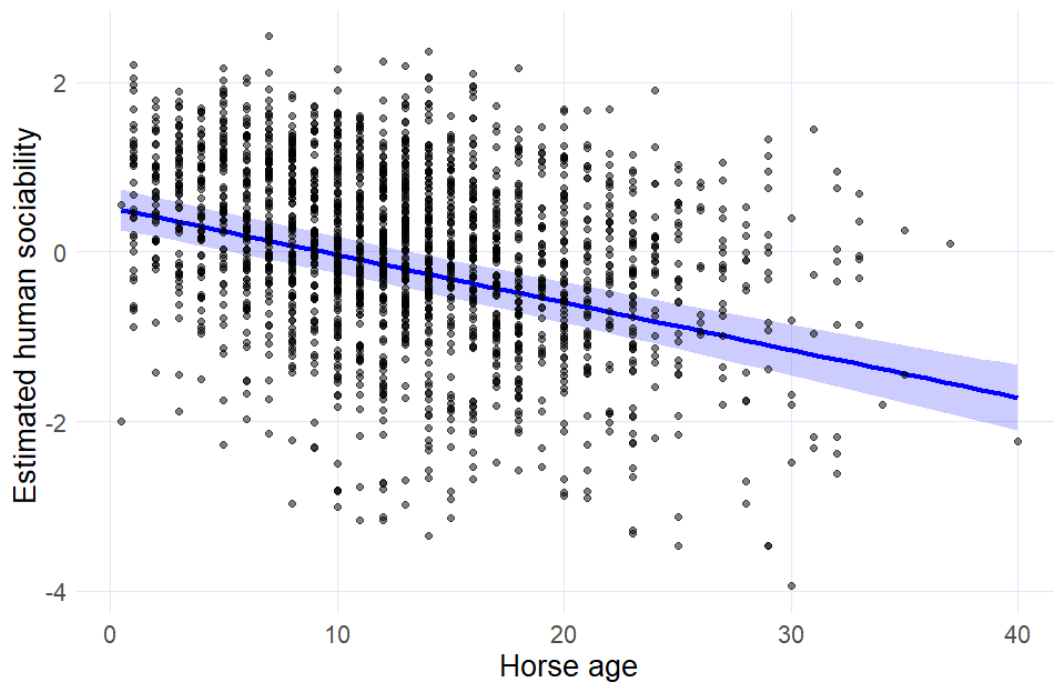
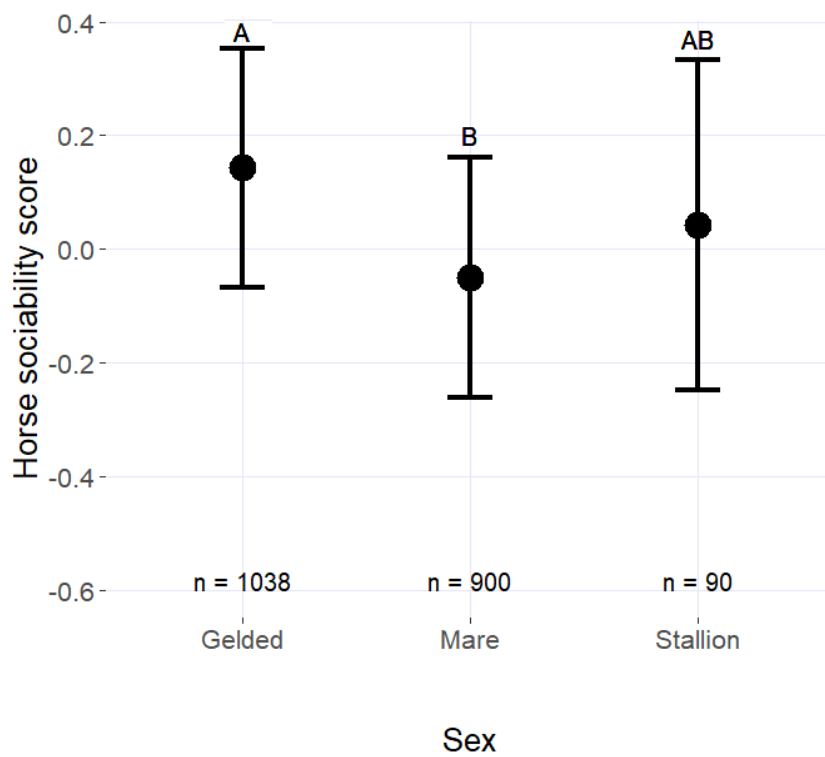


Figure 7. Association of A) attentiveness score and B) human sociability score with the age of the horse.

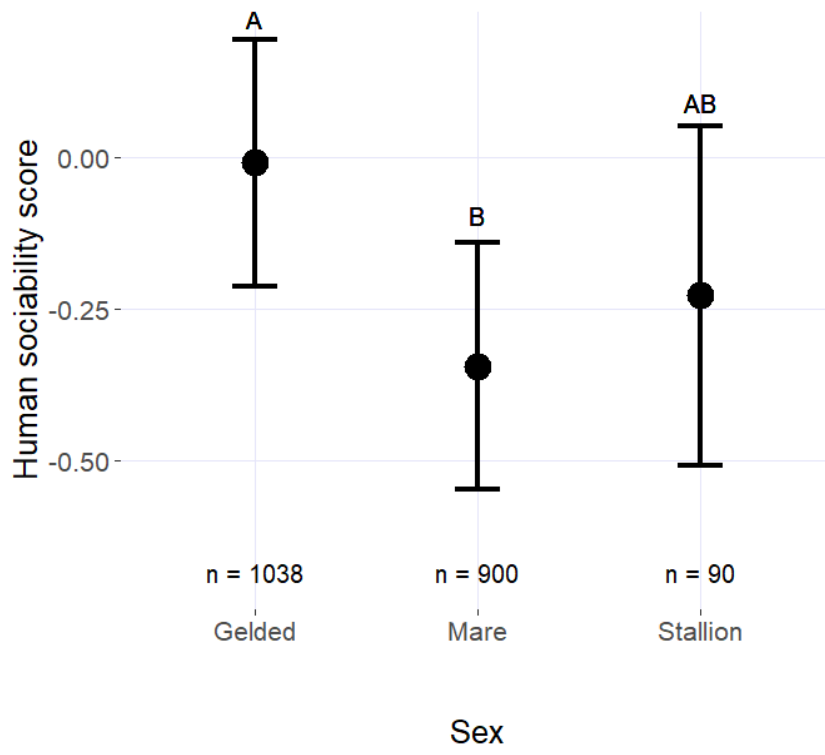
3.8 Horse sex

Horse sex was associated with human sociability, horse sociability, and neuroticism levels. Geldings were reported to be significantly more social with humans ($df = 1909$, $t = 7.572$, $p < 0.0001$) (Fig. 8, Appendix 2) and with horses ($df = 1916$, $t = 4.299$, $p = 0.0001$) than mares (Fig. 8, Appendix 2). Geldings also scored significantly higher on neuroticism levels than mares ($df = 1902$, $t = 3.367$, $p = 0.0022$) and stallions ($df = 1902$, $t = 2.801$, $p = 0.0142$). (Fig 8, Appendix 2).

