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Original Research

Competition Horses Housed in Single Stalls (I): Behavior and Activity Patterns during Free Exercise According to Its Configuration

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ABSTRACT

Although welfare of animals has become more important, housing horses in systems that limit natural behavior patterns is still widespread. Single stalls are the predominant housing system in Germany, especially for competition horses. Free exercise on fields or paddocks helps to improve welfare for the animals, but allowing it is not taken for granted by many horse keepers. In the present study, three common management practices were investigated with regard to their effect on the behavior of six competition horses housed in single stalls: 2-hour turnout after training in groups of two horses (group turnout [GT]), solitary turnout (ST) after training for 2 hours, and no turnout (NT) in addition to training. The aim of the study was to determine the differences in the horses' behavior during turnout, training, and in the stable caused by the treatments. This article focuses on the behavior and activity patterns during turnout. The horses' behavior was observed directly by the scan sampling method (5-minute interval), and the distance covered during turnout was measured by global positioning system devices. During turnout, the horses spent most of the time eating. After 1 hour of being turned out, eating decreased, and occupation, locomotion, and social interaction increased. When turnout was allowed in groups (GT), the horses spent more time in social interactions and less time walking and trotting than in ST. Therefore, they also covered a greater distance in ST than in GT. The distance covered in ST also showed a greater deviation both within and between days compared with GT.

1. Introduction

Horses are characterized as gregarious and flight animals, originating from vast, semi-arid, grass-covered plains; therefore, they are adapted to continuous locomotion and to intake low-energy feed. Despite several thousand years of domestication, these attributes are prevalent till this day [1]. Although animal welfare has become more important, housing systems limiting natural behavior patterns are still widespread. Single stalls confine social interactions and locomotion to a great extent, but despite this, they are predominant in Germany, especially for competition horses [2]. Trying to make the horse give its best performance in sport on the one hand, and involving little labor and low costs on the other, frequently results in single housing without free exercise and social interactions. Houpt et al. [3] and Chaya et al. [4] observed that irregular turnout leads to more trotting, cantering, and bucking, whereas horses provided with regular turnout behave in a much more calm manner when released. If turnout is provided, it is a common practice to decrease the risk of injury by establishing areas for individual horses. This approach accommodates the horse's demand for free exercise but it is still socially isolated.

Because the horse is a species which lives in constant social groups [5], living without social interactions is a

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serious stress factor [6]. In the German guidelines for the evaluation of equine housing systems regarding the aspects of animal protection [7], experts demand at least intervisibility, auditory, and olfactory contact with conspecifics in single housing. They also point out that housing horses in single stalls without free exercise is not species-appropriate according to the horse's physiological demands and may lead to diseases of the musculoskeletal [8,9] and respiratory systems [10,11], as well as to abnormal behavior [12-14]. Nevertheless, this kind of housing remains in practice.

The aim of the present study was to investigate the effect of free exercise on the behavior of competition horses in the stable, during turnout on pasture, and during training. Therefore, three common turnout practices were systematically analyzed: daily training without additional free exercise (no turnout [NT]), free exercise in groups of two horses after training (group turnout [GT]), and free exercise separately after training (solitary turnout [ST]). The present article focuses on the horses' behavior and activity patterns during turnout. The results were intended to provide better information regarding use of free exercise and the effect of the configuration of turnout on the behavior and activity of the horses. In this way, there might be indications on how to optimize free exercise to improve animal welfare in single housing systems.

2. Materials and Methods

2.1. Location of the Study

The research was carried out in a training and competition yard in Noerten-Hardenberg (County of Northeim, Lower Saxony, Germany) in the period between June 7, 2010, and July 18, 2010. The stable contained 16 single stalls ($3.00 \text{ m} \times 3.50 \text{ m}$, 10.5 m^2) in two rows, with an aisle (width: 4.00 m) in the middle.

