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Behavioral responses of mares to short-term confinement and social isolation[1]

M.E. Mal[a,2], T.H. Friend[a,3], D.C. Lay[a], S.G. Vogelsang[b] and O.C. Jenkins[c]
[a]*Department of Animal Science, Texas A&M University, College Station, TX 77843, USA*
[b]*Granada Equine Services, Wheelock, TX 77882, USA*
[c]*Institute of Statistics, Texas A&M University, College Station, TX 77843, USA*

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ABSTRACT

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Thirty-six mares, blocked by age and temperament score, were assigned to one of three treatment groups: pasture (P); confinement stalls (C), allowing social contact; isolation stalls (ISS), allowing no contact with conspecifics. After 48 h on treatment, the mares were observed in situ for 1 h. Medium temperament and highly reactive ISS mares spent more time eating grain ($P<0.01$) and exhibited more grain-eating bouts ($P<0.03$) than P and C mares. Calm P mares had longer forage-eating bouts than C and ISS mares ($P<0.02$). During a 15 min open-field test in a 23 m×23 m pen after 72 h on treatment, ISS mares traveled farther ($P<0.005$) than C and P mares, spent more total time trotting ($P<0.01$) than C and P mares, and exhibited a greater number of trotting bouts ($P<0.01$) than both C and P mares. Isolated mares spent less total time standing during the open-field test than C ($P<0.05$) and P ($P<0.01$) mares, but exhibited a greater number of standing bouts than C ($P<0.05$) and P ($P<0.01$) mares. Isolated mares also exhibited a greater number of total activity bouts ($P<0.01$) during the open-field test than both C and P mares; P mares also exhibited fewer activity bouts than C mares ($P<0.1$). Results indicate that mares kept in confined and isolated environments showed greater motivation for movement and performance of a greater number of activities than those maintained on pasture with conspecifics.

INTRODUCTION

Confinement stress and environmental preferences have been studied in a variety of farm animals (e.g. Barnett et al., 1985; Dellmeier et al., 1985; Taylor and Friend, 1987). However, comparatively little attention has been paid to effects of confinement on the horse (Houpt and Houpt, 1988).

[1]Technical article No. 25694 from the Texas Agricultural Experiment Station.
[2]Present address: Department of Animal and Dairy Sciences, Auburn University, Auburn, AL 36849, USA
[3]Author to whom correspondence should be addressed.

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In a natural environment, the horse is a social animal, spending most of its time in close contact with conspecifics, and many equine managers raise their animals in this natural situation. However, there are often times when horses are placed in confinement, a situation that is foreign to the nature of the horse (Glade, 1984). For example, mares are often removed from the pasture and stalled during some portion of the breeding season, and many housing systems restrict space and limit contact with conspecifics. Because many methods of equine management are different from a horse's natural tendencies, they are quite likely to act as a source of stress to the animal (Stephens, 1980; Crowell-Davis, 1986). Therefore, the role of short-term confinement and isolation as stressors on horses needs to be investigated.

Changes in behavior patterns are among the first manifestations that an animal's perception of its environment is changing. Therefore, behavior can be used as an indicator of an animal's well-being (Dellmeier, 1989). Behavior is a consequence of motivational states; therefore, behavior quantification is actually a measure of motivation (Dellmeier, 1989). A confinement situation often does not allow an animal to perform many activities (such as locomotion, interaction with conspecifics, or foraging behaviors) that are performed under natural conditions. If an animal is not allowed to perform a behavior, the motivation to perform that behavior may increase. This is demonstrated by an increase in the occurrence of that or related behaviors when the animal is allowed to perform that behavior. This may be due to a higher sensitivity to external releasing stimuli, or to a build-up of endogenous motivation (Lorenz, 1981).

In horses, certain activities such as sleeping in lateral recumbency are indicative of a less tense, more at ease animal (McCall et al., 1985). Certain other activities such as walking and vocalizing are a sign of distress (Tyler, 1972; McCall et al., 1985; Houpt and Houpt, 1988).

The objective of this experiment was to determine if differences exist in open-field test and in situ behaviors of mares maintained on pasture and then placed for a short time in confinement and isolation situations. Related physiological data from these mares are summarized here and reported in detail elsewhere (Mal et al., 1991).