a)



b)



c)

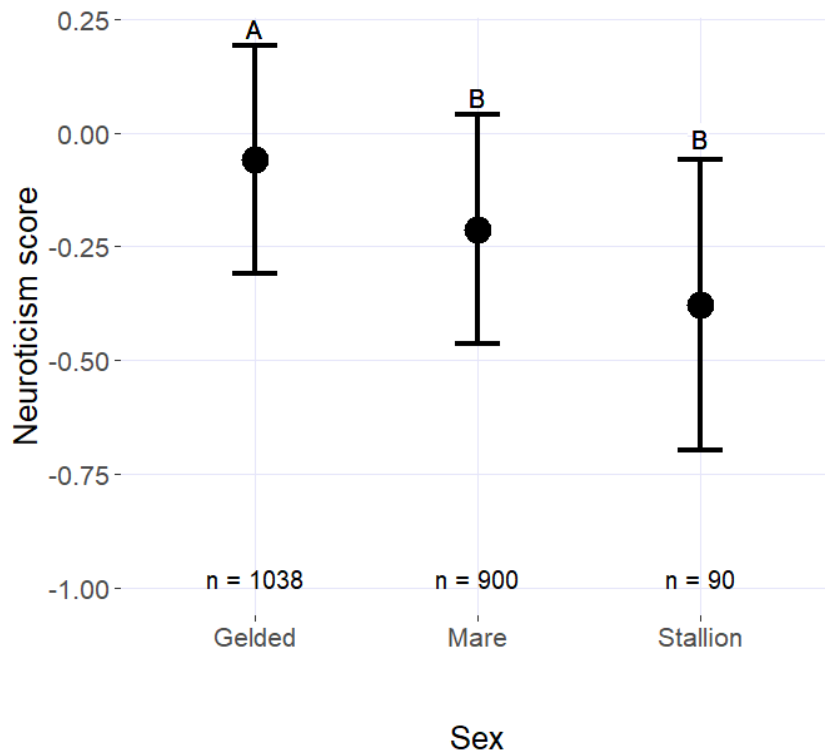


Figure 8. Association of A) horse sociability score and B) human sociability score C) neuroticism score with the sex of the horse. Distinct letters signify notable differences among the groups. The means and their associated 95% confidence intervals (error bars) were extracted from the corresponding model using the function emmeans from the “emmeans” package in R.

3.9 Horse breed

The breed of horses was associated with only neuroticism levels. The draught horses were labeled as significantly less neurotic than warm-blooded horses ($df = 1902$, $t = -5.198$, $p < 0.0001$), ponies ($df = 1902$, $t = -3.039$, $p = 0.0203$), and unknown breeds ($df = 1902$, $t = -3.114$, $p = 0.0161$), while warm-blooded horses were labeled significantly more neurotic than Nordic horses ($df = 1902$, $t = -3.924$, $p = 0.0009$) (Fig. 9, Appendix 2).

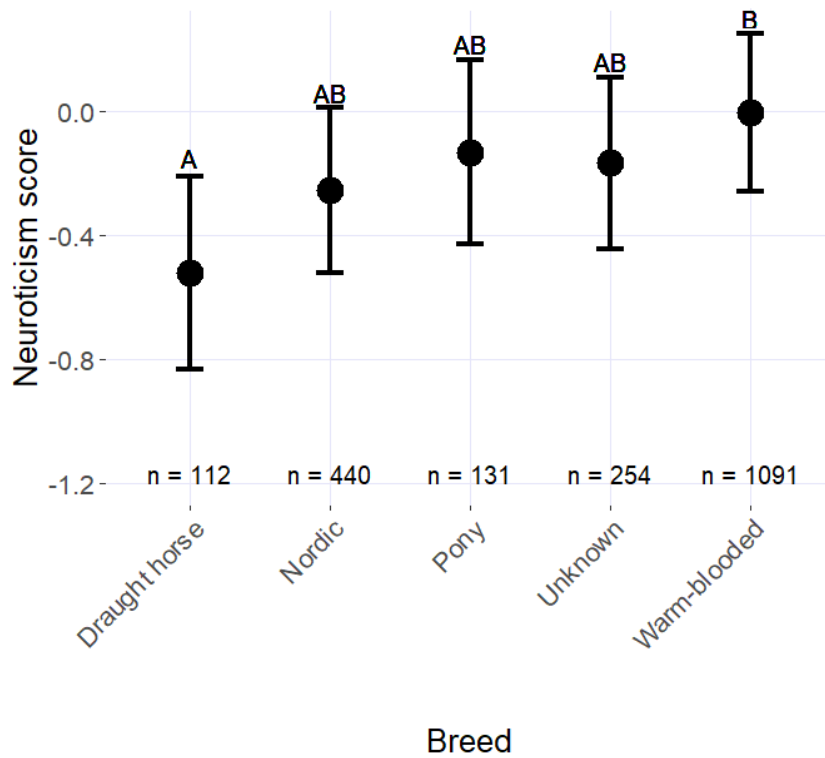


Figure 9. Association of neuroticism score with the breed of the horse. Distinct letters signify statistically significant differences among the groups. The means and their associated 95% confidence intervals (error bars) were extracted from the corresponding model using the function `emmeans` from the “`emmeans`” package in R.

4. Discussion

In this study, I explored human-made environmental factors that could be associated with horse behavior. I hypothesized that horses living in bigger herds would be rated as more attentive than horses housed alone, but this, however, was not the case. Instead, horses living alone were associated with lower horse sociability scores. The second hypothesis predicted that horses with multiple owners and/or handlers would be rated more neurotic, and this was partially true; horses with multiple ownership changes scored higher on neuroticism, but the number of riders did not affect neuroticism – but instead on human sociability levels, revealing that non-ridden horses are associated with lower human sociability scores compared to horses that are ridden with friends and family. The third hypothesis presumed that with

longer relationship lengths come lesser levels of neuroticism, but longer relationships affected human sociability and not neuroticism; the longer the relationship, the higher the horses scored on human sociability. In addition, I hypothesized that frequent riding sessions would increase horses' neuroticism and attentiveness scores, and this was found to be true. However, other activities, such as groundwork and spending quality time with the horse, were not associated with horse personality traits. Lastly, I hypothesized that bridles with bits may lead to increased ratings of neuroticism. Still, the non-ridden horses scored higher on neuroticism, and bitless tacks scored higher on attentiveness than other headgear options. Thus, these results support part of my hypotheses and suggest that human-made environmental choices are involved with horse behavior. Therefore, these aspects should be considered when deciding on horses' environmental factors.