The pasture was located about 300 m southwest of the stable. Its dimensions were $60 \text{ m} \times 90 \text{ m}$ (5400 m^2), and it was bordered by a wooden fence (height: 1.70 m) with an electrical band. For the investigation, the area was divided into three paddocks, each sized $30 \text{ m} \times 60 \text{ m}$ (1800 m^2), using electrical fences. This size gave the horses enough space for free exercise in walking, trotting, and cantering (German guidelines advise at least 150 m^2 for two horses [7]). Across the fences, the horses were able to sniff each other. The paddocks used for GT and ST were rotated daily. Each paddock was covered with grass and contained one old tree within reach of the horses. The paddocks did not contain watering places and no additional feed was given on pasture.

2.2. Animals

Six German Warmblood Horses (height: between 1.65 m and 1.75 m; weight: between 600 and 650 kg) were used for the investigation. All six horses were schooled in dressage and show jumping, and were deployed in competitions in one of these disciplines at prenovice to advanced class. Horse 1 (H1) was a 4-year-old Hanoverian mare, horse 2 (H2) was a 6-year-old Hanoverian gelding, horse 3 (H3) was a 7-year-old Holstein gelding, horse 4 (H4) was a 10-year-old Hanoverian gelding, horse 5 (H5) was a 4-year-old Hanoverian gelding, and horse 6 (H6) was a 6-year-old Hanoverian gelding.

All six horses were moved into their experimental stalls 2 weeks before the investigation was started. They were accommodated in six stalls next to each other. The experimental group partners were kept in neighboring stalls, and restricted physical contact through vertical lattice bars (distance between bars: 6 cm) was possible. All horses were used to doing free exercise three to four times a week on pasture land (both on their own as well as with their experimental group partner for 1 to 2 hours). The riders were asked to retain their method of training during the investigation according to their normal routine. Because the method of training was not standardized, the duration of training varied (between 21 and 65 minutes).

2.3. Bedding Materials and Feed

All six experimental stalls were strewn with wheat straw. New straw (about 10 kg/stall) was given every morning after feeding. The stalls were mucked out once every 4 weeks.

Oats and muesli (Torneo Muesli, onOvo GmbH, Hannoversch Münden, Germany) were fed three times a day (06:00 AM, 12:00 PM, 04:00 PM). At 12:00 PM, 50 g of mineral feed (Torneo Mineral, onOvo GmbH, Hannoversch Münden, Germany) was added to the concentrates. H1 received 1.3 kg of muesli three times a day, whereas all other horses received 1 kg of oats at 6:00 AM and 4:00 PM, and 0.5 kg of oats and 0.7 kg of muesli at 12:00 PM. Hay was given in the morning and in the afternoon before the concentrates. H3 received 4 kg of hay at any one time, whereas all other horses received 5 kg. The amount of feed, feeding quality, and type remained constant over the course of the experiments. Water was available in the stable at all times for each individual horse.

2.4. Measurement Techniques

The behavior of the horses during turnout was documented by direct observation using the scan sampling method (observation interval: 5 minutes).

Four global positioning system (GPS) devices—Garmin Forerunner 205 (Garmin, Olathe, KS)—were used to record the distance covered by the horses during turnout. The devices were fixed on the horses' head collars. This position was chosen because it did not influence the horses' behavior and the device was protected against damage. Movements of the head during grazing resulted in a distance of 0.05 m being measured on average per up-and-down-movement. Thus, the results of the total distances covered during turnout might be slightly overestimated. After measurement, the data were read out and stored using the software program Garmin Training Center (Garmin, Olathe, KS).

During the experiments, a Tinytag Plus 2 (Gemini Data Loggers Ltd., Chichester, UK) recorded the ambient temperature and relative humidity outside the stable hourly.

2.5. Experimental Design

The present article discusses the behavior and activity patterns of a group of horses during turnout. This investigation was part of a greater study composed as follows. The whole study took 6 weeks and was divided into three 2-week-periods (period 1 = June 7, 2010 to June 20, 2010; period 2 = June 21, 2010 to July 4, 2010; and period 3 = July 5, 2010 to July 18, 2010). The experimental horses were also arranged into three groups (group 1 = H1 and H2; group 2 = H3 and H4; group 3 = H5 and H6). During the investigation, all six horses passed through three different treatments, each lasting 2 weeks.

