



Possible influence of neighbours on stereotypic behaviour in horses

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Abstract

Revealing risk factors of abnormal stereotypic behaviour (ASB) in horses can help in the design of protective measures. Previous epidemiological studies indicate that social isolation, housing, management conditions, and feeding regime have a strong effect on developing ASB. The common belief that exposure to a stereotypic horse increases the risk of ASB has never been substantiated. Here we report that a generalised linear mixed models (GLMM) analysis of data on 287 horses of nine riding schools revealed that exposure to a stereotypic neighbour is a significant risk factor for performing stereotypy. Also, aggressive behaviour towards other horses increased the odds of stereotypy in the aggressor. These correspondences are unlikely to be a riding-school effect, because riding schools were treated as random factor in the GLMM. Risk factors identified by epidemiological studies cannot be treated as causal agents without independent evidence. Our aim in presenting these findings was to draw attention to the possibility of neighbour effects so that other researchers would include this variable in their surveys.

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1. Introduction

In the broad sense, stereotypies are repetitive, relatively invariant actions. Stereotypies are considered abnormal when they occur without any primary function and might be detrimental to the health or performance of the animal (Mason, 1991). The prevalence of the most common abnormal stereotypic behaviour (ASB) in horses, such as crib-biting/wind-sucking, weaving, and box-

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walking have been reported at a level of 0.4–5% (McBride and Long, 2001; Mills et al., 2002; Bachmann et al., 2003; Christie et al., 2006), however, with wood-chewing included, overall ASB reached 20–35% of prevalence (McGreevy et al., 1995a; Waters et al., 2002). Such stereotypies have been implicated as a possible cause for gastric ulceration and colic (Nicol et al., 2002; Archer et al., 2004) and for tooth wear, weight loss, and weak condition (McBride and Long, 2001). Once established, ASB are difficult to change; therefore prevention is of great concern.

Long lasting stereotypies together with a variety of other abnormal behaviour can be precipitated by chronic stress as a consequence of restricted milieu at early age in many species (Mason, 1991). This process is reversible by environment enrichment but only at early life which, together with neurobiological evidence suggests a critical period for the neuroprotective effects of complex social and physical milieu (Hadley et al., 2006). On the other hand, temporary stereotypies as normal displacement behaviour are often elicited by acute stress caused by inhibition of the appetitive phase of a goal directed behaviour (Hughes and Duncan, 1988). For example, non-stereotypic horses often performed weaving, nodding, and oral stereotypies when their companions were fed concentrate (Cooper et al., 2005). Although, such displacement behaviours are not abnormal, they are considered prerequisite for ASB (Waters et al., 2002). Sequences of behaviour starting with displacement followed by ASB can be observed even in ASB horses (Ninomiya et al., 2007). Unfortunately, as most caretakers do not note such mild symptoms, we, as others in previous studies, had to narrow our survey to true ASB.

Previous studies indicate that breed type, feeding regime, housing, and management conditions have a strong effect on developing ASB (McGreevy et al., 1995b; Waters et al., 2002; Bachmann et al., 2003; Christie et al., 2006). According to anecdotal evidence, exposure to other horses engaged in stereotypies is a risk factor for developing similar habits (Haupt and McDonnel, 1993). However, controlled experiments or epidemiological studies have never supported such beliefs (Cooper and Albertosa, 2005).

The effect of neighbours on horses with established stereotypies is controversial. On the one hand, it has been suggested that a poster image of a conspecific (Mills and Riezebos, 2005), a mirror in the paddock (McAfee et al., 2002; Mills and Davenport, 2002), or visual contact with other horses (Cooper et al., 2000; Mills and Davenport, 2002) effectively reduced the time spent in weaving. However, any treatment in those studies was limited to 2–5 days, a short period of time for habituation. Possible facilitation of weaving by exposure of weavers to non-stereotypic horses (Cooper et al., 2000) was also limited by the experimental design, because the two individuals with highest level of ASB were exposed to each other rather than to non-weavers. On the other hand, observation of horses visually isolated or being able to see each other as a consequence of housing revealed that weaving was higher among horses whose boxes faced that of other horses than among horses whose boxes did not (Ninomiya et al., 2007).

The aim of this study was to investigate risk factors of ASB in horses. We show that exposure to a stereotypic neighbour may have significant effect on the odds of horses performing abnormal stereotypies.

2. Methods

2.1. Data collection

We performed a questionnaire survey to detect potential risk factors of ASB (crib-biting/wind-sucking, wood-chewing, weaving, and box-walking) on 287 horses by visiting nine riding schools in Hungary.