ANIMALS, MATERIALS AND METHODS

Animal management

Thirty-six mares of predominantly stock horse type, ranging from 3 to 14 years of age were used in this study. The mares were accustomed to being brought in from the pasture where they were maintained prior to the study, haltered, and handled. To accustom the mares to the experimenters, the animals were brought in from the pasture, haltered, and handled for a minimum of five times on 5 separate days. The last day of handling was 2 weeks prior to the experiment. Two weeks before the first replication all mares were brought in from the pasture and weighed to determine adrenocorticotrophic hormone (ACTH) dosage for the physiological study. The mares were assigned a temperament score ranging from one to nine, based upon the ease of catching, reaction to unexpected stimuli (sudden movements of the experimenters in close proximity to the mare), and reaction to routine handling procedures (walking onto a set of scales to obtain a body weight).

The mares were blocked by age and temperament and then assigned to one of the three housing treatment groups (twelve mares on each treatment) described below:

(1) Pasture (P): free ranging on a pasture of approximately 4.5 ha, with unlimited contact with conspecifics.

(2) Confinement (C): maintained in 4.2 m $\times$ 6.0 m stalls. These stalls were solid to 1 m above the floor, with horizontal bars spaced 0.33 m apart extending to 3 m. These stalls allowed visual, auditory, and tactile communication between each mare. Mares in this barn had at least two, but usually three, adjacent stalls occupied by one mare.

(3) Isolation (ISS): maintained in 3.6 m $\times$ 3.6 m stalls that had solid walls from the floor to within 30 cm of the ceiling. The stall fronts were solid to 1.5 m above the floor. The rest of the front was made of vertical bars 7.5 cm apart, extending to the ceiling so that the mares could not extend any part of their bodies out of the stall. These mares were housed in adjacent stalls, and had no visual or tactile contact with other mares. Because these stalls were located in a small windowless building, the mares were also subjected to a reduced level of sensory stimulation when compared with the C and P mares.

The discrepancy in stall size between C and ISS treatments should not have a significant effect, because isolation tends to affect a social animal like the horse more severely than confinement in small pens (Kilgour and Dalton, 1984). Stalls in which horses are isolated, such as when they require veterinary care, are also generally smaller than standard open stalls.

All mares were maintained on pasture prior to the experiment. After the mares were brought in from pasture, weighed, and assigned a temperament score, they were placed with their respective groups in one of three pastures. The pastures were approximately 4.5 ha in size and all had common features.

The mares were kept in a minimum pasture group size of eight mares. Each group initially contained 12 mares, but after the first two replications, four mares from each group and from whom data had already been collected were removed and used in the ranch's commercial breeding program. The mares were kept on pasture for a minimum of 2 weeks before they were placed on treatment, to allow for adjustment to their new herdmates. When not on treatment, the mares were maintained on pasture in their respective groups, except for the previously mentioned mares who were removed for breeding purposes.

While on treatment, all mares were fed 1.5 kg of a commercially available pelleted feed and 3.5 kg of hay at approximately 07:30 and 15:30 h daily.

Data collection

On Day 1 of each replication, two mares from each pasture group were placed in their respective treatments, except for P mares, who remained with their group. Forty-eight hours after placement on treatment (at 14:00 h on Day 3), the mares' behavior was observed in situ and recorded for 1 h. Treatment mares were observed concurrently by trained observers. The number of occurrences of each bout, time spent in each action, and average time per bout were recorded. Quantified behaviors are defined in Table 1.

At 08:00 h on Day 4, the mares were fitted with jugular cannulae for serial blood collections used in a physiological study (Mal et al., 1991). The P mares were placed in a 25 m×30 m pen, and the two mares from whom blood was to be collected were placed in alleyways, 5 m wide, adjacent to the pen. This was done to facilitate sampling but still allow some herd contact. The mares were restrained during cannulation and blood sampling by a hand-held lead rope attached to their halters. Following the blood collection (72 h after placement on treatment), the mares were subjected to individual 15-min open-field tests in a 23 m×23 m outdoor pen to which they had previously been exposed. The paths that the mares traveled when released were traced on a scale map and later measured with a map wheel. A description of the mares' behaviors (Table 2) were recorded onto an audio cassette recorder. These tapes were later played back and the amount of time spent in each action, the number of times an action was performed, the average time per bout for each action, and the total number of actions were determined.