4.1 Herd size

In my study, the herd size the horses lived in was associated with low horse sociability scores and not with attentiveness scores, as my hypothesis would have stated. Previous studies have revealed that attentiveness levels are not always associated with housing conditions, but more so the type of work the horses do (Rochais et al., 2022). The horses living alone scored lower on horse sociability than horses living in a dyad or a group, which was unexpected and unsurprising. When the horses cannot express their sociability toward others, it is also hard for the owners to assess their horses' sociability. However, horses are social animals (Salter & Hudson 1982) who have the behavioral need to be in contact with conspecifics, which is why some of the stables are designing boxes that allow their residents to be more social (Visser et al., 2008; Lansade et al., 2014; Gmel et al., 2022). This access to social contact can lower frustration (Hockenhull & Creighton, 2014) and stereotypical behavior in horses (McGreevy et al., 1995; Flamand et al., 2025). In studies that compared horses' negative or optimistic biases, horses with social contact were more optimistic than their single-housed conspecifics (Henry et al., 2017; Flamand et al., 2024; Flamand et al., 2025). Social contact also lessened the negative behavior targeted toward humans (Flamand et al., 2025). The amount and depth that horses get to communicate affects their wellbeing, since single-housed horses can still suffer from social deprivation if they do not get to exhibit full body contact with another horse (Hockenhull & Creighton, 2014). Social deprivation can also show up in the fact that single-housed horses, when given the chance to go into a paddock for every 15 minutes, chose to stay outside longer when there were conspecifics in the paddock. The restricted environment

is also linked to heightened aggression, nervousness, and excitability (Kiley-Worthington, 1990).

One reason single-housed horses were rated as less social with conspecifics could be that people might think their horse is so socially awkward and possibly dangerous to other horses, that it is safer to keep them alone (Hartmann et al., 2012a). Horses' character begins to develop early in their juvenile stage, as foals start to practice normal behaviors and develop their social skills (Maglieri et al., 2024). The environmental conditions the juveniles have will affect the individuals' behavior also in adulthood, at least in other species, since, for example, veal calves that have not had a group of conspecifics in their juvenile state, perform more aggressive behaviors in adulthood than those who have been raised in groups (Veissier et al., 1994). This supports the idea that social skills often grow to be better in group-raised individuals than those whose social contact was cut short early in life (Christensen et al., 2002). Thus, as every individual's social skills differ based on their juvenile experiences (Veissier et al., 1994; Christensen et al., 2002), some people will decide to house their horses alone, as these horses are thought to lack the adequate skills to communicate with their conspecifics (Hartmann et al., 2012a).

The reasons why humans keep their horses single-housed can vary. People might avoid taking their horses to groups in pasture, since some horses behave non-cooperatively and engage in risky behaviors when removing them from the paddock (Hartmann et al., 2012b). Another reason might be that there is a common belief that group housing can be dangerous (Hartmann et al., 2015), especially between stallions (Christensen et al., 2002; Freymond et al., 2013), even though there is evidence that the injuries happening in groups are not so common or severe (Keeling et al., 2016). Some owners also argue that they can keep a better eye on their horses' health when keeping them indoors and individually (Ross et al., 2023).

4.2 The number of owners and riders

While being a popular companion, work, and sports animal, horses get to experience different amounts of owners (Clough et al., 2021; Liehrmann et al., 2022) and riders (Hanousek et al., 2020; Neumann et al., 2021), each varying in their experience levels and the ways they interact with the horse. I expected to find that the increasing number of riders would lead to

higher neuroticism scores in horses. However, instead, I observed that non-ridden horses were rated as less social with humans compared to those ridden by friends and family. One possible explanation for that is that non-ridden horses are rated less social because they are not ridden at all, or that the owner spends less time with the horse altogether, which leads to fewer interactions. One factor to consider is also that the horse might not be social with humans, which leads to it not being ridden. This lower score in sociability towards humans could be a result of repeated, negative interactions, which can lead to horses having a negative impression of humans (Fureix et al., 2009; Sankey et al., 2010). On the other hand, these horses that have had positive interactions with humans might be described as friendly and social with humans, which might be why horse owners can let these kinds of horses be ridden with friends and family, as they know that the horse is safe and easy to handle. Further research is needed to investigate these aspects.

Alongside the number of riders, I expected that horses with multiple ownership changes would be rated more neurotic than those with fewer changes in ownership. I observed that horses with multiple ownership changes lead to higher neuroticism scores and lower human sociability scores. Ownership of horses can change multiple times in their lifetime (Clough et al., 2021; Liehrmann et al., 2022) for various reasons. One common reason for rehoming is the end of a horse's career. For example, racehorses typically retire around five years old (Shrestha et al., 2021). They may then be sold and repurposed as leisure horses (Shrestha et al., 2021) or for breeding (Sloet van Oldrutenborgh-Oosterbaan et al., 2010). Other common reasons horses are rehomed are lack of time, horse behavior, health issues, and the unsuitability of the human and horse (Rosanowski & Verheyen, 2019). This incompatibility can manifest as difficulty handling the horse, as horses have distinct personalities (Lansade et al., 2017), and not all human-horse pairings are well-matched. In this study, 50% of horses had changed owners more than once, and these horses were rated as more neurotic than those with fewer ownership changes. While we do not know the causality of these results, we could hypothesize that either neurotic horses are sold multiple times because they are considered too neurotic and difficult to handle, or that horses become neurotic because of all of the changes happening in their surroundings. While the former can lead to frequent ownership changes because of horse personality traits, Liehrmann (2022) also hypothesizes that the latter can keep the horses in an ongoing stressful state, affecting their neuroticism levels. We could use further research to determine the causality of these findings.

4.3 Relationship length

As horses can have multiple owners during their lifetime (Clough et al., 2021; Liehrmann et al., 2022) and work with different numbers of riders (Hanousek et al., 2020; Neumann et al., 2021), there is also variation in relationship lengths the horses have with humans. Previous studies show that shorter relationships with owners lead to more reluctance toward novel objects in horses (Liehrmann et al., 2022), which is why I hypothesized that longer relationships with owners would lead to lower scores on neuroticism. This hypothesis did not get confirmation in this study, but in the results, there was an association between relationship length and human sociability scores; the longer the relationship, the more social the horses were rated toward humans.

Relationships are formed based on previous interactions, which can be either positive or negative (Hinde, 1979). Hinde says that through those interactions, the individuals in the relationship start to form a mental image of each other, and based on those mental images, each partner has expectations about how the other behaves. Humans often pursue a relationship built on trust, mutual understanding, cooperation, and predictability (Birke & Hockenhull, 2015), but forming this kind of human-animal bond takes time. In Asian elephants (*Elephas maximus*) it is suggested that eight years is needed to develop trust between an elephant and its handler (Srinivasaiah et al., 2014), while Liehrmann et al. (2022) conclude that with horses it takes around four to six years. The fact that familiar human-horse pairs are known to work together with more cooperation than unfamiliar pairs (Birke & Hockenhull, 2015), also supports the fact that relationship length alters the bond between a human and an animal. The increase in human sociability scores might thus be explained by the increase in trust and familiarity between humans and horses through the years. The result of increasing human sociability levels can't be explained by age instead of relationship lengths, since it was found that the trend for age was the opposite; older horses were rated as less social with humans.

