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Effects of repeated regrouping on horse behaviour and injuries

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ABSTRACT

Domestic horses are faced with social challenges throughout their lives due to limitations in social contact, space restrictions and frequent changes in social companionship. This is in contrast to natural conditions where horses live in relatively stable harem bands. Currently, little is known about how repeated regrouping affect horse behaviour and welfare, and it is unknown whether horses may adapt to regrouping. In this study, we aimed to investigate the effects of an unstable group structure, caused by weekly regroupings, on behaviour and frequency of injuries in young horses. Forty-five horses were included in the study and were randomly assigned to the treatments; Stable (S; seven groups of three horses) or Unstable (U; eight groups of three horses). The experimental period lasted 7 weeks, during which horses in Stable groups remained in the same group, whereas one horse was exchanged between Unstable groups every week. The groups were kept in 80 m × 80 m grass-covered enclosures and were fed additional roughage on the ground daily. Social interactions were recorded in Unstable groups immediately after each regrouping (30 min), and in both Stable and Unstable groups on day 1, 3 and 6 after each regrouping (2 × 20 min/group/day). Injuries were scored by the end of the experimental period. The level of aggression shown by horses in Unstable groups immediately after regrouping was not affected by week ($F_{5,35} = 0.42$, $P = 0.83$), indicating that horses neither habituated, nor sensitized, to repeated regrouping. Compared to horses in Stable groups, more agonistic behaviour was shown by horses in Unstable groups (i.e. non-contact agonistic; $F_{1,65} = 5.60$, $P = 0.02$), whereas there was no treatment effect on other variables. The level of play behaviour appeared, however, to be more variable in Unstable groups. There was a significant effect of week on the level of contact agonistic interactions as well as greeting behaviour, due to a high occurrence in weeks 4–6. Non-contact agonistic interactions constituted the major part of agonistic interactions (66%). Possibly as consequence, no serious injuries were registered and there was no treatment effect ($U = 184$; $P = 0.11$). We conclude that the behaviour of young horses is affected by group management, and that horses appear not to adapt to weekly regroupings.

1. Introduction

Under natural conditions, horses typically form small stable groups and display a female defence polygamous mating system (Boyd and Keiper, 2005). Harem bands tend to be rather stable and may not be readily open to admitting strangers (Waring, 2003). Harem instability has been found to affect reproductive rate with females belonging to unstable bands having a significantly lower reproductive success than those from stable bands (Berger et al., 1983; Goodloe et al., 2000). Social cohesion within the band is maintained through a social hierarchy and through affiliative relationships. The more stable the social grouping and the stronger the social bonds between individuals of the

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same social unit, the less aggression is shown (Feh, 2005; Waring, 2003).

Under domestic conditions, horses are frequently kept with limited social contact to other horses, and groups of horses frequently change composition due to high exchange rates at horse facilities. Whenever horses are regrouped, the group's social structure becomes disrupted and a temporary increase in aggression level is typically observed until the new dominance order is established (Christensen et al., 2002a; Hartmann, 2010). This increase in aggression may lead to an increased risk of injury, which remains a major concern among horse owners and one of the main objections against group housing of riding horses. Nevertheless, group housing has been shown to be beneficial for horses, both in terms of horse–horse (Bourjade et al., 2008; Christensen et al., 2002a) and horse–human relationships (Søndergaard and Ladewig, 2004; Rivera et al., 2002). It is currently unknown whether horses may adapt to repeated regrouping so that horses, which experience regular regrouping, become less aggressive because the animals benefit from previous experience. For instance, Van Putten and Buré (1997) found that 3–4 experiences of regrouping improved the social skills of pigs. Similarly, Veissier et al. (2001) found that calves appeared to adapt to repeated regrouping by adopting a more passive strategy toward new partners. Gupta et al. (2008) reported that steers adapted to regrouping and relocation by the third and subsequent regroupings. In contrast, Raussi et al. (2005) found that repeated regrouping led to an increase in agonistic interactions in heifers and that no habituation to regrouping occurred. In pigs, repeated regrouping led to increased intensity of aggression whereas the frequency of aggression decreased (Giersing and Andersson, 1998). Similarly, experiences prior to regrouping may affect the outcome; Olsson et al. (1999) showed that pigs from an enriched environment behaved differently than pigs from a poor environment when regrouped, and pigs reared under poor conditions inflicted more wounds on each other. The authors suggested that pigs reared in a socially poor environment may have difficulty in establishing dominance relationships, due to impaired development of social skills. Similarly, Kondo and Hurnik (1990) found that cows with social experience were faster to form a stable social hierarchy than cows without previous social experience. Christensen et al. (2002a) found that depriving 2-year old horses of social contact with conspecifics during a 6-months period resulted in increased aggression as well as less submissive behaviour when later mixed with other horses.