TABLE 1

Definition of in situ behaviors

Feeding[1]	Taking grain into the mouth, chewing, and swallowing
Grazing[1]	Taking grass or hay into the mouth, chewing, and swallowing
Standing alert	Standing with all four feet on the ground, eyes open, ears forward
Standing non-alert	Standing with two of the following actions: one hindlimb cocked, lower lip drooping, eyes partially closed, ears relaxed and held back
Cribbing	Grasping object with teeth, tensing neck, and sucking in air
Mouthing	Handling of objects other than feed with mouth or tongue
Walking	Moving all four feet in progression and going from one location to another
Drinking	Mouth placed into water receptacle, with intake of water
Vocalization	All sounds made with the vocal cords, especially whinnies and nickers

[1]For statistical analysis, feeding and grazing were combined into one category, "eating".

TABLE 2

Definition of open-field test behaviors

Timed	
Standing	Supported by three or four legs, with no forward, backward, or sideways movement
Walking	Moving legs in a diagonal and lateral four-beat gait
Trotting	Moving legs in a diagonal two-beat gait
Cantering	Moving legs in a three-beat gait with a diagonal pair of legs touching the ground at the same time
Rolling	Lying on the ground and moving from one side of the body to the other
Counted	
Bucking/kicking	A springing motion consisting of raising the front and/or rear quarters off the ground, often accompanied by a longitudinal twisting of the body. Kicking included lashing out with one or both hind legs
Pawing	Striking the ground with a forelimb

Statistical analysis

The experiment consisted of six replications, with six mares per replication (two mares on each treatment). The experiment was of a $3\times3\times3$ factorial design, with treatment, age, and temperament as the main effects. The levels of each effect were:

Treatment: P, C, and ISS.

Age: young (Y, mares 3–6 years), medium (M, mares 7–9 years), and old (O, mares 10 years or older).

Temperament: calm (CL), medium (MD), and highly reactive (HR).

Data were analyzed as a general linear model with interaction. The count data were subjected to square root transformation, prior to statistical analysis. When the F statistic of the Type III sums of squares was significant for main effects interactions, the data were plotted to determine the nature of that interaction. When there were no interactions, and the F statistic for Type III sums of squares was significant for main effects, differences were analyzed using t-tests. Pearson's correlation coefficients were used to determine relationships between in situ behaviors, open-field test behaviors, and physiological measurements.

RESULTS

In situ behaviors

There were no significant treatment differences in the in situ behaviors. In situ behavioral characteristics that had significant treatment and temperament interactions were: number of feeding bouts ($P<0.03$, Fig. 1), total time spent feeding ($P<0.01$, Fig. 2), and average grazing bout duration ($P<0.02$, Fig. 3).

Open-field test behaviors

The mares were not totally isolated when tested, and were aware of the presence of other mares. However, they did not show a preference for the area of the open-field test pen that was near the location of the other mares, indicating that there was little motivation of social contact.

There was a gradation across treatments with the more confined and isolated mares performing more energetic activities; they traveled farther, trotted more often and for a longer period of time, and had a greater number of standing bouts but spent less total time standing (Table 3). The confined and isolated mares also performed a greater number of behavioral bouts (Table 3). There were only two mares who rolled during the open-field test. Both of these mares had been isolated, and both were classified as highly reactive. The

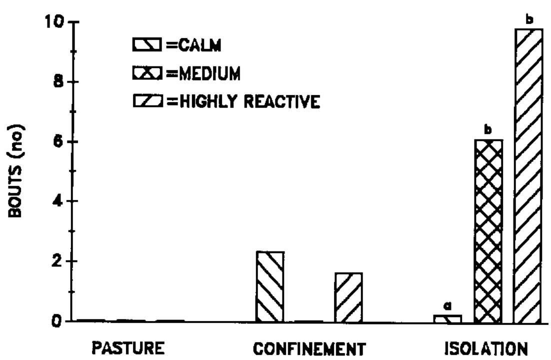

Fig. 1. Treatment and temperament interaction — effect on number of feeding (taking grain into the mouth, chewing, and swallowing) bouts. Bars with different letters differ, $P<0.01$.

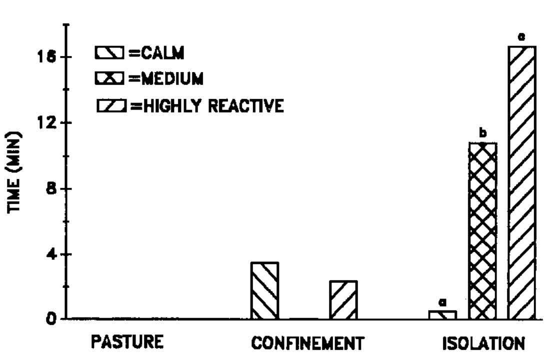

Fig. 2. Treatment and temperament interaction — effect on total time spent feeding (taking grain into the mouth, chewing, and swallowing). Bars with different letters differ at $P<0.05$.