In the first treatment, the horses received free exercise on the pasture after training for 2 hours in groups of two horses (GT). In the second treatment, solitary turnout (ST: one horse per piece of pasture) was allowed for 2 hours on pasture after training; whereas in the third treatment, no free exercise was allowed in addition to training (NT; as this article focuses on turnout, this treatment will not appear in the Results or Discussion section). The test procedure is presented in Table 1.

Training was carried out according to the horses' individual routine between 8:00 AM and 11:00 AM by three experienced riders, who also presented the horses at competitions. After training, between 11:00 AM and 2:00 PM, free exercise on the pasture was allowed according to the respective treatment. ST and GT were always carried out simultaneously. In the treatments with turnout, the midday feeding was done after turnout. Depending on the particular time of training, the horses spent 30 minutes to 2 hours within their stall in-between training and turnout.

2.6. Data Collection

The data were collected daily from Monday to Friday. No data were collected on Saturdays and Sundays because most of the experimental horses were at the competition venues. On these days, free exercise was managed according to the treatment the horses were being subjected to during the respective period (ST, GT, or NT; exact time of day sometimes differed from the experimental times).

Direct observations during turnout were carried out by one person sitting next to the paddocks (visible to all horses) and did not move during the turnout time. Six behavior patterns were recorded in the protocols and analyzed: "standing/dozing"; "standing/occupation" (including pawing the ground, nibbling the trees, self care at the trees, watching the surroundings attentively or nervously); "eating" (grass); "walking"; "trotting/cantering"; and "social interaction" (including body care among each other, playing, sniffing [at horses on the neighboring fields across the fence in ST]; aggressive behavior was not observed).

Table 1
Test procedure

Period	Group 1 (Horses 1 + 2)	Group 2 (Horses 3 + 4)	Group 3 (Horses 5 + 6)
Period 1 (weeks 1 + 2)	ST	NT	GT
Period 2 (weeks 3 + 4)	GT	ST	NT
Period 3 (weeks 5 + 6)	NT	GT	ST

NT, no turnout; ST, solitary turnout; GT, group turnout.

The observed horses were equipped with individual GPS devices during turnout, which measured the distance covered and the horse's speed. Measuring was started on the way to pasture and stopped when the horses returned to the stable. For the analysis, only 2 hours of data starting from when the horses were released into the paddock were used; thus, the way to and from the paddock is not included in the analyzed distances.

The ambient temperature and relative humidity were averaged over the turnout time (11:00 AM to 2:00 PM).

2.7. Statistical Analysis

The statistical evaluation of the data was carried out with the software program SAS 9.1 (SAS Institute Inc., Cary, NC).

As the observation interval used in the behavior observations during turnout was 5 minutes, any recorded behavior was considered to have lasted for 5 minutes in the analysis. The direct observation generated 112 analyzable behavior protocols (six protocols in ST and two in GT could not be analyzed because of the horses being at a competition). Data of the behavior "eating" were available in Gaussian distribution. To create a Gaussian distribution of the data set of "standing/occupation," the square root was taken. The behaviors "standing/dozing," "social interaction," "walking," and "trotting/cantering" could not be transformed into Gaussian distributions. For the data available in Gaussian distribution, general linear model was computed using the following model: $y_{ijkl} = \mu + T_i + P_j + H_k + e_{ijkl}$ (where, y_{ijkl} = observed value; μ = mean value; T_i = fixed effect of the treatment, i = ST, GT, NT; P_j = fixed effect of the period, j = period 1 to 3; H_k = random effect of the horse, k = horse 1 to 6; e_{ijkl} = random residual of y_{ijkl}). The interaction between horse and treatment and the covariables ambient temperature and relative humidity had no significant influence on the variables (tested by *F* test, $P > .1$), and thus were not included in the model. For data that could not be transformed into Gaussian distribution, the influences of the effects were estimated using the nonparametric test for location and scale differences across a one-way classification and Wilcoxon two-sample test. Additionally, the coefficient of correlation according to Spearman (*r*) was computed between the behaviors.