4.4 Practices

People can perform different activities with their horses, and in this study, I focused on the frequencies of riding, groundwork, and quality time spent with the horses. My study found that increased riding frequency was associated with higher levels of attentiveness and

neuroticism. This aligned with my hypothesis, though I also anticipated effects from the frequency of groundwork and quality time, which, contrary to expectations, showed no association with any personality traits in this study. This study revealed that horses ridden frequently were assessed as more neurotic and attentive than non-ridden horses. The reason behind the increased neuroticism levels might be explained by the amount and type of stimuli horses experience in riding; the more you ride, the more likely you may encounter situations and stimuli that are frightening to the horse (McGreevy et al., 2007; Hall et al., 2013), and the more you find situations where the horse can be rated as neurotic or attentive. Frequent riding also increases horses' stress levels, as horses ridden four times a day are more stressed than horses ridden twice a day (Jung et al., 2019). In addition, chosen riding methods can induce fear and discomfort (von Borstel et al., 2009), which might partly explain the increased neuroticism ratings in ridden horses. Some of the results can also be explained by the fact that retired horses are no longer placed in situations where they might encounter frightening experiences, such as riding. So they are usually rated as less neurotic.

We can seek the reason for increased attentiveness in training methods. Since horses are more likely to approach humans who pay attention to them (Proops & McComb, 2010), the attention humans give to the horse can increase the attentiveness of the horse itself. Then, we can conclude that attentiveness might be increased by training, and the more the horse is ridden, the more trained they are; hence, increased attentiveness scores when riding. Attentive horses have also better learning performance (Rochais et al., 2014), indicating that attentive horses are quick learners. Nevertheless, another contributing factor is that there are also rider preferences playing a part in choosing the horse to ride, as some riders prefer to ride with horses that are assessed to be attentive to the rider's aid (Visser et al., 2008), meaning that attentive horses are more often used in riding.

Even though owners have described that the horses might enjoy the time spent together as much as the owners (Keaveney, 2008), this study did not find links between quality time spent and horse behavior. Similarly, there was no support for the claim that groundwork would affect horse behavior, even though previous studies have concluded that the frequent practice of groundwork has increased horses' interactivity with unfamiliar humans (Grandgeorge et al., 2024).

4.5 Headgear

This study examined the relationship between horse personality traits and the choice of using headgear with bits or bitless options among horse owners. The results show that contrary to the hypothesis, bitted gear did not increase the horses' neuroticism levels; instead, the non-ridden horses were rated with higher neuroticism levels than ridden horses who used gear. Another finding was that horses using bitless equipment were rated as more attentive than with other modalities of gear.

The different headgear is used to communicate the rider's requests to the horse; thus, controlling the horse (Condon et al., 2022; Luke et al., 2023). There have been varied results in investigating whether the type of headgear affects horse behavior: some conclude no difference in behavior when using bitted or bitless bridles (Scotfield, R. 2014; Condon et al., 2022), while some find small support for the differences (Quick & Warren-Smith, 2009). This study supports the results of the latter study, since the use of gear affected neuroticism and attentiveness levels.

The usage of headgear leads to different kinds of sensations, which can be discomfort and pain, if the gear isn't used correctly (Cook, 2003; Quick & Warren-Smith, 2009; Mellor, 2020). When getting used to different kind of headgear, horses might place aversive behaviors against the gear or especially the bit (Luke et al., 2023). However, the active use of the gear might lead to habituation, which means that horses' response to a repeated presentation of a stimulus, in this case, for example, the sensation of the bit, decreases over time (McGreevy & Boakes, 2011; Condon et al., 2022), meaning that the possible aversive behavior lessens through time. Thus, this habituation can lead humans to see their horses less neurotic, as the horses do not react so strongly to the stimulus as before. On the other hand, young horses that are possibly just being trained to be rideable, do not have this habituation to stimuli, and so might react more strongly when trained to use headgear.

Bitless gear is often considered a better choice for the horses' welfare (Stehouwer, 2014; Luke et al., 2023), while only a few voices challenge that view (Scotfield & Randle, 2013). When believing that the bitless gear improves welfare, we can expect that rider safety improves also with the welfare (Luke et al., 2022). This could lead to humans trying out bitless options, even though the safety differences between bitless or bitted horses are not fully recognized (Luke et

al., 2023). Nevertheless, when given the fact that riders using bitless gear are linked to having better horse-rider partnerships than riders using bitted gear (Luke et al., 2023), it is clear that the choice of gear affects the relationship between a horse and the rider. Previous studies have found horses using bitless gear to be more attentive and willing to be in contact with the rider (Cook & Mills, 2009), and thus riders may favor using the bitless options, as they want to have the positive impact of that relationship. On the other hand, people might be more comfortable trying bitless gear with an already attentive horse, as they feel safe and secure with those kinds of horses. This could lead to a circle where bitless gear leads to attentive horses, and humans with attentive horses may favor bitless gear.

The headgear used can also vary according to different training methods. The bitless gear can be associated with the practice of natural horsemanship (Scofield & Randle, 2013), while in some disciplines, like dressage, horses are required to use bitted gear (Federation Equestre Internationale, 2022). The practitioners of natural horsemanship believe in harmony between horse and rider (Tom, 2015), and try to connect with a horse with attentiveness, trust, and respect (Sporer, 2013). This implies that different training methods with different gear can treat the horse differently; the attentiveness of the natural horsemanship can lead to attentive horses, as the attention the human pays to the horse, increases the attentiveness of the horse (Proops & McComb, 2010). This could imply that training methods using specific gear can influence how attentive and involved the horses are in their interactions with humans.

4.6 Intrinsic factors (horse age, sex and breed)

In this study, I examined how horse personality traits relate to age, sex, and breed. I found that sociability towards humans decreases with age, supporting previous findings that younger horses are more curious and open to new experiences (Spier et al., 2004; Sackman & Houpt, 2019). While earlier studies in dogs and humans suggest that selective attention peaks in middle age (Clark et al., 2006; Wallis et al., 2014), this study found increasing attentiveness with age. Maylor et al. (1998) suggest that age-related attention differences may reflect a general slowing down rather than a decline in ability, which could explain why older horses appeared more attentive.

In this study, respondents rated geldings as more social with both humans and horses, but also more neurotic than mares and stallions. These perceptions may reflect the respondents' biases,

as geldings are often seen as calm, reliable, and preferred for recreational use (Dashper et al., 2018; Fenner et al., 2019a; Świszczewska et al., 2020). This good mental image people have with geldings might be why geldings had better sociability scores in this study than other sexes. Their higher usage might also expose them to more stress, explaining the higher neuroticism scores. In contrast, mares are often perceived less favorably, partly due to gender stereotypes portraying them as moody or unpredictable (Dashper et al., 2018), which can influence expectations and interactions. Some studies also report that mares tend to be more aggressive and excitable than geldings (Duberstein & Gilkeson, 2010).

The results of this study revealed that draught horses were labeled as significantly less neurotic than warm-blooded horses, ponies, and unknown breeds, and, in contrast, warm-blooded horses were labeled significantly more neurotic than Nordic horses. Horses have been selected and bred with different characteristics (Lloyd et al., 2008), and scientific evidence shows that breeds can behave differently (Hausberger & Muller, 2002; Lloyd et al., 2008; Sackman & Houpt, 2019). On the side of selective breeding, there is also some human perception that plays a part in describing behavior differences between breeds. People tend to describe certain breeds with certain adjectives; (Lloyd et al., 2008), and my results supported the findings that draught horses might be described as less nervous than other breeds (Sackman & Houpt, 2019).