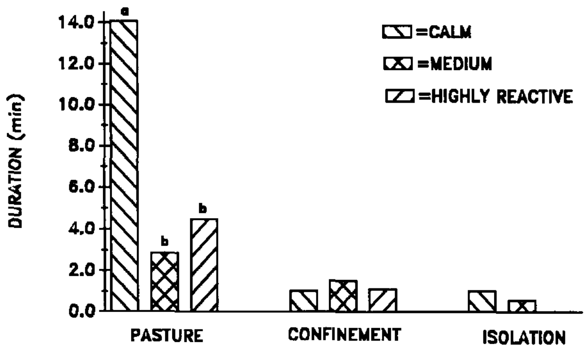

Fig. 3. Treatment and temperament interaction — effect on duration of grazing (taking grass or hay into the mouth, chewing, and swallowing) bouts. Bars with different letters differ, $P<0.002$.

TABLE 3

Least squares means ± SE of characteristics of open-field test behaviors

	Pasture	Confinement	Isolation	$P<$[1]
Distance traveled (m)	$236^{b}\pm221$	$528^{b}\pm165$	$1207^{c}\pm137$	0.004
Standing bouts (no.)	$22.8^{b}\pm0.1$	$33.8^{c}\pm0.1$	$42.5^{d,e}\pm0.5$	0.007
Standing time (min)	$11.2^{b}\pm1.4$	$8.2^{c}\pm1.0$	$6.2^{d,e}\pm0.8$	0.04
Trotting bouts (no.)	$0.9^{b}\pm0.8$	$3.7^{b}\pm0.3$	$26.6^{e}\pm0.2$	0.0009
Trotting time (min)	$0.1^{b}\pm1.0$	$0.7^{b}\pm0.7$	$3.8^{e}\pm0.61$	0.006
Av. trotting bout (min)	$0.01^{b}\pm0.02$	$0.04^{b}\pm0.02$	$0.1^{e}\pm0.01$	0.0002
Walking bouts (no.)	21.5 ± 0.3	33.6 ± 0.1	42.5 ± 0.10	0.3
Walking time (min)	3.8 ± 1.2	6.1 ± 0.9	4.7 ± 0.7	0.8
Av. walking bout (min)	0.1 ± 0.02	0.2 ± 0.02	0.1 ± 0.02	0.2
Cantering bouts (no.)	0.5 ± 0.2	0.7 ± 0.1	2.4 ± 0.1	0.3
Cantering time (min)	0.0 ± 0.4	0.0 ± 0.3	0.3 ± 0.3	0.8
Av. cantering bout (min)	0.0 ± 0.1	0.0 ± 0.1	0.1 ± 0.05	0.2
Pawing (no.)	0.5 ± 0.01	0.8 ± 0.0	5 ± 0.0	0.4
Bucking/kicking	0.5 ± 0.6	0.8 ± 0.1	2.0 ± 0.06	0.4
Total actions (no.)	$43.7^{b}\pm0.4$	$71.8^{c}\pm0.2$	$110.7^{e,f}\pm0.2$	0.0001

[1]Level of significance from Type III sums of squares, general linear model analysis of variance.
Means in the same row with different superscripts differ: $^{b,c}P<0.1$; $^{c,d}P<0.05$; $^{b,e}P<0.01$; $^{c,f}P<0.01$.

data from rolling behaviors, therefore, did not lend themselves to formal statistical analyses. Open-field test behaviors were not influenced by temperament.

There was a significant treatment and age interaction on the average duration of standing bouts during the open-field test (Fig. 4, $P<0.0002$).

Relationships between in situ and open-field test behaviors

The average duration of each grazing bout was correlated with: number of standing bouts in the open-field test ($r=-0.33$, $P<0.05$), number of trotting

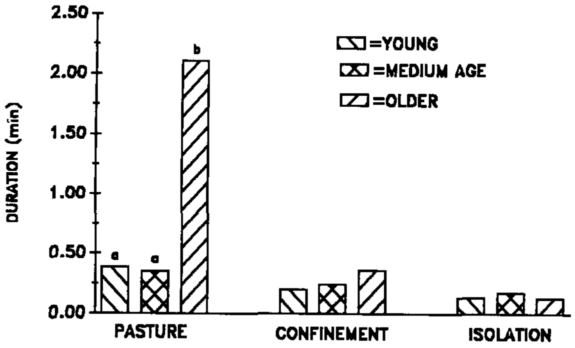

Fig. 4. Treatment and age interaction — effects on duration of standing bouts during the 15 min open-field test. Bars with different letters differ at $P<0.001$.