The GPS measurements during turnout produced 111 analyzable data sets (6 measurements in ST and 3 in GT could not be analyzed because of competition or technical problems). To create Gaussian distributions, the natural logarithm was taken twice as well from the distance covered as from the average speed. General linear model was computed using the following model: $y_{ijkl} = \mu + T_i + b \times (a_j - \bar{a}) + b \times (c_k - \bar{c}) + e_{ijkl}$; where, y_{ijkl} = observed value; μ = mean value; T_i = fixed effect of the treatment, i = ST, GT, NT; $b \times (a_j - \bar{a})$ = regression of y_{ijkl} on ambient temperature (a); $b \times (c_k - \bar{c})$ = regression of y_{ijkl} on relative humidity (c); e_{ijkl} = random residual of y_{ijkl}. The random effect of the horse, the fixed effect of the period, and the interaction between horse and treatment had no significant influence on the variables (tested by *F* test,

$P > .1$), and so were not included in the model. The data of the distances covered within the days were not available in Gaussian distributions; thus, the differences between and within the treatments were calculated using the nonparametric test for location and scale differences across a one-way classification and Wilcoxon two-sample test. Additionally, the coefficient of correlation (Pearson product-moment correlation coefficient, *r*) between distance and speed was computed and the coefficient of variation was computed for the treatments.

Significant difference was defined at $P \leq .05$. The *P* values between .05 and .1 were seen as tendencies (*t*-test). If not explicitly indicated, the first three days of the treatments were not taken into account. This was done to reduce the effect of the previous treatment on the treatment under investigation.

3. Results

During the investigation, the ambient temperature varied between 16°C and 31°C, and the relative humidity varied between 46% and 80% (period 1: 16°C to 24°C and 47% to 80%; period 2: 17°C to 28°C and 52% to 68%; period 3: 18°C to 31°C and 46% to 70%, respectively).

3.1. Behavior during Turnout

The direct observation of the horses during turnout revealed that more than half of the turnout time (about 75 minutes) was spent "eating" (Fig. 1). Only very little time (<5 minutes) was spent "standing/dozing." No significant differences between the treatments were found in the behaviors. In GT, "social interaction" was performed for 5.25 minutes. Aggressive social interactions such as kicking, biting, and chasing were not observed. In ST, only 1.39 minutes were spent with "social interaction," and it only consisted of sniffing at each other across the fences. The individual horse and the period of the investigation had a significant influence on "eating," "standing/occupation," and "social interaction" (Table 2). "Eating" was performed significantly shorter and "standing/occupation" was performed significantly longer in period 3, compared with the other periods ($P < .01$ in both behaviors). "Social interaction" was observed significantly less in period 2 compared with the other periods ($P < .05$). The more the horses were occupied with "eating," the less the behaviors "standing/occupation" ($r = -0.73$; $P < .0001$), "walking" ($r = -0.53$; $P < .0001$), and "social interaction" ($r = -0.34$; $P = .0025$) were performed. The more time the horses spent "trotting/cantering," the less they spent with "standing/occupation" ($r = -0.35$; $P = .0021$). During the course of turnout, the time spent "eating" decreased, whereas for the other behaviors it increased toward the end of turnout. In Figure 2, the development of "eating," "locomotion" (walking, trotting, catering), and "social interaction" during the course of the turnout is presented. "Locomotion" increased slightly in the course of turnout and was recorded more often in ST. "Social interaction" was observed in both treatments, but increased considerably after 80 minutes in GT.