4.7 Limitations of the study

This study's limitation is that it uses a cross-sectional design, which cannot determine the direction or causality between human-made choices and horse personality traits. While specific associations can be observed, collecting data at a single point in time limits the ability to assess whether specific choices influence horse behavior or if the relationship works in the opposite direction. To investigate how these factors interact, we should implement longitudinal studies.

Another limitation is that, unfortunately, this study cannot provide a detailed analysis of how a horse's breed affects horse behavior, as most breeds do not have sufficient representation in the collected data. However, previous studies have shown that breed-specific behaviors exist (Hausberger & Muller, 2002; Lloyd et al., 2008; Sackman & Houpt, 2019), and my results found a preliminary impact further support this. Therefore, further research is needed to

determine whether these behavioral differences among breeds remain significant and persistent over time.

4.8 Conclusions

The results of this study indicate that there is a clear association between human-made choices and horse behavior. Horse personality traits – human sociability, horse sociability, attentiveness, neuroticism – were affected by human-made choices regarding housing conditions, headgear, the number and lengths of interactions with humans, and the frequency of practices. There were also links between personality traits and horses' sex, age and breed. This study can't, however, allow us to define the causality of these results – a reason why future research is needed on this subject. This study opens the way for continuing investigation of this subject and provides a framework for future studies.

In this study, I found factors linked to horse neuroticism levels. Horses' neuroticism levels greatly affect the safety of both humans and horses, as when placed in a situation where horses feel threatened or insecure, they can display aversive behaviors, such as shying, bolting, and aggressive threats, like kicking or biting (Visser et al., 2008), which can lead to injuries. Understanding a horse's history, such as the number of ownership changes it has undergone, provides owners with information that their horses may be more sensitive to fearful reactions, which can be helpful and allow for more informed care. This information can also aid in developing strategies to reduce neurotic behaviors.

With the information from this study, we can find ways to shape our relationships with horses in a direction that leads to better and healthier interactions. The results indicate that while developing strong relationships with horses can take years, once established, these bonds foster greater sociability between horses and humans. More importantly, recognizing and understanding the interactions between human actions and horse behavior provide a valuable foundation for initiating conversations on responsible horse ownership and management practices.

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Appendices

Appendix 1. Horse Personality Questionnaire

Table 4.

Horse personality questionnaire in English, Finnish and French. Respondents were asked to indicate their level of agreement with each adjective using a six-point scale: "strongly disagree," "disagree," "neutral," "agree," "strongly agree," and "I don't know."

Adjective	English	Finnish	French
Active	My horse is very active, moves around a lot and does not like to stand still for long	Hevoseni on aktiivinen ja liikkuu paljon, eikä ole pitkiä aikoja aloillaan	Mon cheval est très actif, bouge beaucoup et n'aime pas rester immobile longtemps
Apprehensive	My horse is anxious about everything, fears or avoids any kind of risk	Hevoseni on ahdistunut, pelkää riskejä ja välttää niiden tekemistä	Mon cheval est anxieux à propos de tout, il craint ou évite tout type de risque
Confident	My horse is confident, behaves in a positive, assured manner, and is not restrained or tentative	Hevoseni käyttäytyy positiivisella ja varmalla tavalla, eikä ole estynyt tai varuillaan oleva	Mon cheval est confiant, se comporte de manière positive et assurée. Il ne se retient pas et n'est pas hésitant
Curious	My horse is curious, readily explores new situations and or objects	Hevoseni on utelias ja tutkii mielellään uusia tilanteita ja/tai tavaroita	Mon cheval est curieux, explore facilement de nouvelles situations et/ou objets
Eccentric	My horse shows stereotypes, unusual mannerisms and exaggerated behaviour	Hevoseni näyttää stereotyyppisiä, epätavallisia maneereita ja ylitseampuvaa käyttäytymistä	Mon cheval montre des stéréotypes, des comportements inhabituels et exagérés
Effective	My horse is effective, gets it's own way and controls other horses	Hevoseni on tehokas yksilö, joka kulkee oman tiensä mukaan ja voi kontrolloida muita hevosia	Mon cheval sait se faire entendre, il obtient ce qu'il veut et contrôle les autres chevaux
Equable	My horse is equable, reacts to other horses in an even, calm way and is not easily disturbed	Hevoseni on tasainen ja käyttäytyy tasaisesti ja rauhallisesti muiden hevosten seurassa, eikä häiriinny helposti	Mon cheval est tempéré, réagit aux autres chevaux de manière égale et calme, et n'est pas facilement dérangé
Excitable	My horse overreacts to any change and is easily excited or highly strung	Hevoseni ylireagoi kaikkiin muutoksiin ja innostuu helposti	Mon cheval sursurragit à tout changement et s'excite facilement ou est très nerveux
Fearful	My horse is fearful, retreats readily from outside disturbances	Hevoseni on pelokas ja vetäytyy helposti ulkopuolisten häiriöiden luota	Mon cheval est craintif, il se retire facilement des perturbations extérieures

Adjective	English	Finnish	French
Insecure	My horse is insecure, hesitates to act alone and seek reassurance from other horses or human	Hevoseni on epävarma, epäröi toimia yksin ja etsii varmuutta muilta hevosilta tai ihmisiltä	Mon cheval est inquiet, hésite à agir seul et cherche la réassurance auprès d'autres chevaux ou d'humains
Irritable	My horse is irritable, reacts negatively with little provocation	Hevoseni on ärsyyntyvä ja reagoi negatiivisesti pienestäkin provokaatiosta	Mon cheval est irritable, réagit négativement avec peu de provocation
Motherly	My horse provides warm receptive secure base for horses and is tender and caring	Hevoseni tarjoaa lämpimän ja vastaanottavan, turvallisen pohjan muille, ja on hellä ja huolehtiva	Mon cheval fournit une base sécurisante, réceptive et chaleureuse pour les autres chevaux: Il est doux et attentionné envers les autres chevaux.
Opportunistic	My horse seizes a chance as soon as it arises (eg sneak outside the fences, steal food)	Hevoseni tarttuu tilaisuuteen heti kun se tulee (esim. pakenee aitauksesta tai varastaa ruokaa)	Mon cheval est opportuniste et saisit une opportunité dès qu'elle se présente (par exemple, sortir discrètement de l'enclos, voler de la nourriture)
Permissive	My horse is permissive and does not interfere with behaviour of other horses	Hevoseni on salliva eikä häiritse muiden hevosten käyttäytymistä	Mon cheval est permissif et ne s'immisce pas dans le comportement des autres chevaux
Playful with horses	My horse initiates play and joins in when play is solicited by other horses	Hevoseni aloittaa leikillistä kanssakäyntiä ja liittyy mukaan muiden hevosten aloittamaan leikkiin	Mon cheval initie le jeu et y participe lorsqu'il est sollicité par d'autres chevaux
Playful with humans	My horse joins in when play is solicited by humans	Hevoseni liittyy mukaan ihmisten aloittamaan leikkiin	Mon cheval se joint aux jeux quand il est sollicité par les humains
Popular	My horse is popular among other horses and is sought out as an appreciated companion	Hevoseni on suosittu muiden hevosten keskuudessa ja sen seuraa arvostetaan	Mon cheval est populaire auprès des autres chevaux. Il est perçu comme un compagnon apprécié.
Protective	My horse is protective and prevents harm or possible harm to other horses	Hevoseni on suojeleva ja estää mahdollisen tai todellisen vahingon sattumista muille	Mon cheval est protecteur et empêche les autres chevaux de se blesser ou d'être en danger
Slow	My horse moves slowly in a relaxed manner. Is not easily hurried	Hevoseni liikkuu ja lepää rennosti, hitaasti ja harkitusti, eikä helposti kiirehdi	Mon cheval se déplace lentement de manière détendue. Il n'est pas facilement pressé
Sociable	My horse is sociable, seeks	Hevoseni on sosiaalinen ja etsii muiden hevosten seuraa	Mon cheval est sociable, il cherche la compagnie d'autres chevaux