TABLE 4

Least square means ± SE of physiological measurements from Mal et al. (1991)

	Pasture	Confinement	Isolation	$P<$ [1]
Adrenal function[2]	77.8 ± 19.3	98.7 ± 14.5	110.1 ± 12.0	0.52
Basal cortisol ($ng\ dl^{-1}$)	36.5 ± 4.3	35.4 ± 4.2	36.2 ± 4.2	0.98
Triiodothyronine ($ng\ dl^{-1}$)	76.3 ± 17.4	72.3 ± 13.0	94.3 ± 10.8	0.33
Thyroxine ($ng\ dl^{-1}$)	2.0 ± 0.5	2.5 ± 0.4	2.6 ± 0.3	0.66
3,3′,5′-triiodothyronine ($ng\ dl^{-1}$)	$7.7^{d}\pm6.8$	$8.2^{d}\pm5.1$	$27.4^{e}\pm4.2$	0.01
Hemoglobin ($g\ dl^{-1}$)	$12.5^{d}\pm0.5$	$13.1^{d}\pm0.5$	$15.0^{e}\pm0.3$	0.006
Mean corpuscular hemoglobin content (%)				
Treatment × age interaction				0.001
Young	33.4 ± 4.4	34.2 ± 4.5	$25.92^{h}\pm2.5$	
Medium	33.3 ± 3.5	33.4 ± 4.5	$33.9^{i}\pm3.2$	
Old	32.8 ± 6.3	32.7 ± 7.3	$28.0^{h}\pm4.1$	
Treatment × temperament interaction				0.001
Calm	$32.7^{d}\pm5.1$	$32.9^{d}\pm4.7$	$18.5^{e,h}\pm3.2$	
Medium	33.3 ± 2.8	32.9 ± 3.8	$34.2^{i}\pm2.8$	
Highly reactive	33.4 ± 7.0	34.5 ± 6.9	$35.0^{i}\pm3.6$	
Response to phytohemagglutinin[3]				
Treatment × age interaction				0.002
Young	83 ± 2107	$1823^{h}\pm2074$	$2260^{h}\pm1662$	
Medium	1424 ± 1971	$5720^{h,i}\pm1672$	$4391^{h}\pm1867$	
Old	543 ± 4108	$8328^{i}\pm2814$	$9749^{i}\pm2314$	

[1]Level of significance from Type III sums of squares, general linear model analysis of variance.
[2]Cortisol integrated for 0–3.5 h post-intravenous administration of 1.02 IU ACTH $kg^{-0.75}$ body weight.
[3]Measured as the product of the length, width and double-skin thickness of the swelling 18 h post-intradermal injection of 0.1 mg phytohemagglutinin less the product of the control (saline) injection.
Means in the same row without a common superscript differ: $^{d,e}P<0.05$; $^{e,g}P<0.05$; $^{h,i}P<0.1$.

bouts ($r=-0.31$, $P<0.06$), average duration of trotting bouts ($r=-0.37$, $P<0.03$), the distance traveled ($r=-0.35$, $P<0.03$), and the number of total actions performed ($r=-0.38$, $P<0.02$).

TABLE 5

Pearson correlation coefficients ($P<0.07$) between open-field test behaviors and physiological measurements from Mal et al. (1991) with significance levels under each coefficient

Behaviors	Phytohemagglutinin response[1]	Plasma 3,3′,5′-triiodothyronine
Total time spent standing		−0.38
		0.022
No. trotting bouts	0.31	0.39
	0.067	0.019
Total time spent trotting	0.38	0.51
	0.021	0.001
Av. trotting bout duration	0.32	0.51
	0.059	0.001
Distance traveled	0.38	0.40
	0.023	0.014

[1]Measured as the product of the length, width and double-skin thickness of the swelling 18 h post-intradermal injection of 0.1 mg phytohemagglutinin less the product of the control (saline) injection.

