Szent István University

Postgraduate School of Veterinary Science

Aetiology and treatment of crib-biting behaviour in horses

Thesis of PhD dissertation

Written by:

Krisztina Nagy

2009

Szent István University

Postgraduate School of Veterinary Science

Supervisor:

.....

Dr. Gábor Bodó, PhD, Dipl. ECVS

Szent István University, Faculty of Veterinary Sciences

Clinic for Large Animals

Advisors:

Dr. Péter Kabai, PhD

Szent István University, Faculty of Veterinary Science

Department of Ecology

Dr. Walter Hecker, PhD

Professor emeritus

.....

Krisztina Nagy

Introduction

Stereotypies are repetitive, relatively invariant actions considered abnormal when they occur without any primary function. Since function of any behaviour is seldom obvious, stereotypy has been recently redefined as repetitive behaviour induced by frustration, repeated attempts to cope and/or central nervous system dysfunction. This new definition poses new challenges to research, as the development of stereotypies is a long process and little is know about their origin; possible central nervous system dysfunctions are difficult to study; and coping function of a behaviour detrimental to the health of the animal might be questionable.

Stereotypical behaviour is widespread amongst captive animals and is the cause for much concern with regards to animal welfare. Most common stereotypies in horses involve weaving, box-walking (locomotor stereotypies), crib-biting and wood-chewing (oral stereotypies) with a mean prevalence of 4%, 2%, 4% and 18%, respectively.

Wood-chewing is often confused with crib-biting although the two behaviours are different. Crib-biting usually involves grasping onto fixed horizontal surfaces with the incisor teeth, contracting the strap muscles of the ventral throat, retracting the larynx caudally and emitting of a grunt called “wind-sucking”. During wood-chewing the wood is eaten by the horse from a number of different sites within its stable or in the paddock, and is never accompanied by the grunting sound called wind-sucking.

Certain breeds, like Thoroughbreds are more likely to be affected, and it is a commonly held belief that horses may learn to crib-bite from affected horses. Although controlled experiments or epidemiological studies have never supported such beliefs, it is not uncommon that stereotypic horses are kept isolated from other horses.

Crib-biting is primarily associated with feeding of concentrates; being most frequent during and particularly following consumption of meals. The bases of this relationship are being widely investigated, although the exact mechanism is not well known. Crib-biting may represent an unsatisfied foraging need, or more likely a visceral discomfort as grain feeding can cause large intestinal acidosis. Its function might be to lower gastric acidity by increasing saliva production. It can be initiated by the release of endogenous opioids triggered by eating concentrates, or by altered basal ganglia function. Recent studies suggest that upregulation of transmission in midbrain dopaminergic pathways has important role in equine stereotypy development. The impaired basal ganglia function found in crib-biting horses might be

associated with visceral discomfort, as well as with predisposed genotype or with early life experiences involving stress.

Basal ganglia dysfunction may also express itself in lower learning abilities. Crib-biting horses were less successful and required longer time to perform an instrumental task and persisted more during extinction of a positive reinforcement operant task than control horses. Furthermore, crib-biting horses failed to recognise differences in short versus long delays to reinforcement in an instrumental choice procedure. Learning differences exhibited in behaviour tests among crib-biters and control horses raise the question whether the trainability of crib-biting horses is also affected.

Since crib-biting is associated with tooth-erosion, weight loss, altered gut function, gastric inflammation/ ulceration, and epiploic foramen entrapment colic, the economical value of the horse may decrease, and it is also considered an unsoundness. The importance of reducing the incidence of crib-biting is supported by such undesirable consequences. Detection might be difficult, as novel environment may temporarily prevent performing this unpleasant behaviour.