Adjective	English	Finnish	French
	companionship of other horses		
Solitary	My horse is solitary and spends a lot of time alone by choice	Hevoseni on itsenäinen ja viettää paljon aikaa yksinään omasta halustaan	Mon cheval est solitaire et passe beaucoup de temps seul par choix
Subordinate	My horse gives in readily to other horses, submits easily and does not put up a fight to defend self	Hevoseni antaa herkästi periksi muille hevosille, alistuu helposti eikä ryhdy taisteluun puolustaakseen itseään	Mon cheval cède facilement aux autres chevaux, se soumet facilement et ne se bat pas pour se défendre
Strong	My horse depends upon sturdiness and muscular strength	Hevoseni luottaa lihasvoimaan ja lujuteen	Mon cheval est robuste et est conscient de sa force.
Tense	My horse shows restraint in posture and movement; they carry the body stiffly, which suggests a shrinking tendency, as if to pull back and be less conspicuous	Hevoseni osoittaa hillintää asennoissa ja liikkeissä, sekä kantaa kehoaan jäykästi, mikä viittaa ikään kuin tarpeeseen vetäytyä ja olla vähemmän näkyvä	Mon cheval montre de la retenue dans sa posture et ses mouvements ; il porte son corps avec raideur, ce qui suggère une tendance à se rétracter, comme s'il voulait être moins visible
Understanding	My horse responds in a discriminating and appropriate manner to the behaviour of other horses	Hevoseni reagoi arvostelukykyisesti ja asianmukaisesti muiden hevosten käyttäytymiseen	Mon cheval répond de manière discriminatoire et appropriée au comportement des autres chevaux
Suspicious of humans	My horse does not trust humans readily, trusts few individuals	Hevoseni ei luota ihmisiin helposti ja luottaa vain muutamaan yksilöön	Mon cheval ne fait pas facilement confiance aux humains, il ne fait confiance qu'à quelques individus
Suspicious of horses	My horse does not trust horses readily, trusts few individuals	Hevoseni ei luota toisiin hevosiin helposti ja luottaa vain muutamaan yksilöön	Mon cheval ne fait pas confiance aux autres chevaux facilement, il ne fait confiance qu'à quelques individus
Reliable	My horse can be trusted to do things or behaves well, is considered a safe horse	Voin luottaa siihen, että hevoseni käyttäytyy hyvin ja tekee asiat sovitusti, sitä voidaan pitää turvallisena	Mon cheval peut être considéré comme sûr. On peut lui faire confiance et il se comporter bien.
Hardworking	My horse is keen to do well, behaves well during 'work', and concentrates on what it is being asked to do	Hevoseni haluaa tehdä asiat kunnolla ja käyttäytyy hyvin "työn" aikana. Se keskittyy siihen, mitä sitä on pyydetty tekemään	Mon cheval est désireux de bien faire, se comporte bien pendant le "travail" et se concentre sur ce qu'on lui demande de faire
Stubborn	My horse is stubborn does not give in	Hevoseni on itsepäinen, eikä anna helposti	Mon cheval est têtu, ne cède pas facilement et n'est pas très coopératif

Adjective	English	Finnish	French
	easily, and is not very cooperative	periksi, tai ole yhteistyöhaluinen	
Intelligent	My horse is smart, learns new things easily/fast benefits from mental stimulation	Hevoseni oppii uusia asioita helposti ja nopeasti, sekä hyötyy mentaalisesta stimulaatiosta	Mon cheval est intelligent, apprend facilement et rapidement de nouvelles choses et bénéficie de la stimulation mentale
Aggressive toward horses	My horse is aggressive and threatens other horses or causes harm to them	Hevoseni on aggressiivinen, uhkailee muita hevosia ja aiheuttaa todellista tai potentiaalista kipua niille	Mon cheval est agressif et menace les autres chevaux ou leur cause du tort
Aggressive toward humans	My horse is aggressive and threatens and causes harm or potential harm to the handler	Hevoseni on aggressiivinen ja uhkailee, sekä aiheuttaa todellista tai mahdollista haittaa käsittelijälle	Mon cheval est agressif et menace les humains et peut causer des dommages ou des risques de blessure
Attentive	My horse is attentive, listens closely to everything handlers say or do	Hevoseni kiinnittää huomiota ja kuuntelee tarkasti kaikkea mitä käsittelijä sanoo ja tekee	Mon cheval est attentif, il porte attention a tout ce que les cavaliers/entraîneurs disent ou font
Dominant to horses	My horse do not respect personal space and threatens other horses	Hevoseni ei kunnioita henkilökohtaista tilaa ja on uhka toisille hevosille	Mon cheval ne respecte pas l'espace personnel et menace les autres chevaux
Dominant to humans	My horse is not easy to handle, doesn't respect personal space and threatens humans	Hevostani ei ole helppo käsitellä, sillä se ei kunnioita henkilökohtaista tilaa, ja on uhka ihmisille	Mon cheval n'est pas facile à gérer, ne respecte pas l'espace personnel et menace les humains
Tactile sensitivity	My horse is sensitive to human touch and responds quickly with a physical response (e.g., stepping aside, being startled)	Hevoseni on herkkä ihmisen kosketukselle ja reagoi nopeasti fyysisellä reaktiolla (esim. astumalla syrjään, säikähtämällä)	Mon cheval est sensible au toucher humain et réagit rapidement avec une réponse physique (par exemple, en reculant, en sursautant)
Tolerating human company	My horse is outreaching and easy to approach by handler	Hevoseni on ulospäin suuntautuva ja käsittelijän on helppo lähestyä sitä	Mon cheval est accessible et facilement approchable par les humains
Cooperative in work	My horse responds well to the handler, is attentive and keen to do well. They easily correct their behavior to fulfill task or command	Hevoseni reagoi hyvin käsittelijään ja on tarkkaavainen ja innokas suoriutumaan hyvin. Sen käytöstä on helppo korjata tehtävän tai käskyn suorittamiseksi	Mon cheval répond bien au cavalier/entraîneur, est attentif et désireux de bien faire. Il corrige facilement son comportement pour saquitér de la tâche ou la commande
Erratic	My horse is inconsistent in its behavior, and expresses widely	Hevoseni käyttäytyy epäjohdonmukaisesti ja ilmaisee hyvin vaihtelevia	Mon cheval est inconsistant dans son comportement, et