Socialization may be defined as the "acquisition of social capability through the experience of interaction with conspecifics as a consequence of growing up within a group" (Immelmann and Beer, 1992). This implies that socialization is a learning process and that it may be important to gain the right experiences at the right age in order to achieve appropriate social competences for later formation of relationships, bonding behaviour, acceptance into a group and assumption of roles. If horses are able to adapt to regrouping it may be beneficial for them to experience regrouping in the developmental period. In spite of this possible positive effect of regrouping experience, however, several authors have reported increased aggression and welfare implications caused by repeated regrouping and abrupt breaking of social relationships (e.g. Hanlon et al., 1995; Fernandez et al., 2007; Sevi et al., 2001; Coutellier et al., 2007), and Knubben et al. (2008) noted that a stable group hierarchy is an important factor for prevention of kick and bite injuries in domestic horses.

The aim of this study was to investigate the effect of weekly regrouping on social behaviour and injuries in young female horses. The horses were all familiar with each other prior to the study in order to isolate the effect of group stability from the effect of being mixed with strangers.

2. Materials and methods

The study was conducted from August to October 2007 and from July to September 2008 on research farm facilities at Aarhus University, Denmark. The study conformed to the 'Guidelines for ethical treatment of animals in applied animal behaviour and welfare research' by the ethics board of the International Society of Applied Ethology (www.applied-ethology.org).

2.1. Animals and management

Forty-five 2-year old Danish Warmblood mares were used for the study (2007: 21 mares; 2008: 24 mares). In 2007, the horses were all from the same privately owned stud, whereas in 2008, the horses were borrowed from 3 studs. The horses were familiar with group housing at the studs.

Before entering the experiment, the horses were pastured together in one large group (within years, i.e. 21 mares in 2007 and 24 mares in 2008) for one month at the research centre. During the experimental period, horses were pastured 24 h in groups of three horses (Fig. 1) and additional feed (a mixed ration of grass silage, barley straw, barley, rape seed cake and minerals) was fed on the ground daily at 15:00. Paddocks were 80 m × 80 m and fenced with an electric wire. All paddocks contained a watering trough. Paddocks were situated in two rows of 4 paddocks but separated within rows by double fencing 1.5 m apart so no physical contact between groups was possible. A 4 m runway separated the two rows of paddocks (Fig. 1).

2.2. Groups and treatments

Horses were assigned to groups of three horses and treatment Stable (S) or Unstable (U), balanced according to stud, paternity and previous participation in other studies at the research centre (e.g. Hartmann et al., 2009).

Stable groups (3 in 2007 and 4 in 2008) did not change composition during the experimental period of 7 weeks. In Unstable groups (4 in 2007 and 4 in 2008) one horse was exchanged once per week, i.e. a horse was removed from the group and a new horse from one of the other Unstable groups entered. Regrouping was carried out each Tuesday for a total of 6 weeks (Table 1).