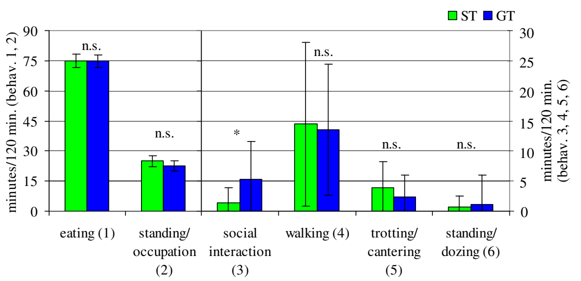

Fig. 1. Least squares means and standard errors of the behaviors "eating" and "standing/occupation," and the means and standard deviation of the behaviors "social interaction" (median: ST = 0 minute, GT = 5 minutes), "walking" (median: ST = 10 minutes, GT = 10 minutes), "trotting/cantering" (median: ST = 5 minutes, GT = 0 minute) and "standing/dozing" (median: ST = 0 minute, GT = 0 minute) during turnout subdivided according to treatment. (Duration of turnout = 120 minutes; ST = solitary turnout; GT = group turnout; n = 76 observation periods [ST = 36; GT = 40]; n.s. = not significant [$P > .05$]; * = as "social interaction" is restricted by the fences in ST, significant difference is to be expected between the treatments; therefore, direct comparison of the values is of little information).

3.2. Distance Covered during Turnout

The distance covered was highly correlated to the speed with which the horses moved during turnout ($r = 0.99$; $P < .0001$). The deviation of values between the measuring days is considerably greater in ST than in GT (Fig. 3). The distance covered varied between 1.5 and 6.5 km in ST (coefficient of variation: 38.27%), and between 1.4 and 4.1 km in GT (coefficient of variation: 26.74%). On average, the distance covered in ST was significantly longer than in GT ($P = .0447$; Fig. 4). The distance covered was significantly shorter when the ambient temperature ($P = .0217$) and relative humidity ($P = .0084$) were higher.

Regarding the individual horses, the differences between the treatments were not significant. Nevertheless, all horses (apart from H6) covered a greater distance in ST than in GT (Fig. 4). Figure 5 shows the development of the distance covered during the course of the treatments. Apart from day 9, the distance covered was always greater in ST than in GT. Although the differences between and within the treatments were not significant, the distance on day 1 in ST was considerably longer than on all the other days. The development of the distance covered within the turnout time is presented in Figure 6. In the first 5 minutes, the horses' activity was comparatively high in both treatments and then decreased. The activity increased in both treatments in the last 30 minutes, although the progression was more intense in ST.

4. Discussion

4.1. Activity Patterns

Several studies have revealed considerable differences in general activity between individual horses [15-18]. The horses in the present study covered between 2.5 and 3.8 km within 2 hours of turnout (Fig. 4), which indicates quite a homogenous group of experimental horses. In the treatment ST, direct observations revealed that the horses showed more "walking" and "trotting/cantering" (Fig. 1), and accordingly GPS measurements led to a greater distance covered compared with the treatment GT (Figs. 3 and 4). The fact that the difference between the

Table 2
Least squares means (LSM) and standard error (SE) of the duration of the behaviors "eating" and "standing/occupation," and the means (M) and standard deviation (SD) of the behavior "social interaction" subdivided according to period (total duration of turnout: 120 minutes)

Period	n	Eating		Standing/Occupation		Social Interaction	
		LSM (minutes)	SE	LSM (minutes)	SE	M (minutes)	SD
Period 1	26	81.09a	4.16	15.21a	3.46	4.62a	3.98
Period 2	28	81.57a	4.04	21.99a	3.36	0.71b	1.78
Period 3	22	61.47b	4.44	34.07b	3.69	5.45a	7.70

n, number of values.
Period 1 = June 7, 2010 to June 20, 2010.
Period 2 = June 21, 2010 to July 4, 2010.
Period 3 = July 5, 2010 to July 18, 2010.
[a, b]LSM/M with different letters are significantly different between the periods ($P < .05$).