Physiology

Physiological data from these mares have been reported by Mal et al. (1991) and are summarized in Table 4. Slight, but non-significant trends were evident in adrenal function, triiodothyronine and thyroxine. Concentrations of 3,3′,5′-triiodothyronine, hemoglobin and mean corpuscular hemoglobin content were significantly affected by treatments.

When Pearson correlation coefficients were calculated between the in situ and open-field test data, and the physiological measurements that were affected ($P>0.01$) by treatments, there was little correlation with hemoglobin and mean corpuscular hemoglobin content. Significant correlations occurred between the open-field test data and the response to intradermal injection of phytohemagglutinin and plasma concentrations of 3,3′,5′-triiodothyronine (Table 5).

DISCUSSION

In situ behaviors

The ISS mares tended to spend more time feeding while exhibiting a greater number of feeding bouts. The results for in situ ingestive behaviors in this experiment differ from those of Houpt and Houpt (1988), who found that when horses were maintained alone, they spent less time eating than did the horses maintained together. Research has shown that horses spend approximately 70% of their time grazing when in a natural setting (Crowell-Davis et al., 1985). However, when domestic horses are fed grain, they usually eat it within a relatively short time. The ISS mares exhibited more feeding bouts and spent more time feeding because they had not finished their morning feed when observations were made. Calm mares in isolation exhibited few feeding bouts (Fig. 1) and spent less time feeding (Fig. 2) because the morning feed was readily consumed. The calmer mares may not have perceived their environment to be enough of a stressor to disrupt their feeding habits. Treatment differences in feeding behavior may also be due to feeding being socially facilitated (Tyler, 1972), something the ISS mares lacked.

Pastured mares had a greater grazing bout length than C and ISS mares, although all three groups spent the same total time grazing. Mares that grazed for longer bouts were possibly more relaxed. Mares that spent less time in various behavioral bouts performed a greater number of behavioral changes, indicative of a more nervous horse.

The lack of differences in walking between treatments may be owing to the stalled mares walking in circles. Such stall walking was not differentiated from the walking of the pastured mares, who appeared to have a specific destination.

Open-field test behaviors

Mares kept isolated showed a greater motivation for movement as indicated by the greater distance they traveled ($P<0.01$) during the 15 min open-field test. The greater distance traveled indicates a "damming up" or an increase in the motivation for performance of a behavior (Lorenz, 1981) that occurs when an animal is prevented from performing a behavior for a period of time. This increased motivation for movement was also reported in calves that were kept chronically confined and socially deprived (Dantzer et al., 1983; Dellmeier et al., 1985). Isolation mares and C mares also showed an increase in motivation to perform more activities, as indicated by the greater number of trotting bouts shown by the ISS mares ($P<0.01$), the greater number of standing bouts exhibited by the C ($P<0.1$) and ISS ($P<0.05$) mares, and the increase in total number of activity bouts in the C ($P<0.1$) and ISS ($P<0.01$) mares. Studies by Dantzer et al. (1983) and Dellmeier et al. (1985) found that isolated calves also perform more activities in an open-field test.

The correlations between open-field test and in situ behaviors indicate that the mares who performed more activity bouts and spent a shorter amount of time in each in situ bout were also more likely to expend more energy, travel farther and perform more activities during the open-field test.

Physiology

Although the interpretation of the data are complicated by interactions, a general trend can be seen in 3,3′,5′-triiodothyronine, hemoglobin, mean corpuscular hemoglobin content and response to phytohemagglutinin (Table 4) that suggests physiological changes indicative of stress occurred in the ISS, and to a lesser extent, the C mares.

The strong correlation coefficients between the various measurements of activity during the open-field tests (time spent standing, trotting and distance traveled) and the response to phytohemagglutinin and plasma concentrations of 3,3′,5′-triiodothyronine, indicated that the mares with the greatest motivation for movement also had the greatest physiological response.

CONCLUSIONS

When differences in behaviors were present, ISS mares were always different from P mares. Confined mares appeared to exhibit intermediate responses, sometimes being the same as P or ISS mares. Thus, the mares were more affected by the compounded effects of being socially isolated, confined and the lack of stimuli associated with the isolation stalls, than by confinement alone.

The congruity between the behavioral and physiological data (Mal et al., 1991) indicated that placing a mare who was accustomed to being maintained in a herd on pasture in an isolation stall, as is commonly done to treat certain illnesses, may adversely affect certain aspects of a mare's well-being. Because this study examined short-term confinement, however, further research is needed on the habituation of horses to chronic confinement and isolation.

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