Before asking the horse-owners to complete the questionnaire, we explained them the definition of stereotypic and other behaviour problems (according to McGreevy et al., 1995b). During our 4–6 h stay at each riding school we observed stereotypic behaviour in all horses reported to have ASB. The survey items focused on subject variables, housing, management conditions, food regime, stereotypies, and problematic behaviour performed by the individual horse or by a horse in its visual contact.

2.2. Data analysis

Following a data-quality check, variables likely to be subject to recording bias and variables with a frequency more than 50% of missing values were excluded from further investigation. The remaining variables were classified as being recorded on a binary or an ordinary scale, and can be summarized as follows

Stereotypies were dependent variables in five separate models (crib-biting/wind-sucking, wood-chewing, weaving, box-walking, and stereotypies in general, a derived variable for the occurrence of any of the four listed abnormal behaviours). The independent variables included the usage of the horse (competition or non-competition), subject variables, housing, and management conditions (as summarized in Table 1), problematic behaviour performed by the given horse (aggression towards horses and people, door opening or knot-untying behaviour, and behaviour problems during riding), stereotypies and problematic behaviour of the “neighbour horses”. Position of the horses in the stable was also recorded so spatial proximity of stereotypic horses could be calculated. Horses not further than three boxes away and in three boxes across the aisle facing the given individual were considered neighbours.

Table 1
Items of the questionnaire survey

	Range of variables (no. of horses)			
Age	3–5 years (9)	5–15 years (101)	15–20 years (15)	Missing value (1)
Gender	Male (16)	Gelding (69)	Mare (41)	
Breed	Thoroughbred (6)	Hungarian halfbred ^a (61)	Other (30)	Missing value (29)
Type of housing	Stall (21)	Box (105)		
Bedding	Straw (124)	Shavings (2)		
Frequency of feeding roughage (hay) per day	2 times (30)	3 times (65)	5 times (31)	
Frequency of feeding concentrates (oats) per day	1–2 times (100)	3 times (26)		
Daily amount of oats in kg	Less than 7 (93)	More than 7 (33)		
Tactile contact with other horses	Just sniff or see (17)	Touch (109)		
Move freely in the paddock weekly	Less than once (13)	1–2 days (18)	3–5 day (27)	More than 5 days (68)
Weekly box-rest (confined to the stall for 24 h)	Less than 1 day (103)	More than 1 day (23)		
Weekly riding	Less than once (9)	1–2 times (0)	3–5 times (29)	More than 5 times (88)
No. of riders using the horse	No riders (5)	1–2 riders (58)	More than 2 riders (63)	
Daily grooming time (min)	Less than 10 (42)	10–30 (53)	More than 30 (30)	Missing value (1)

Levels of the independent factors (subject variables and housing and management conditions), and the number of non-competition horses in each level in brackets.

^a Cross between thoroughbred and Hungarian native breeds.

Riding school was considered as a random variable, and its effect was calculated within the statistical models.

2.3. Statistical analysis

To determine which of the survey answers were the best predictors of the presence or absence of a stereotypic behaviour, first we performed a univariate analysis for the five stereotypic categories independently, using a single logistic mixed regression (generalised linear mixed models, GLMM) separately for all factors obtained from the questionnaire. Variables with $P < 0.10$ were considered for initial inclusion in the mixed-effect multivariate logistic regression model. Variables lacking a statistically significant association ($P > 0.10$) with the particular outcome variables were excluded from the given model, however, the same variables could have been included in the other models.

In the GLMM the effect of the riding school was treated as a random factor to control for possible yard effects. In case of crib-biting the variance of the random factor was negligibly small compared to the variance of the error term, so in this case we have used the generalised linear model (GLM) instead of the GLMM. GLM and GLMM were applied with binomial error distribution and logit link function. The penalised quasi likelihood method (PQL) was used to estimate the parameters in the GLMM (Breslow and Clayton, 1993). The models were manually built using a backward elimination process. Variables with a $P > 0.05$ were excluded, except in the case of crib-biting and stereotypies in general, where $P > 0.10$ was chosen to ensure better-predicted values by the models. The removal of the non-significant factors resulted models with lower Akaike information criterion (AIC) in each case, interpreted as that the explanatory power of the initial and final models are the same. The exponentials of β -coefficients in the final models were interpreted as odds ratios of the five outcome variables. All analysis was carried out using the R statistical software 2.2.0 (Ihaka and Gentleman, 1996).