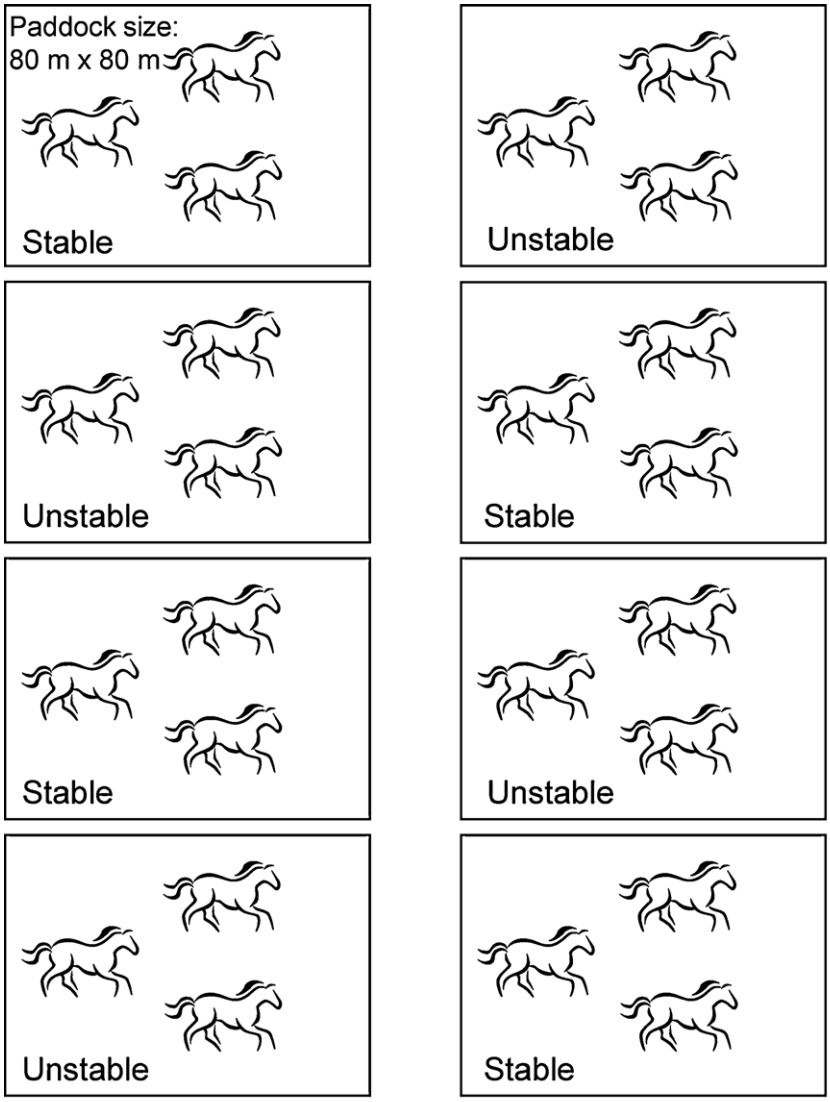

Fig. 1. Experimental area.

Table 1
Experimental outline.

Week	Action	Registrations
1	Horses transferred from large enclosure to experimental paddocks, 3 horses per group	
2–7	*Tuesdays*: Regrouping of horses in Unstable groups. Horses in Stable groups remain in the same group throughout the experimental period	*Tuesdays*: Behavioural observations in Unstable groups: 30 min, starting immediately after mixing
		Wednesdays, Fridays and *Mondays*: Behavioural observations: 2 × 20 min/group (total: 6 × 20 min/group/week)
7	End of experiment	Injuries

Table 2
Ethogram (modified after McDonnell and Haviland, 1995; Christensen et al., 2002b).

Behaviour	Description
Non-contact agonistic interactions	
Displacement	Approach of one horse causes another to move away so that distance is maintained or increased, without overt aggression (also termed retreat/avoidance, depending on whether receiver or sender is noted).
Threat to bite	Bite intention movement with ears back and neck extended, with no actual contact.
Threat to kick	Kick intention movement, performed by swinging rump or backing up, and by waving or stamping hind leg toward another horse, without making contact.
Chase	One horse pursuing another usually at the gallop in an apparent attempt to direct the movement of the other. The chaser typically pins the ears, exposes the teeth and bites at the rump and tail of the pursued horse.
Mouth clapping	Submissive behaviour. Opening and closing mouth with lips retracted. Typically, the head and neck are extended, and the ears oriented back or laterally (also termed snapping).
Contact agonistic interactions	
Bite	Opening and rapid closing of the jaws with actual contact to another horse's body. The ears are back and lips retracted.
Kick	One or both hind legs lift off the ground and rapidly extend backwards toward another horse, with apparent intent to make contact.
Push	Pressing of the head, neck, shoulder, chest or body against another horse, causing it to move one or more legs to retain balance.
Play interactions	
Low intensity play	Playful interactions directed at another individual, which may or may not reciprocate; includes low intensity play movements such as nipping, grasping and pulling mane or tail.
Play fight	High intensity play, which is reciprocated by one or more partners; includes vigorous play movements such as rearing, boxing, circling, kneeling and chasing.
Friendly interactions	
Social grooming	Reciprocal coat care in which the partners stand beside one another, usually head-to-shoulder or head-to-tail, grooming each other's neck, mane, rump or tail by gently nipping, nuzzling or rubbing.
Head rest	One horse rests its chin or entire head on the neck, body or rump of another horse.
Greeting behaviours	
Nasal sniff	Olfactory investigation. Two or more horses sniff mutually head to head.
Body sniff	Olfactory investigation. A horse sniffs the neck, withers, flank or tail of another horse, which may or may not reciprocate.
Genital sniff	Olfactory investigation. A horse sniffs the genital region of another horse, which may or may not reciprocate.
Strike	One foreleg is rapidly extended forward toward another horse. The strike is typically associated with arched neck threat and posturing. The strike is often accompanied by a snort or squeal.