Crib-biting is probably the most detrimental abnormal stereotypy in horses, prevention of its development is very important. Once established, stereotypies are difficult to change; therefore prevention is of great concern. Previous studies indicate that equine stereotypies are attributed mainly to the reduced eating time due to low fibre cereal based concentrate diets, lack of social contact and the restrictive nature of the stable environment from a locomotor perspective. Treatment methods of crib-biting usually include attempts to prevent grasping of objects, to interfere with wind-sucking and to introduce punishment for grasping and neck-flexion, or suggest the use of acupuncture, pharmaceuticals, operant feeding and environmental enrichment. The most common prevention method is the collar. It has been shown that wearing collar causes stress and even with collar horses may continue to perform crib-biting. A surgical procedure designed to treat crib-biting, the modified Forssell's operation, is gaining popularity among horse-owners. The procedure involves the removal of the ventral branch of the spinal accessory nerves and the myectomy of m.omohyoideus, m.sternohyoideus, m.sternothyroideus. Previous studies focused solely or mainly on the degree of stereotypy inhibition, complications and side-effects of this procedure. None of them have recorded measurable welfare or stress parameters. If crib-biting has the function to reduce stress, prevention may cause disturbances in the coping response of the horse to stress challenges.

Aim of the studies

1. To investigate the risk factors of stereotypic behaviour in horses, and to see whether exposure to a stereotypic neighbour has a significant effect;
2. To compare the performance of classification methods used in risk factors analysis, such as the logistic regression model, the classification tree and the conditional inference tree methods;
3. To conduct a questionnaire survey on equine temperament and compare 'Nervousness', 'Trainability' and 'Affability' between crib-biting and control horses;
4. To develop a crib-biting triggering stress-test in order to prove the presence of this behaviour more accurately
5. To assess the success-rate of the modified Forssell's procedure, its implication for the welfare, and to compare the stress coping ability of surgically treated horses to that of collar treated, crib-biting and control (non-stereotypic) horses

Experiment 1.

Methods

We performed a questionnaire survey to detect potential risk factors of stereotypic behaviour (crib-biting/wind-sucking, wood-chewing, weaving, and box-walking) on 287 horses by visiting nine riding schools in Hungary. The survey items focused on subject variables, housing, management conditions, food regime, stereotypies and problematic behaviour (e.g. aggression or door opening/knot-untying behaviour) performed by the individual horse or by a horse in its visual contact (neighbour horse). Horses not further than three boxes away and in three boxes across the aisle facing the given individual were considered neighbours.

Generalised linear mixed models were used to determine which of the survey answers were the best predictors of the presence or absence of a stereotypic behaviour. Riding school was considered as a random variable, and its effect was calculated within the statistical models.

Results and discussion

Prevalence of stereotypic behaviour in the nine Hungarian riding schools was not different from those of other countries. Results showed, that exposure to a stereotypic neighbour is a significant risk factor for performing stereotypy (odds ratio: 7-21). Also, aggressive behaviour towards other horses increased 4-11 times the risk of stereotypy in the aggressor.

The nature of the relation between aggression and stereotypies is poorly understood. Dominant horses are usually more aggressive, and foals of dominant mares are more likely to develop abnormal behaviour, perhaps because they are sensitive to even slight restrictions. Others believe, however, that both stereotypies and aggression are a common consequence of frustration. On the basis of our epidemiological studies we cannot state that neighbours have a causal effect on stereotypic behaviour. Even if such effects are substantiated by other studies, isolating stereotypic horses is bad management because social deprivation enhances stress and attenuates stereotypic behaviour. Careful monitoring of the horses for early signs of enhanced displacement behaviour is important to prevent the establishment of stereotypies. Horses susceptible to developing stereotypies might be moved away from stress agents, including stereotypic neighbours.

Experiment 2.

Methods

To illustrate the effectiveness of tree-based methods and to compare them to logistic regression, the data set on risk factors of crib-biting in horses presented in Experiment 1. was re-analyzed.

An important difference between these two statistical approaches is that logistic regression makes a number of assumptions about the underlying data, whereas tree-based methods do not. Another difference is that logistic regression can be used to derive odds ratios for the significant risk factors, while tree-based methods create a tree, where the ramifications represent the risk factors. The probability of occurrence is assigned to each end of branch in the tree. The brief description of the algorithm is as follows. In each first step an explanatory variable and a threshold is selected and the sample is split into two groups. That variable and threshold is selected that leads to the split with the most homogeneous groups with respect to the outcome variable. The process results in a tree-like structure of groups, also called nodes, in which each node has two "child nodes". Terminal nodes, or branches of the tree, define the classification of subjects. For building classification and conditional inference trees, the *rpart* and *party* add-on packages of the R 2.7.2. Statistical Software were used.