treatments is only significant in GPS measurements was probably caused by the observation method selected for direct observations. Scan sampling only *estimates* the duration of behavior patterns, whereas accuracy depends on the duration of performance of the observed behavior pattern and the observation interval. The main aim of the direct observation was to get an indication on the performed behaviors and their approximate duration which was achieved. GPS measurements are more exact as the distance covered was recorded continuously. This result (more activity in ST than in GT) was also found by Kusunose et al. [19], but oppositional observations are also published. Søndergaard and Schougaard [20] observed a greater distance covered during a 3-hour turnout on a grassless paddock when turnout was allowed in groups of three compared with ST. In run-in stables, Hoffmann [15] also detected more activity in group housing (six horses) than in solitary housing (observation time: 24 hours). The greater values and wider fluctuation of the distance covered in ST in the present investigation (Fig. 5) indicate that the studied horses behaved more restlessly during ST. The restlessness might have been caused by the animal missing the safety of a herd [16,19]— although there were horses visible on the neighboring paddocks—or the horse's attempt to get as close as possible to the horses on the neighboring paddocks (see also Section 4.2). Additionally, the horses might have been teased by insects to a greater extent when they were on their own, because they could not distribute the insects by one another. Berger et al. [21] also observed increased activity in summer (July) when the insect pressure was high.

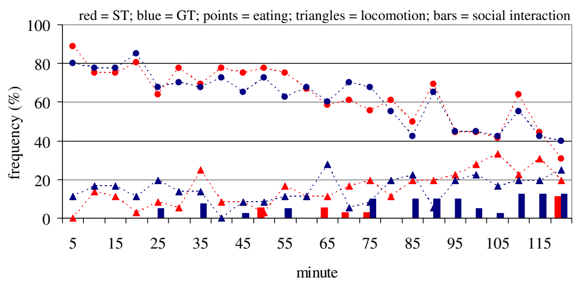

Fig. 2. Observed frequency (%) of the behaviors "eating," "locomotion" (walking, trotting, and cantering), and "social interaction" during the course of turnout subdivided according to treatment. (Duration of turnout = 120 minutes; ST = solitary turnout; GT = group turnout; n = 76 observation periods [ST = 36; GT = 40]).

Another reason for the greater activity in group compared with solitary housing observed in earlier studies might have been the group size. In the present study, the groups consisted of two animals, whereas the other studies investigated groups of three or more horses [15,16,20-22]. In larger groups, the mutual animation to exercise and synchronic behavior is more pronounced [19,20,23-26]; thus, higher activity may be expected.

Voswinkel [16] investigated the activity of horses in the period between November and May (temperature between −9°C and 22°C) and found a longer distance covered when the temperature was higher. In contrast to this result, the distance covered in the present study was shorter when temperature was higher. This might have been caused by generally higher temperatures (high summer) varying less than those occurring during Voswinkel's investigation [16]. Hoffmann [15] found that low temperature (measurements between September and October of the following year, temperature varied between −10°C and 30°C) and high wind speed cause more activity. The present study also revealed that the distance covered was longer when the relative humidity was lower. Because sweating is hindered at high temperatures in combination with high relative humidity [27], this might have caused the decreased activity.

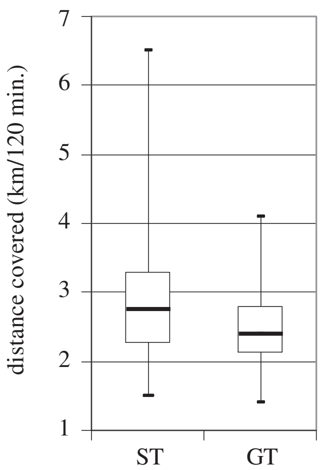

Fig. 3. Box plots (error bars indicating minimum and maximum value) of the distance covered during turnout subdivided according to the treatments. (Duration of turnout = 120 minutes; ST = solitary turnout; GT = group turnout; n = 77 [ST = 36; GT = 41]).