2.3. Behavioural observations

Each group was observed for 20 min in the morning (8:00–11:00 h) and 20 min in the afternoon (12:00–15:00 h) by means of direct, continuous observation of social interactions (Table 2) every Monday, Wednesday and Friday, i.e. 6 × 20 min per group per week. The time of observation was randomized within morning and afternoon observations. Additionally, behaviour was scored in the Unstable groups for 30 min immediately after the release of a new horse into the group.

2.4. Injury score

All horses were scored for injuries before grouping as well as by the end of the experimental period. Each body part was examined for hairless skin, scuffs, open wounds and swellings by an experienced technician and any lameness was scored when observing the horse in walk. The severity of the injuries was categorized on a scale from 0 to 5 (Table 3).

2.5. Statistical analysis

Social interactions were merged into main categories as follows:

Non-contact agonistic: displacement, threat to bite, threat to kick, chase, and mouth clapping; *Contact agonistic*: bite, kick and push; *Play*: play and play fight; *Friendly*: Social grooming and head resting; *Greeting*: nasal sniff, body sniff, genital sniff and strike. The total number of interactions in each category was summed per group per week. Obser-

Table 3
Injury scale (modified after Grogan and McDonnell, 2005; Mejdell et al., 2010).

Category	Description
0	No visual lesions
1	Lesions involving hairless areas only (no damage to the skin or deeper tissue)
2	Lesions involving a moderately swollen area (with or without hair-loss) and/or a superficial wound, where the skin is not perforated (i.e. underlying tissue is not visual)
3	Injury with a (minor) cut through the skin, or a larger crush with obviously swollen parts
4	Cut through the skin which involves damage to underlying tissue (muscles, tendons), or a cut through the skin that normally requires stitching
5	Extensive and severe injury that may cause loss of function over a long time (e.g. serious damage to a tendon or joint, fracture) or even death/euthanasia

vations were considered as count data and modelled in a generalized mixed model assuming a Poisson-distribution (Fahrmeier and Tutz, 2001). The model included the fixed effects year (2007, 2008), treatment (S, U), week (2–7) and the interaction treatment × week, as well as the random effect of group and a random residual to account for overdispersion. The analysis was performed with PROC GLIMMIX of the software SAS 9.2 (www.sas.com).

The total frequency of agonistic interactions and greeting behaviour in Unstable groups immediately after regrouping were analysed in a similar model where the fixed effects were year and week. Additionally, the frequency of agonistic interactions after regrouping was analysed for an effect of horse in a Kruskal–Wallis One Way Analysis of Variance test. The frequency of injuries was analysed for a treatment effect using the Mann–Whitney Rank Sum test.

3. Results

3.1. Social interactions

The mean number of social interactions in Stable and Unstable groups per week is shown in Table 4. The majority of agonistic interactions were non-contact interactions (Stable: non-contact: 69% vs. contact: 31% and Unstable: non-contact: 64% vs. contact: 36%). There was a significant effect of treatment ($F_{1,65} = 5.60$, $P = 0.02$) and year ($F_{1,65} = 4.86$, $P = 0.03$) on the frequency of non-contact agonistic interactions, whereas there was no effect of week and no interaction. The frequency of contact agonistic interactions was significantly affected by week ($F_{5,65} = 3.04$, $P = 0.02$), whereas the effect of year ($F_{1,65} = 3.44$, $P = 0.07$) and treatment ($F_{1,65} = 3.12$, $P = 0.08$) were borderline significant and there was no interaction. The frequency of greeting behaviour was significantly affected by week ($F_{5,65} = 8.40$, $P < 0.001$), due to a high occurrence in weeks 4–6. The frequency of play behaviour was significantly affected by year only (2007: 4.3 ± 1.1 vs. 2008: 1.3 ± 0.4, $F_{1,65} = 6.88$, $P = 0.01$), but the level appeared to be less variable in the Stable horse groups (Table 4). There was a significant interaction between treatment and week in the occurrence of friendly contact behaviour ($F_{5,65} = 2.62$, $P = 0.03$) due to horses in stable groups showing more friendly behaviour in weeks 3 and 4 only.