Results and discussion

Both methods found the two main risk factors reported in Experiment 1., but the number of risk factors revealed by logistic regression were less in quantity compared to the tree-based methods, and also the number of correctly classified stereotypic horses was less. According to tree-based methods, it seems like that the influence of crib-biting neighbours on crib-biting behaviour in horses may manifest itself only in special circumstances. Additionally, results showed that horses show crib-biting behaviour more likely if housed in stalls and tethered with a rope. Tethering as a method of managing horses is considered unsatisfactory from many points of view. In Denmark keeping horses tethered is legally prohibited. Our results underline the importance of these actions.

In summary, we can conclude that tree-based methods are useful tools in finding risk factors, or even for data mining, alone or together with logistic regression method.

Experiment 3.

Methods

In this study, we conducted a questionnaire survey on equine temperament to test the hypothesised differences between crib-biting and control horses (i.e. lower learning abilities and reduced stress tolerance in crib-biting horses). Where possible, control horses (N=50) were selected from the same establishment as the crib-biters (N=50). Groups did not differ significantly regarding age, breed, gender training level or usage (competition or leisure).

The questionnaire has been previously shown to reliably measure 'Anxiety', 'Trainability' and 'Affability' temperamental traits. Principal component analysis has revealed that the 'Anxiety' factor is based on items reflecting 'Nervousness', 'Excitability', 'Panic', 'Inconsistent emotionality', 'Vigilance', 'Skittishness', and 'Timidity'. 'Trainability' is based on 'Concentration', 'Trainability', 'Memory', and 'Perseverance'. 'Affability' contains items as 'Friendliness toward people', 'Cooperation', 'Docility' and 'Friendliness toward horses'. Differences in the obtained factor scores between control and crib-biting horses were tested by using general linear models, where the effect of age, breed, gender, training level, usage and their possible interactions served also as independent factors.

Results and discussion

Temperament traits were not affected by age, gender, breed or training level, but the usage of the horse and the presence of crib-biting behaviour had a significant effect. Competition horses had lower level of 'Anxiety' (p=0.032) and higher level of 'Trainability' (p=0.068) than leisure horses. Owners reported crib-biting horses have significantly lower level of 'Anxiety' than control horses (p<0.001), while 'Trainability' and 'Affability' did not differ between groups (p=0.823 and p=0.543, respectively).

Competition horses, as well as their riders, might have become more habituated to frightening stimuli since these horses are usually exposed to a wider variety of stimuli and have higher training level than horses used for leisure activities. It is also possible that more supple horses are favoured for competition purposes, and that the rider of a competition horse might have more experience defusing nervous behaviour of the horses.

Previous studies reported crib-biting horses to be less reactive when challenged as compared to control horses. Crib-biters were reported to have lower basal vagal and higher sympathetic tone than control horses, resulting in less flexible physiological reactivity when facing a stressor. We suggest that the virtual calmness and lower nervousness of the crib-biting horses might be due to the passive coping style of these animals. Contrary to expectations, scores on 'Trainability' had not coincided with the impaired learning of crib-biting horses reported in laboratory tests. However, previous behavioural tests on equine learning rarely had a direct relevance to the training abilities of the horses. 'Affability' of horses, on the other hand, might be more related to housing and management conditions than to crib-biting.

It seems that impaired learning abilities of crib-biting horses obtained in the laboratory tests do not predict learning deficiencies in training.

Experiment 4.

Methods

In this study we present an effective stress-test for triggering crib-biting in horses. In this study we used 12 crib-biters (4 moderate and 8 severe crib-biters) and 4 control horses.