Adjective	English	Finnish	French
	varying behaviors and moods	käyttäytymismalleja ja mielialaa	exprime des comportements et des humeurs très variables
Affectionate to familiar humans	My horse seeks physical closeness with known humans	Hevoseni etsii fyysistä läheisyyttä tutun käsittelijän kanssa ja nauttii ihmisen seurasta	Mon cheval cherche une proximité physique avec les humains qu'il connaît
Affectionate to unfamiliar humans	My horse seeks physical closeness with unknown humans	Hevoseni etsii fyysistä läheisyyttä tuntemattomien ihmisten seurasta	Mon cheval cherche la proximité physique avec les humains inconnus
Obedient	My horse is obedient, does not respond negatively to commands and agrees to everything	Hevoseni on tottelevainen, ei reagoi kielteisesti käskyihin ja suostuu kaikkeen	Mon cheval est obéissant, ne répond pas négativement aux commandes et accepte tout
Distracted	My horse is easily distracted, loses focus easily and has a short attention span. Does not focus long on specific activities	Hevoseni menettää helposti keskittymiskykyä, sillä on lyhyt tarkkaavaisuus, eikä se keskity pitkään tiettyihin aktiviteetteihin	Mon cheval est facilement distrait, perd facilement sa concentration et a une courte attention. Il ne se concentre pas longtemps sur des activités spécifiques
Scared of strangers	My horse avoids interaction with human stranger and runs away if possible	Hevoseni välttää kontaktia tuntemattomien ihmisten kanssa ja juoksee pois tilanteesta, mikäli mahdollista	Mon cheval évite l'interaction avec les étrangers humains et s'enfuit si possible
Friendly	My horse is interpreted as a nice and kind individual by humans	Ihmiset tulkitsevat hevoseni mukavaksi ja ystävälliseksi yksilöksi	Mon cheval est interprété comme un individu gentil et bienveillant par les humains
Considerate	My horse respects human personal space (eg., it would not walk on handlers' feet or push handlers during food distribution)	Hevoseni kunnioittaa ihmisen henkilökohtaista tilaa (esim. se ei kävele käsittelijöiden jaloille tai työnnä käsittelijöitä ruoan jakelun aikana)	Mon cheval respecte l'espace personnel humain (par exemple, il ne marcherait pas sur les pieds des gens ni ne les pousserait pendant la distribution de nourriture)
Predictable	My horse's behavior is consistent and steady over extended periods of time, they do not act in unexpected ways or deviate from their usual behavioral routine	Hevoseni käyttäytyminen on johdonmukaista ja tasaista pitkiä aikoja, eikä toimi odottamattomilla tavoilla tai poikkeava tavanomaisesta käyttäytymisrutiinistaan	Le comportement de mon cheval est cohérent et constant sur des périodes de temps prolongées, il n'agit pas de manière inattendue ou ne dévie pas de sa routine comportementale habituelle
Indifferent toward humans	My horse does not seek human company and ignores humans	Hevoseni ei hae ihmisten seuraa, eikä kiinnitä huomiota lähellä oleviin ihmisiin	Mon cheval ne cherche pas la compagnie humaine et ignore les humains lorsqu'ils sont à proximité

Adjective	English	Finnish	French
	when they are in the vicinity		
Curious towards humans	My horse is interested in what humans are doing, approaches humans without being asked to	Hevoseni on kiinnostunut ihmisten tekemisistä ja lähestyy ihmisiä ilman pyyntöä	Mon cheval s'intéresse à ce que les humains font, s'approche des humains sans qu'on le lui demande
Impatient	My horse does not coop well with constraint and get easily annoyed when asked to wait	Hevoseni ei pärjää hyvin rajoitusten kanssa ja ärsyyntyy helposti, jos sitä pyydetään odottamaan	Mon cheval ne coopère pas bien avec les contraintes et devient facilement agacé lorsqu'on lui demande d'attendre
Easy to catch in the field	My horse is easy to catch in the paddock/pasture, willingly approach me when I come in the enclosure with an halter/lead rope in my hands, does not avoid me and does not need treats to be attracted	Hevoseni on helppo napata tarhalta/laitumelta. Se lähestyy minua vapaaehtoisesti kun menen aitaukseen riimun kanssa, eikä välttele minua tai tarvitse herkkuja houkuttimeksi	Mon cheval est facile à attraper dans le paddock/pré, il s'approche volontairement de moi lorsque j'arrive dans l'enclos avec un licol/une longe dans les mains, il ne m'évite pas et n'a pas besoin de friandises pour être attiré

Appendix 2. Pairwise Comparison Results (Post Hoc Analyses)

In this study I used post hoc pairwise comparisons with estimated marginal means (EMMs) through the *emmeans* package to examine specific differences between groups. These comparisons identify group-level effects for key factors of interest. Pairwise comparisons were conducted for significant factors using Tukey's HSD adjustment method (95% CI).

Table 5.

The estimated marginal means for each factor, along with pairwise comparisons and corresponding confidence intervals, for the model using **human sociability score** as the response variable.

VARIABLES	CONTRAST	ESTIMATE	SE	DF	T.RATIO	P.VALUE
Other rider	Not ridden - Exclusive rider	-0.14571	0.0581	1909	-2.508	0.0590
	Not ridden - Friends/family	-0.21408	0.0695	1909	-3.079	0.0113
	Not ridden - Shared with others	-0.20769	0.0824	1909	-2.522	0.0569
	Exclusive rider - Friends/family	-0.06837	0.0575	1909	-1.189	0.6337

VARIABLES	CONSTRAST	ESTIMATE	SE	DF	T.RATIO	P.VALUE
	Exclusive rider - Shared with others	-0.06198	0.0729	1909	-0.851	0.8301
	Friends/family - Shared with others	0.00639	0.0818	1909	0.078	0.9998
Previous owners	Owner is breeder - bought from breeder	0.021	0.0724	1909	0.291	0.9545
	Owner is breeder - Multiple ownership	0.193	0.0800	1909	2.412	0.0422
	Bought from breeder - Multiple ownership	0.172	0.0529	1909	3.248	0.0034
Relationship length	(0 - 1) - (2 - 5)	-0.0863	0.0760	1909	-1.136	0.6673
	(0 - 1) - (6 - 10)	-0.1553	0.0832	1909	-1.867	0.2425
	(0 - 1) - > 10	-0.3448	0.1032	1909	-3.340	0.0047
	(2 - 5) - (6 - 10)	-0.0690	0.0585	1909	-1.179	0.6401
	(2 - 5) - > 10	-0.2585	0.0806	1909	-3.207	0.0074
	(6 - 10) - > 10	-0.1895	0.0688	1909	-2.753	0.0303
Horse sex	Gelded - Mare	0.336	0.0443	1909	7.572	<.0001
	Gelded - Stallion	0.219	0.1094	1909	2.001	0.1123
	Mare - Stallion	-0.117	0.1092	1909	-1.069	0.5337

Table 6.

The estimated marginal means for each factor, along with pairwise comparisons and corresponding confidence intervals, for the model using **neuroticism score** as the response variable.