The frequencies of agonistic and greeting behaviour in the Unstable groups for 30 min immediately after mixing were analysed for an effect of week in order to investigate whether the horses became more or less aggressive in response to mixing as the 6-week experimental period progressed. However, there were no effects of week on any behaviour, indicating that the horses neither habituated, nor sensitized, to repeated regrouping (Table 5). In general, the horses showed more social interactions in the first year of the study and there was a significant effect of year (non-contact: $F_{1,35} = 6.79$, $P = 0.01$; contact: $F_{1,35} = 18.93$, $P < 0.01$; greeting: $F_{1,35} = 6.43$, $P = 0.02$).

The frequencies of agonistic interactions immediately after mixing were also analysed for an effect of horse to investigate whether some horses were always more aggressive, regardless of the other group members. There

Table 4
Frequency of social interactions (mean ± sem) in Stable and Unstable groups in weeks 2–7 (6 × 20 min group/week).

Behaviour	Stable						Unstable					
	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
Non-contact agonistic	3.1 ± 1.0	2.6 ± 0.7	4.1 ± 1.4	2.3 ± 1.0	2.0 ± 0.7	2.1 ± 0.9	6.0 ± 1.5	4.8 ± 1.2	4.5 ± 1.1	6.1 ± 1.9	4.3 ± 1.9	2.4 ± 1.0
Contact agonistic	0.7 ± 0.5	1.9 ± 1.1	1.1 ± 0.6	2.1 ± 1.4	1.0 ± 0.3	0.6 ± 0.3	2.5 ± 1.0	1.5 ± 0.5	2.4 ± 1.0	4.9 ± 1.2	3.8 ± 1.4	0.6 ± 0.3
Play	2.0 ± 0.8	2.7 ± 1.3	4.1 ± 2.3	3.7 ± 1.3	2.9 ± 1.5	3.6 ± 1.8	2.3 ± 1.6	0.6 ± 0.3	2.6 ± 2.2	1.6 ± 0.7	6.4 ± 4.6	0.6 ± 0.4
Friendly interactions	3.7 ± 1.2	7.1 ± 2.5	6.3 ± 2.7	3.0 ± 1.0	2.6 ± 0.5	1.6 ± 0.6	2.3 ± 1.7	1.5 ± 0.7	2.4 ± 0.8	4.3 ± 1.3	4.5 ± 1.2	0.9 ± 0.4
Greeting behaviour	5.4 ± 1.3	6.3 ± 1.3	12.9 ± 3.1	11.9 ± 3.3	10.4 ± 1.8	11.3 ± 4.2	5.4 ± 0.4	6.9 ± 2.1	12.5 ± 2.9	20.0 ± 4.2	14.3 ± 1.8	6.0 ± 1.1

Table 5
Frequency of agonistic and greeting behaviour (mean ± sem) in Unstable groups after regrouping in weeks 2–7 (30 min/group).

Behaviour	Unstable					
	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
Non-contact agonistic	7.5 ± 1.0	9.3 ± 2.6	8.4 ± 1.7	11.4 ± 4.3	8.1 ± 1.6	7.1 ± 3.0
Contact agonistic	3.8 ± 2.0	2.6 ± 0.8	3.8 ± 1.4	4.8 ± 2.5	4.8 ± 1.8	2.6 ± 1.4
Greeting behaviour	18.6 ± 4.9	14.4 ± 2.8	14.1 ± 4.5	12.6 ± 3.5	22.0 ± 4.9	20.9 ± 3.9

was a significant effect of horse (range: median (25,75% quartiles): highly aggressive: 13 (4.17) vs. non-aggressive: 0 (0.0), $H = 59.7$, $P < 0.001$).

3.2. Injuries

Only minor injuries were observed; 9 injuries were registered as "score 2″, whereas the rest were minor scratches/hairless areas ("score 1″: $n = 97$). 16 horses had no injuries at all; of these were 7 from the Unstable groups and 9 from the Stable groups. There was no difference between the treatment groups in the total frequency of injuries (median (25,75% quartiles): Unstable: 2 (0.6) vs. Stable: 1 (0.2); $U = 184$, $P = 0.11$). No horses were found lame.