Five minutes before the test the horses were tighten to their box with a rope long enough so they could reach the ground. The test lasted for 20 minutes and responses were first and last 5-5 minutes no other stimuli were given to the horse. After that, the experimenter was walking up and down in front of the box and was making noise with a bowl filled with oats (feeding-bowl) to direct attention to the bowl. Seven minutes after the start the feeding-bowl was placed in front but out of the reach of the horse. The feeding-bowl stayed there for eight minutes, meanwhile tidbits were given to the horses (~5 grams oats was taken from the feeding-bowl into the feed bin with delivery duration of ~10 sec) three times. Two minutes after the 3rd tidbit the bowl was removed, and for five minutes no stimulus was presented, however, the horses stayed tied up. Behaviour was videotaped continuously throughout the test and the total time spent with crib-biting behaviour was calculated and compared among control horses, moderate -, and severe crib-biters by using general linear models.

Results and discussion

The test induced crib-biting behaviour in 10 of the 12 examined crib-biters. None of the control horses showed stereotypic behaviour. Horses that were categorised by the owners as moderate crib-biters spent 4.6 ± 3.3% (mean ± S.E.) of the total time with oral activities whereas horses categorised as severe crib-biters performed it significantly longer, 27.1 ± 6.4% át (t_9=-3.286, p=0.010).

The reported test is easy to conduct, and may trigger crib-biting in a relatively short period of time in most crib-biters. The test gives reliable information about the severity of crib-biting, therefore it might be considered as a useful tool in research or field-veterinarian practice as well.

Experiment 5.

Methods

The aims of our study were to assess the success-rate of the modified Forssell's procedure, its implication for the welfare, and to compare the stress coping ability of 13 surgically treated horses to that of 13 collar treated, 13 crib-biting and 13 control (non-stereotypic) horses. Differences between the four groups were tested by the reported crib-biting triggering stress-test. Behaviour and heart rate variability (HRV: LF/HF ratio) of the horses were recorded throughout the test. R-R intervals were recorded by Polar® Equine S810i heart rate monitor. Hypotheses were tested by linear mixed model analyses.

Results and discussion

In the present study we found that crib-biting horses spent more time with oral activities, primarily with cribbing than controls or inhibited horses, whereas their stress level as indicated by heart rate variability were indistinguishable from controls and significantly lower than that of the inhibited groups. Overall our results suggest that performance of oral stereotypies in a stress situation successfully diminishes stress, while inhibition of such stereotypy elevates it. Thus crib-biting may be a true coping strategy.

Control horses were usually trying to reach the feeding-bowl while present and were standing still afterwards, whereas the other three groups had not really made efforts to obtain the food but performed or tried crib-biting. Control and crib-biting horses showed good stress-adaptation to the challenge since their HRV, after an initial increase, returned to the basal value. Both collar and surgical treatment inhibited crib-biting successfully, though not totally. These horses could not use crib-biting behaviour to "flight", but at the same time, they did not have the impetus to "fight" (obtain the food). HRV of both collar and surgically treated horses remained elevated and showed large oscillations throughout, showing that these horses failed to find a successful coping behaviour.

Since prevention may significantly increase distress, inhibition in itself is insufficient. Along with prevention, the motivation of the horse to perform crib-biting should be addressed also. In addition, considering that prevention by collar or surgery did not result in significant behavioural or physiological differences, the superiority of the modified Forssell's procedure compared to the collar treatment is questionable.

New scientific results

1. I showed empirically for the first time in the literature that exposure to a stereotypic neighbour has significant effect on the odds of horses performing stereotypic behaviour.

2. I demonstrated that tree-based classification methods are useful tools in finding risk factors, or even for data mining in veterinarian science, alone or together with logistic regression method

3. I compared the temperament traits of crib-biting and control horses with a previously validated personality questionnaire. I showed that the passive coping strategy of crib-biters is responsible for the lower level of 'Nervousness' in crib-biting horses compared to control horses. No differences were found regarding 'Trainability' or 'Affability'. With that I demonstrated that the previously reported impaired learning of stereotypic horses does not affect the horse's performance or trainability in a negative way.

4. I have developed a crib-biting provoking stress-test, which does not require any special paraphernalia and trigger crib-biting behaviour successfully in a relatively short period of time. The test also gives reliable information about the severity of crib-biting, therefore it is a useful tool in both research and field-veterinarian practice.