VARIABLES	CONSTRAST	ESTIMATE	SE	DF	T.RATIO	P.VALUE
Riding frequency	(Unbroken/retired) - Never	-0.1732	0.1127	1902	-1.537	0.6402
	(Unbroken/retired) - Rarely	-0.5660	0.1547	1902	-3.658	0.0036
	(Unbroken/retired) - Once or twice a month	-0.5117	0.1660	1902	-3.083	0.0253
	(Unbroken/retired) - Once or twice a week	-0.4466	0.1541	1902	-2.898	0.0439
	(Unbroken/retired) - 4 to 7 times a week	-0.3219	0.1581	1902	-2.036	0.3223
	Never - Rarely	-0.3928	0.1204	1902	-3.262	0.0143
	Never - Once or twice a month	-0.3385	0.1310	1902	-2.584	0.1016
	Never - Once or twice a week	-0.2734	0.1161	1902	-2.355	0.1730
	Never - 4 to 7 times a week	-0.1486	0.1206	1902	-1.232	0.8210

VARIABLES	CONSTRAST	ESTIMATE	SE	DF	T.RATIO	P.VALUE
	Rarely - Once or twice a month	0.0543	0.0941	1902	0.577	0.9925
	Rarely - Once or twice a week	0.1194	0.0720	1902	1.659	0.5592
	Rarely - 4 to 7 times a week	0.2442	0.0799	1902	3.057	0.0274
	Once or twice a month - Once or twice a week	0.0651	0.0809	1902	0.805	0.9667
	Once or twice a month - 4 to 7 times a week	0.1899	0.0877	1902	2.164	0.2552
	Once or twice a week - 4 to 7 times a week	0.1248	0.0613	1902	2.035	0.3229
Previous owners	Owner is breeder - bought from breeder	0.0535	0.0758	1902	0.705	0.7604
	Owner is breeder - Multiple ownership	-0.1599	0.0837	1902	-1.911	0.1358
	Bought from breeder - Multiple ownership	-0.2134	0.0542	1902	-3.939	0.0002
Headgear	Bitless only - Combination bitless and bit	-0.1760	0.1350	1902	-1.304	0.5606
	Bitless only - Bit only	-0.1067	0.1357	1902	-0.786	0.8606
	Bitless only - Not ridden	-0.4482	0.1825	1902	-2.455	0.0675
	Combination bitless and bit - Bit only	0.0692	0.0539	1902	1.284	0.5730
	Combination bitless and bit - Not ridden	-0.2722	0.1363	1902	-1.998	0.1892
	Bit only - Not ridden	-0.3415	0.1343	1902	-2.542	0.0540
Horse sex	Gelded - Mare	0.153	0.0455	1902	3.367	0.0022
	Gelded - Stallion	0.319	0.1140	1902	2.801	0.0142
	Mare - Stallion	0.166	0.1134	1902	1.463	0.3091
Breed	Draught horse - Nordic	-0.2659	0.1105	1902	-2.406	0.1141
	Draught horse - Pony	-0.3882	0.1278	1902	-3.039	0.0203
	Draught horse - Unknown	-0.3533	0.1135	1902	-3.114	0.0161
	Draught horse - (Warm-blooded)	-0.5169	0.0994	1902	-5.198	<.0001
	Nordic - Pony	-0.1223	0.1013	1902	-1.207	0.7472
	Nordic - Unknown	-0.0873	0.0870	1902	-1.004	0.8538
	Nordic - (Warm-blooded)	-0.2509	0.0640	1902	-3.924	0.0009
	Pony - Unknown	0.0350	0.1066	1902	0.328	0.9975
	Pony - (Warm-blooded)	-0.1286	0.0915	1902	-1.406	0.6238

VARIABLES	CONSTRAST	ESTIMATE	SE	DF	T.RATIO	P.VALUE
	Unknown - (Warm-blooded)	-0.1636	0.0697	1902	-2.346	0.1309

Table 7.

The estimated marginal means for each factor, along with pairwise comparisons and corresponding confidence intervals, for the model using **attentiveness score** as the response variable.

VARIABLES	CONSTRAST	ESTIMATE	SE	DF	T.RATIO	P.VALUE
Riding frequency	(Unbroken/retired) - Never	-0.1924	0.1129	1909	-1.704	0.5293
	(Unbroken/retired) - Rarely	-0.1228	0.1554	1909	-0.790	0.9693
	(Unbroken/retired) - Once or twice a month	-0.0924	0.1671	1909	-0.553	0.9939
	(Unbroken/retired) - Once or twice a week	-0.2943	0.1547	1909	-1.903	0.4008
	(Unbroken/retired) - 4 to 7 times a week	-0.3606	0.1578	1909	-2.285	0.2006
	Never - Rarely	0.0697	0.1225	1909	0.569	0.9930
	Never - Once or twice a month	0.1000	0.1333	1909	0.750	0.9755
	Never - Once or twice a week	-0.1019	0.1178	1909	-0.864	0.9549
	Never - 4 to 7 times a week	-0.1681	0.1215	1909	-1.384	0.7365
	Rarely - Once or twice a month	0.0303	0.0956	1909	0.317	0.9996
	Rarely - Once or twice a week	-0.1715	0.0734	1909	-2.338	0.1795
	Rarely - 4 to 7 times a week	-0.2378	0.0801	1909	-2.968	0.0359
	Once or twice a month - Once or twice a week	-0.2019	0.0827	1909	-2.442	0.1425
	Once or twice a month - 4 to 7 times a week	-0.2682	0.0884	1909	-3.034	0.0295
Once or twice a week - 4 to 7 times a week	-0.0663	0.0615	1909	-1.078	0.8904	
Headgear	Bitless only - Combination bitless and bit	0.33899	0.1371	1909	2.473	0.0645
	Bitless only - Bit only	0.37192	0.1361	1909	2.732	0.0322
	Bitless only - Not ridden	0.33503	0.1850	1909	1.810	0.2686
	Combination bitless and bit - Bit only	0.03293	0.0532	1909	0.619	0.9261
	Combination bitless and bit - Not ridden	-0.00397	0.1383	1909	-0.029	1.0000

VARIABLES	CONSTRAST	ESTIMATE	SE	DF	T.RATIO	P.VALUE
	Bit only - Not ridden	-0.03690	0.1362	1909	-0.271	0.9931

Table 8.

The estimated marginal means for each factor, along with pairwise comparisons and corresponding confidence intervals, for the model using **horse sociability score** as the response variable.

VARIABLES	CONSTRAST	ESTIMATE	SE	DF	T.RATIO	P.VALUE
Herd size	Alone - Dyad	-0.27155	0.0644	1915	-4.216	0.0001
	Alone - Herd	-0.26373	0.0573	1915	-4.606	<.0001
	Dyad - Herd	0.00783	0.0537	1915	0.146	0.9884
Horse sex	Gelded - Mare	0.1926	0.0459	1915	4.196	0.0001
	Gelded - Stallion	0.1002	0.1137	1915	0.881	0.6522
	Mare - Stallion	-0.0925	0.1135	1915	-0.814	0.6942