4. Discussion

The main finding of this study was that group instability, caused by weekly regroupings, led to an increase in the frequency of agonistic interactions, and in some weeks a lower frequency of friendly contact behaviour as well as a more variable level of play behaviour, compared to stable control groups. An increased level of agonistic interactions in regrouped animals has also been observed in several other social species (e.g. Sevi et al., 2001; Raussi et al., 2005; Andersen et al., 2008). In other studies, however, the animals were mixed with unknown animals when regrouped and thus the increased level of aggression is likely to be related to settling of the dominance hierarchy. In our study, the horses were all familiar with group housing and they all knew each other prior to the study. This design was chosen in order to isolate the effect of group instability and mimic horse facilities where horses are familiar with each other but pastured in unstable groups. Horses have been found to show individual recognition even after a year's absence, whereas horses that meet again after 18 months absence treat each other as unfamiliar (Boyd and Keiper, 2005). Thus we would expect the horses in our study to be familiar to each other during the seven-week experimental period. The higher level of aggression that was shown immediately after regrouping (Tables 4 and 5) may still be related to settling the dominance hierarchy in the newly formed small groups. In addition, horses in the Unstable groups did not appear to adapt to repeated regrouping as there was no decrease in the frequency of greeting and agonistic behaviour immediately after regrouping. This result implies that the importance of greeting and settling the dominance hierarchy remains unchanged, even when the horses are familiar and have prior experience of regrouping.

The increase in agonistic interactions in Unstable groups did not, however, lead to significantly more injuries. When mixing animals, there appears to be a correlation between injuries and aggression (Weng et al., 1998), but due to the low level of physical interactions in the present experiment, it is not surprising to find a relatively low level of injuries, which were all unserious. Small injuries and areas with hairless skin may also be caused by play behaviour, which was more common than contact agonistic interactions in the stable horse groups (Table 4). Furthermore, this study involved young horses, meaning that dominance may be less apparent; they were well-socialized and had been living in one large group prior to the study. It is likely that mature horses, or horses that are less well-socialized (e.g. horses that have been deprived of social contact; Christensen et al., 2002a), would show more aggression and thus more injuries would be expected. It is also very likely that the way the regrouping is carried out affects the outcome. In an experiment with horses where newcomers were introduced to dominant resident horses in a small area, the newcomers were highly stressed and suffered from severe respiratory infections after 9–14 days (Alexander and Irvine, 1998). In stable horse groups, however, Grogan and McDonnell (2005) and Jørgensen et al. (2009) reported a low level of injuries of which the majority was minor. Using a similar ethogram as in the present study, Jørgensen et al. (2009) found that 80% of all agonistic interactions were non-contact agonistic in a study on the effect of gender composition of horse groups. Thus the proportion of non-contact agonistic interactions was higher in their study, compared to approx. 66% in the present study, which may be caused by either the difference in gender or age composition. Indeed, recent studies have found less contact agonistic interactions in age heterogeneous horse groups (Bourjade et al., 2008, 2009).

We found an unexpected year effect on the level of agonistic interactions and play behaviour, due to horses interacting more in the first year. This year effect may be caused by individual horse differences, or it may be related to external factors such as weather (study period: July–September in 2007 vs. September–October in 2008), or grass quality.

We further found a significant horse effect on the frequency of aggression at regrouping and were able to identify a few highly aggressive horses. These horses remained highly aggressive regardless of the composition of their group. This result implies that individual characteristics, relationships among group members and group composition are of crucial importance and that each regrouping demands careful attention from managers. In practise, it may be relevant to identify such aggressive

horses and ensure that they are grouped with e.g. older and higher ranking horses, or at least that groups with aggressive horses are allowed sufficient space with opportunity for other group members to escape aggressive interactions.

Although the welfare benefits of group housing compared to individual housing have been highlighted in several studies (e.g. Christensen et al., 2002a; Søndergaard and Ladewig, 2004), the majority of riding horses are still kept in individual housing systems. It may be this limitation in social contact, space restrictions or the frequency of regrouping that constitutes the major social challenge for domestic horses compared to natural conditions (Knubben et al., 2008; Fürst et al., 2006). It remains to be investigated whether some regrouping experience at a young age may be beneficial for horses in the long-term, given that they will experience regrouping as adults.

In conclusion, we found that group instability, caused by weekly regroupings, led to an increase in the level of agonistic interactions among young, well-socialized horses that were all familiar with each other prior to the study. The frequency of agonistic interactions immediately after regrouping did not decrease as the six-week experimental period progressed and thus the horses did not appear to adapt to regrouping. Although it appears beneficial to keep horses in stable groups, weekly regroupings did not increase the risk of injury in young horses. Although the general level of agonistic interactions was low, some horses appeared to be particularly aggressive and individual characteristics and relationships between group members should be taken into consideration when horses are regrouped.

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