5. With the help of the developed crib-biting provoking stress-test I compared the stress-coping abilities between control and crib-biting horses (with or without inhibition). Inhibition of crib-biting behaviour either by collar or modified Forssell's surgical procedure decreased crib-biting to a similar extent. No significant behavioural or physiological differences were found between the two prevention methods. I showed that performance of oral stereotypies in a stress situation successfully diminishes stress, while inhibition of such stereotypy elevates it. Thus crib-biting has proven to be a true coping strategy. Therefore, inhibition without changing the motivation of the horse to perform the replacement behaviour is unsatisfactory and insufficient.

Publications related to the dissertation

Full-text papers published in peer-reviewed journals in English

1. **Nagy, K.**, Schrott, A., Kabai, P. Possible influence of neighbours on stereotypic behaviour in horses. Appl. Anim. Behav. Sci. 2008. 111, 321–328. (**IF**: 1.823)

2. **Nagy, K.,** Reiczigel, J., Harnos, A., Schrott, A., Kabai, P. Tree-based methods as an alternative to logistic regression in revealing risk factors of crib-biting in horses. J.Equine Vet. Sci. accepted for publication (**IF**: 0.515)

3. **Nagy, K.,** Bárdos, Gy., Bánszky, N., Bodó, G. Differences in temperament traits between crib-biting and control horses. Appl. Anim. Behav. Sci. submitted for publication (**IF**: 1.823)

4. **Nagy, K.,** Bodó, G., Bárdos, Gy., Harnos, A., Kabai, P. The effect of a feeding stress-test on the behaviour and heart rate variability of crib-biting horses (with or without inhibition). Appl. Anim. Behav. Sci. submitted for publication (**IF**: 1.823)

Full-text papers published in peer-reviewed journals in Hungarian

5. **Nagy, K.,** Bodó, G. A megtámasztásos levegőnyelés és gyógykezelésének új lehetőségei. Magy. Állatorv. Lapja 2009. 131. 8-17. (**IF**: 0.104)

6. **Nagy, K.,** Bodó, G. Levegőnyelést provokáló stressz-teszt lovak számára. Magy. Állatorv. Lapja accepted for publication (**IF**: 0.104)

Papers in conference proceedings, in english

Nagy, K., Schrott A, Kabai P, 2005. Do horses learn stereotypic behaviour from other horses? Poszter. XXIX. International Ethological Congress, Budapest, (poster, abstract) 2005

Nagy, K., Bodó G., Bárdos, Gy., Harnos, A. Is modified Forssell's operation superior to cribbing collar in preventing crib-biting in horses? International Equine Science Meeting, Regensburg, (oral presentation, abstract) 2008

Papers in conference proceedings, in hungarian

Nagy, K., A lovak rendellenes sztereotip viselkedésének előfordulási gyakorisága magyarországi lovardákban, Poszter. XII. Lógyógyászati Kongresszus, Budapest, (poster, abstract) 2004

Nagy, K.,, Schrott A, Kabai P. Lehet-e tanult a lovak sztereotip viselkedése? IX. Magyar Etológiai Konferencia, Göd, (oral presentation, abstract) 2004.

Nagy, K., Reiczigel J, Harnos A, Schrott A, Kabai P. Döntési fák, mint a logisztikus regresszió alternatívája: Rizikófaktorok keresése lovak sztereotip magatartászavarainál (esettanulmány), Poszter. VII. Magyar Biometriai és Biomatematikai Konferencia, Budapest, (poster, abstract) 2005

Nagy, K., Bodó G.. Lovak leggyakoribb rendellenes sztereotip viselkedései és kezelési lehetőségük. XIII. Lógyógyászati Kongresszus, Budapest, (oral presentation, abstract) 2005.

Nagy, K., Bodó G. A karórágás gyógykezelési lehetőségei lovaknál. MTA ÁTB ülése, Akadémiai beszámoló, Budapest, (oral presentation, abstract) 2006.