3. Results

3.1. Housing conditions and prevalence of behavioural disorders

In the population of 287 horses sampled, the prevalence percentage of crib-biting/wind-sucking was 4.53% ($N = 13$), wood-chewing was 10.10% ($N = 29$), weaving was 2.79% ($N = 8$), and box-walking was 3.83% ($N = 11$). The occurrence of any of the four listed abnormal behaviours (ASB in general) was 16.70% ($N = 48$). Aggression towards horses was noted in 17.07% ($N = 49$) of individuals, aggression towards people was 9.41% ($N = 27$), behaviour problems during riding was 9.06% ($N = 26$), and door or tier opening behaviour was 5.23% ($N = 15$).

Stereotypies were more common in non-competition horses compared to competition horses (33 out of 126 non-competition horses and 12 out of 161 competition horses showed abnormal stereotypic behaviour; $\chi^2_1 = 13.264$, $P = 0.0003$). Although the risk factors revealed by the final models were consistent concerning non-competition horses ($N = 126$) and all horses ($N = 287$), to ensure reliable classification we present the data on risk factors among non-competition horses.

Housing conditions among non-competition horses were similar (Table 1). There was no variation in forage type (only hay was offered), all horse's diet contained grains, no individual was socially isolated, and all horses except two had straw bedding. All horses but nine individuals were ridden at least three times a week, most of them had no rest day and could move freely in the paddock 3 or more days a week. All horses but six individuals were non-thoroughbred, and the total number of horses in a yard were less than 60 in most cases.

Table 2
Risk factors of stereotypies in the final multivariate models

Outcome variable	Risk factors	OR	CI at 95%	<i>P</i>
Crib-biting/wind-sucking	Presence of a weaving neighbour	20.81	1.74–315.12	0.018
	Aggression towards horses	11.36	2.36–82.89	0.005
	Presence of a crib-biting neighbour	6.59	0.63–66.7	0.099
	Presence of a box-walking neighbour	–	–	n.s.
	Presence of an aggressive neighbour	–	–	n.s.
	Door opening or knot-untying behaviour	–	–	n.s.
	Box-walking	–	–	n.s.
	Wood-chewing	–	–	n.s.
Wood-chewing	Receiving oats more than 2 times a day	24.82	2.66–231.47	0.006
	Box-walking	33.44	4.19–266.52	0.001
	More than two riders using the horse	–	–	n.s.
Weaving	Presence of a weaving neighbour	14.14	1.75–113.98	0.014
	Presence of an aggressive neighbour	20.21	3.30–123.62	0.002
	More than two riders using the horse	33.05	4.44–245.83	0.001
	Aggression towards horses	6.11	1.51–24.75	0.013
	Wood-chewing	35.84	7.95–161.65	<0.001
	More than two riders using the horse	0.02	0.00–0.19	0.001
	Crib-biting	–	–	n.s.
	Presence of an aggressive neighbour	–	–	n.s.
Stereotypies in general	Presence of a stereotypic neighbour	10.14	2.22–46.29	0.003
	Aggression towards horses	4.43	1.52–12.86	0.007
	Receiving oats more than 2 times a day	3.40	0.89–13.03	0.070
	Presence of an aggressive neighbour	–	–	n.s.

Odds ratios (OR) and confidence intervals (CI) of the significant risk factors for stereotypic behaviours included in the final mixed-effect multivariate logistic regression, with riding-school being a random factor in the model. The non-significant (n.s.) factors have not been included in the final multivariate model, although they were preselected by the univariate analysis.

3.2. Risk factors

Univariate GLMM statistics revealed 11 factors (presence of a weaving, or crib-biting, or box-walking or aggressive neighbour, performing aggression towards horses, receiving oats more than two times a day, more than two riders using the horse, performing box-walking, crib-biting, wood-chewing or door and tier opening behaviour) associated ($P < 0.10$) with any of the four stereotypies (Table 2). Eight of those factors (presence of a weaving, or crib-biting, or aggressive neighbour, performing aggression towards horses, receiving oats more than two times a day, more than two riders using the horse, performing wood chewing or box-walking) remained significant in the final model of the multivariate GLMMs (Table 2). The overall classification accuracy of the final models was 81–97%. Each model classified horses without stereotypic behaviour more accurately (96–100%) than stereotypic horses (30–65%) suggesting that risk factors are not absent in normal horses.