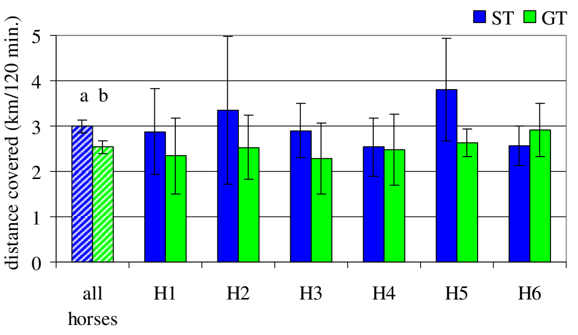

Fig. 4. Least squares means and standard errors of the average distance covered during turnout of all the horses subdivided according to treatment (Duration of turnout = 120 minutes; ST = solitary turnout; GT = group turnout; n = 77 [ST = 36; GT = 41]; a,b = least squares means within a behavior with different letters are significantly different [$P < .05$]; striped bars). Means and standard deviations of the distance covered during turnout subdivided according to treatment and horse (5 to 7 measurements per treatment and horse; solid color bars).

4.2. Social Interaction and Other Behavior Patterns

Regarding the horses' behavior during turnout, only social interaction differed significantly between the treatments, and this was to be expected because the fences restricted this behavior pattern in ST (only sniffing was possible across the fences; Fig. 1). Avoiding social interactions entirely during ST might have confounded results slightly, but because it is not a common practice to isolate horses completely in ST, this was also not applied in this study. Aggressive social interaction was not observed in either ST or in GT, which was presumably because of the fact that the horses knew their experimental partners very well. Aggressive social interaction may lead to serious injuries. To avoid this, group partners are supposed to get on well with each other and be steady. That way, "friendships" may be established, as is also observed in free-ranging horses [5,28]. The lack of social interaction in ST was obviously compensated by "standing/occupation" and "locomotion" (Figs. 1 and 2). During the course of the turnout time, "eating" decreased and was replaced mainly by "locomotion" and "social interaction" (Fig. 2). Some differences between the treatments might have been lost

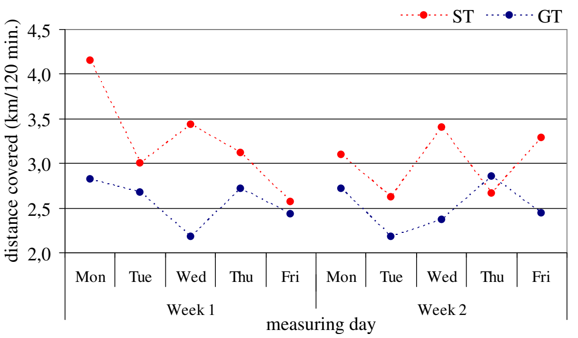

Fig. 5. Mean distance covered during turnout on the individual measuring days subdivided according to treatment. (Duration of turnout = 120 minutes; ST = solitary turnout; GT = group turnout; n = 111 [4 to 6 measurements per day and treatment]).

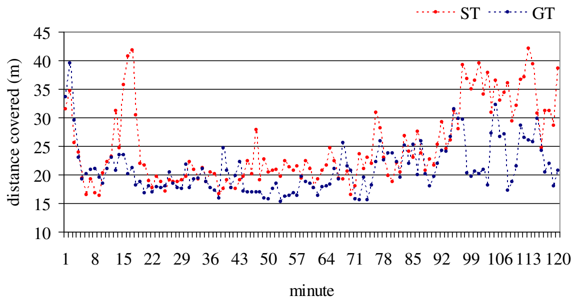

Fig. 6. Mean distance covered during the course of turnout subdivided according to treatment. (Duration of turnout = 120 minutes; ST = solitary turnout; GT = group turnout; n = 77 [ST = 36; GT = 41]).