Nagy, K., Bodó G. 2006. A karórágás és levegőnyelés megelőzése és gyógy-kezelésének lehetőségei. Lótenyésztési Tudományos Napok, Debrecen, (oral presentation, abstract) 2006.

Nagy, K., Bodó G. A karórágó műtét hatékonyságának felmérése Magyarországon. MTA ÁTB ülése, Akadémiai beszámoló, Budapest, (oral presentation, abstract) 2007

Nagy, K., Bodó G. A karórágás (levegőnyelés) gátlásának hatása a lovak stressz-kezelési stratégiájára. MTA ÁTB ülése, Akadémiai beszámoló, Budapest, (oral presentation, abstract) 2008

Nagy, K., Bodó G.. A karórágás gátlásával csökkenhet a lovak stresszel szembeni megküzdő képessége. MTA ÁTB ülése, Akadémiai beszámoló, Budapest, (oral presentation, abstract) 2009

Acknowledgements

Working on a PhD dissertation is usually a lonely and isolating experience, but it definitely would not have been possible for me without the personal and practical support of the following people.

First of all, I am deeply grateful to my supervisor, *Dr. Gábor Bodó*, for his continuous help and encouragement throughout the years. I am especially grateful that he ensured me all the time and financial support, as well as the professional advices which were needed to conduct my researches.

I would like to acknowledge to all my teachers during my graduate and postgraduate studies who helped me to acquire knowledge especially in the field of animal behaviour and biostatistics. My thank goes to *Dr. Péter Kabai*, who helped me to engage my practical experiences with horses into the science of animal behaviour during my early student years as a zoologist. I am grateful to *Dr. Ryo Kusunose* (JRA Equine Research Institute, Tokyo, Japan) who introduced me to his researches, which served me as a constant inspiration throughout my studies, as well as to *Dr. János Kis, Dr. György Bárdos, Dr. Péter Sótonyi, Dr. Sándor Fekete, Dr. András Bába, Dr. Jenő Reiczigel, Anikó Schrott, Dr. Bókony Veronika, Daniella Kováts, Zsuzsa Halmai* and *Dr. Zoltán Kerekes* for allowing me to disturb them any time with my questions. I am also thankful to *Dr. Katherine A. Houpt* (Cornell University, Ithaka, USA) and to *Dr. Gyula Huszenicza* for their words of appreciation and encouragement.

I would especially like to express my sincere gratitude to *Dr. Andrea Harnos* and *Prof. Dr. Zsolt Harnos*, who provided me a job opportunity after my PhD scholarship expired, helping me also to deepen my knowledge in statistics. It has been a real challenge to investigate the effect of the climate change on bird migration.

I wish to thank to *Kinga Gavalda, Gerogina Kiss* and *Noémi Bánszky* for assistance in the field, and to the horse-owners who contributed with their animals to this study (among others to *Zoltán Varga, Anikó Bakonyi, Kármen Molnár, Ilona Maus, Krisztina Csermákné Lócsy* and *János Hargitai*), as well as to the horses – of course.

I also warmly thank my colleagues (among others to *Dr. Zita Makra, Dr. Kata Orsolya Veres, Dr. Orsolya Kutasi, Dr. Péter Tóth, Dr. Simon Izing, Szilvia Kovács*, and to all the colleagues at the Clinic for Large Animals) for their support and the joyful time together.

Last but not least, I owe to my warmest gratitude to my parents, grandparents, to my extended family – including my horses – and to my friends who stood beside me during the important moments of my life and helped me whenever it was needed.

I am forever indebted to the doctors working at Szent János Hospital, and at MÁV Hospital (among others to *Dr. János Ferenczi* and *Dr. Katalin Smolcz*), to the members of the International Society for Krsna Consciousness (especially to *Srila Indradyumna Maharaja, Srila Sivarama Swami* and *Srila Prabhupada*) and to the nectar teachings of the *Bhagavad Gita* for all their contribution to my recovery after the severe horse accident I went trough towards the end of my graduate studies, so that now I can live a healthy life again, both physically, mentally and spiritually.

Budapest, 11th September, 2009.

Krisztina Nagy