4. Discussion

Prevalence of abnormal stereotypic behaviour (ASB) in Hungarian riding schools was not different from those of other countries (McBride and Long, 2001; Christie et al., 2006). However,

factors associated with ASB revealed by our analysis are in apparent contrast with previous epidemiological surveys. Management methods restricting natural behaviour have been suggested as major risk factors for developing ASB. Oral stereotypies (crib-biting/wind-sucking and wood-chewing) are mostly associated with the diet and the restriction of normal grazing behaviour (McGreevy et al., 1995b; Waters et al., 2002; Bachmann et al., 2003), whereas locomotor stereotypies such as box-walking and weaving might be activated by social isolation or inadequate physical exercise (McGreevy et al., 1995b; Bachmann et al., 2003).

It is not surprising that many risk factors reported by others were not identified in our study, because management practices in the studied nine riding schools were very similar and lacked most of the risk factors identified by previous studies, and other factors, like behaviour of the neighbouring horses, have not been included in previous surveys.

Only two management conditions emerged as risk factors for ASB. First, receiving concentrates more than twice a day increased the odds of wood-chewing and ASB in general, in accordance with previous studies (McGreevy et al., 1995b; Waters et al., 2002; Bachmann et al., 2003). Second, having more than two riders increased the odds of weaving, but diminished the odds of box-walking. The number of riders as a possible risk factor has not been studied previously, and such a bi-directional effect is difficult to explain, as box-walking was reported to coincide with weaving (Mills et al., 2002). In a previous study, Ninomiya et al. (2007) found that contact with unfamiliar riders increased the incidence of weaving, however, they provided no data on the number of riders. We can only speculate that horses ridden by many riders are more stressed (increasing the odds of weaving) but also receive more exercise, thus reducing the odds of box-walking. Disentangling the possible effects of number of riders, amount of exercise and riding by strangers needs further investigations.

All other risk factors, such as aggression toward horses or presence of a neighbour performing aggression or some kind of stereotypy, are behavioural variables. The nature of the relation between aggression and stereotypies is poorly understood. Dominant horses are usually more aggressive, and according to the findings of Waters et al. (2002), 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 (Mills and Nankervis, 1999). Presence of an aggressive or stereotypic neighbour increased the odds of crib-biting/wind-sucking and weaving, a finding not reported previously. The possibility that stereotypic horses in proximity to each other experience the same stressor (waiting for food distribution, or to be driven out of the stable) can be ruled out, because the position of stereotypic horses was random in relation to distance to the gate, windows or ventilation of the stable. Caretakers reported that positioning of newly arrived horses was determined by the availability of free space, and stereotypic horses were not deliberately put close to each other in the paddock.

Epidemiological studies are not designed to reveal causal relations; therefore we should be careful to interpret our findings. It is possible that factors not present at the time of the survey are responsible for the development of stereotypies in some individuals. Some existing factors could have been overlooked. For example, we have data on the daily frequency of feeding roughage; however, it is not known how long roughage was available after it was provided. Nevertheless, such possible sampling biases do not explain significant associations between the behaviour of neighbours.

The effect of neighbours has been reported on other species with stereotypic behaviour (Cooper and Nicol, 1994; Lindberg et al., 1999; Garner et al., 2006). In horses, copying or observational learning as a mechanism of developing stereotypies is unlikely (Lindberg et al.,

1999); however, social facilitation or stimulus enhancement cannot be ruled out. A stereotypic neighbour spends less time eating and resting than normal horses (McGreevy et al., 2001). As stereotypies are more frequent in disturbed environments, or when general activity of the horses is great (Cooper et al., 2000), constant movement during weaving, or sound production during wind-sucking by stereotypic horses can make sensitive individuals restless and induce ASB. There is only anecdotal evidence for a possible role of stimulus enhancement. Cooper et al. (2000) noted that horses showed interest in areas cribbed by stereotypic neighbours. Horses who observed cribbing were not seen cribbing themselves; however, contact of horses with no stereotypy with ASB individuals was limited to 5–10 days, a short period for the emergence of abnormal stereotypy.

The precise nature of the possible effect of neighbours on ASB should be studied experimentally before concrete suggestions can be given for practical management. However, as the majority of managers believe that stereotypies are not just inherited but also learned from other horses (McBride and Long, 2001) we cannot avoid the responsibility to make some general remarks. On the basis of our epidemiological studies we cannot state that neighbours have a causal effect on ASB, our aim in presenting these findings was to draw attention to the possibility of such effects so that other researchers would include this variable in their surveys. Even if such effects are substantiated by other studies, isolating stereotypic horses is bad management because social deprivation enhances stress and attenuates ASB (Bagshaw et al., 1994). 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.

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