because of the 5-minute intervals used in the scan sampling method. A shorter interval or continuous sampling could possibly have produced more details on short-term behavior patterns. But as one person is not able to observe four horses continuously at the same time and the focus was on long-term behavior patterns, the observation interval was set at 5 minutes. Anyway, the distribution of the observed behaviors during the 2-hour turnout approximately resembles the findings of 24-hour time budgets in near-natural environments (60% eating, 20% standing, 10% other [including locomotion]; [29]). Greater differences in behavior between the treatments might be displayed when the turnout time is prolonged because within the 2 hours used here, most of the time was spent eating. All of the horses took the advantage of free exercise for social interaction; even in ST, they tried to interact with the horses on the neighboring paddocks (Figs. 1 and 2), which was hardly ever observed in GT. This supports the fact—widely accepted in the meantime—that horses are social animals, and so social interactions are of great importance for their welfare.

4.3. Development of Activity in the Course of Turnout and in the Course of the Experiment

When free exercise is not allowed, it is frequently justified by the risk of injury [2]. Besides injuring each other (as mentioned in Section 4.2), especially the very first moments of free exercise are feared because the horses might show vehement running and/or bucking as a consequence of accumulated energy [30]. Abrupt starts and stops may lead to injury [31], especially when the musculoskeletal system is cold and therefore not elastic [9] as a result of stabling. In the present study, the horses' activity in the first 5 minutes was higher than in the following 90 minutes, but vehement running was not observed (Fig. 6).

More and higher peaks of activity were found in ST than in GT (Fig. 6). This result also argues for providing turnout in groups: a lower degree but steady activity decreases the risk of injury, whereas social interaction increases animal welfare. In ST, the distance covered on day 1 of the measurements (Fig. 5) was considerably greater than on other days. For groups 2 and 3 (H3 to H6), this treatment was carried out after the treatment without turnout (Table 1). This indicates that *regular* turnout is also an important factor for reducing activity—which was also found by Houpt et al. [3] and Chaya et al. [4]—and so decreases the risk of injury during free exercise. Regarding the development of activity during the course of the turnout time, it was comparatively high in the first minutes, then decreased and increased again in the last 30 minutes, especially in ST. This observation might indicate that a 2-hour turnout does not fulfill the demand for exercise because the horses still perform locomotion at the end of turnout. Possibly, the horses had had enough of eating after about 90 minutes and then only "started" performing other behaviors such as locomotion, social interaction, and occupation. If they had just stood and dozed, they might have signalized that their demand for exercise was fulfilled. In contrast, it is supposable that the horses became restless toward the end of turnout because they wanted to get back into their stable. In the present study, this also is a possibility because the horses were used to a 2-hour turnout, might have been annoyed by flies (especially once eating grass had lost importance), and received their mid-day feed when they returned back to the stable. Further investigation is necessary to clarify this and to identify the optimal turnout time.

The fact that eating was decreased and obviously replaced by standing/occupation in period 3 of the investigation (Table 2) was probably caused by the decreasing amount of grass available on the pasture during the course of the study. The horses H1 and H2 (GT in period 2, Table 1) generally showed less social interactions compared with the other groups, which might explain the lower values of social interaction in period 2.

5. Conclusions

In conclusion, the study shows that the configuration of turnout (solitary or in groups of two) affects horses' behavior and activity during turnout. Behavior observations revealed that a 2-hour turnout on pasture is predominantly used for eating but also for locomotion and social interaction. Even if ST was given, the horses tried to interact with the animals on neighboring paddocks. Aggressive behavior was not observed. The distance covered was greater in ST, which indicates that they behaved in a more restless manner when alone. Regular turnout led to calm behavior on the pasture in all the horses, especially when it happened in groups. Thus, if free exercise is permitted regularly and in well socialized groups, the risk of injury is decreased because of less activity. If these findings are considered and horses are warmed up before turnout (eg, by training), free exercise is also feasible for competition horses. Further investigation is necessary to prove the findings in a larger group of animals, and to determine the optimal duration of free exercise in single housing systems.

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