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Could Adults be Used to Improve Social Skills of Young Horses, *Equus caballus*?

ABSTRACT: *We investigated the effects of the introduction of foreign adults on the behavior of young horses. First, we observed the behavior of 1- and 2-year-old domestic horses housed in same-age and same-sex groups (a standard housing system, but different from a natural situation). Then, two same-sex adults were introduced into each experimental group. Observations made before, during and after an introduction indicated that young horses reared in homogeneous groups of young had different behaviors compared to other domestic horses reared under more socially natural conditions. After the introduction of adults, young horses expressed new behaviors, preferential social associations emerged, positive social behavior increased and agonistic interactions decreased. These results have important implications both for understanding the influence that adults may have on the behavior of young horses, and in terms of husbandry, indicating the importance of keeping young horses with adults, although further studies are still necessary.* Dev Psychobiol 50: 408–417, 2008.

Keywords: *horse; social influence; young–adult interaction; social development*

INTRODUCTION

Young animals receive social influence from their conspecifics and are able to learn from them: developmental trajectories result in recurring social interactions among group members (Hinde, 1983; West, King, & White, 2003; White, King, Cole, & West, 2002b). Social context, partly determined by the social structure of a species, refers to the quality and number of individuals young can interact with (age, sex, relatedness. . .) or to the duration of their association. Such a social context can affect learning opportunities and therefore shape the young's behavior (Berman, Rasmussen, & Suomi, 1997; White et al., 2002b). Mothers provide the first social influence young mammals receive (Berman et al., 1997; Holmes & Mateo, 1998; Kendrick, Haupt, Hinton, Broad, & Skinner, 2001). However, the presence of siblings or conspecifics of the opposite sex can affect social preferences (e.g., Belding ground squirrels, *Spermophilus beldingi*: Holmes & Mateo, 1998; domestic horses: Khalil & Kaseda, 1998) or social behavior (e.g., social play in female kittens, *Felis catus*: Caro, 1981; aggressiveness in mice, *Mus musculus*: Korpela & Sandnabba, 1994). Similarly, other adult group members can influence sexual development, maturation, or development of aggressiveness (e.g., musk shrews, *Suncus murinus*: Rissman, Taymans, & Wayne, 1990; guinea pigs, *Cavia porcellus*: Sachser & Lick, 1991; mice: Sandnabba, 1993; elephants, *Loxodonta africana*: Slotow, van Dyk, Poole, Page, & Klocke, 2000; golden hamsters, *Mesocricetus auratus*: Delville, David, Taravosh-Lahn, & Wommack, 2003).

Social enrichment experiments with captive, domestic, or wild animals showed mainly that the presence of conspecifics enhanced success in coping with future social challenges (Pietropaolo et al., 2004; Schapiro, Bloomsmith, Porter, & Suarez, 1996). For example, young rhesus monkeys, *Macaca mulatta*, housed in pairs or in groups developed more species-specific behavioral patterns in comparison to isolated individuals (Schapiro et al., 1996). In elephants, older bull control young males by decreasing their aggressiveness and suppressing their

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musth pattern, which normally increases sexual and aggressive activity (Poole, 1987; Slotow et al., 2000). One have to consider that adults in social groups could play an important role through (i) their behavioral responses when young interact with them; (ii) their role of social model (e.g., cowbirds, *Molothrus ater*: White, King, & West, 2002a; White et al., 2002b); and (iii) their social status, which could affect relationships. In primate societies, adult males have been demonstrated to assume a ''control role,'' thus stabilizing social relationships (e.g., vervet monkeys, *Cercopithecus aethiops sabaeus*: Fairbanks & McGuire, 1979; gorillas, *Gorilla gorilla*: Hoff, Nadler, & Maple, 1982), and so do adult Campbell's monkey females, *Cercopithecus campbelli campbelli* (Lemasson, Gautier, & Hausberger, 2005), or elephant matriarchs (McComb, Moss, Durant, Baker, & Sayialel, 2001).

The question of the influence of adults on social development is particularly interesting in horses, as all studies on feral and wild populations emphasize the multiplicity of social partners during a foal's ontogeny (Boyd, 1988; Feh, 2005; Ladewig, Søndergaard, & Christensen, 2005). Young horses normally live in small year-round stable groups including one stallion (usually their father), their mother, a few other mares, their siblings and unrelated peers of different ages and sexes (Berger, 1986; Boyd & Keiper, 2005; Feist & McCullough, 1976). Some domestic horses kept under more socially natural conditions can thus be taken as a reference for behavioral studies (i.e., Icelandic horses: Sigurjónsdóttir, Van Dierendonck, Snorrason, & Thórhallsdóttir, 2003; van Dierendonck, Sigurjónsdóttir, Colenbrander, & Thórhallsdóttir, 2004). On the contrary, for practical and ''traditional'' reasons (avoidance of early mating between colts and fillies, use of adults for other purpose. . .), most of young domestic horses are generally maintained in same-age and same-sex groups, from weaning until training (2–3 years old). One has to consider that young horses in these homogeneous social groups may not necessary find all the social stimulations required in their development and could therefore show singular behavioral patterns compared to domestic horses living in socially natural conditions. In the present study, we first checked the social and non-social behavior of young horses in same-age and same-sex groups and second increased group heterogeneity, investigating the effects of a temporary introduction of adults into groups of young domestic horses. Therefore, we hypothesized that the introduction of adults would affect the social and non-social behavior of these young horses. This type of study combines two centers of interest: insight into the effects of social enrichment on the behavior of young horses and an applied aspect for the management of groups of young horses in domestic situations.

METHODS

Animals and Study Sites

This study involved 52 one- and two-year-old Anglo-Arab and Arab horses, *Equus caballus* of both sexes. These young horses were divided into four experimental groups: two male groups of 1 (EM1) and 2 (EM2) year-old horses; two female groups of 1 (EF1) and 2 (EF2) year-old horses as well as two control groups: a 2-year-old male group (CM2) and a 2-year-old female group (CF2) (Tab. 1). It was highly difficult to find several groups of young horses on the same sites and in the same conditions, and still more to ask the managers to use several pastures for a same generation. Therefore, we were not able to have a 1-year-old control group. However, similarities between 1- and 2-year-old experimental groups suggested that this was not crucial (see Results Section). All these horses were managed the same way since weaning: same-sex and same-age groups living in 2 ha pastures. No additional food was provided during the observations (August–October 2004). All groups were on sites managed by the National French Studs (''Haras Nationaux'') located in southwest France. Four groups were housed in ''Jumenterie de la Rivière,'' Pompadour, and two in Chamberet, about 40 km away. Eight unfamiliar adult horses, four females (10-, 13-, 15-, 15-year old) and four geldings (4-, 11-, 15-, 20-year old), had been selected by the local staff on the basis of their social experience in order to avoid excessive aggressiveness toward the young. Same-sex pairs of adults were introduced into each experimental group after 10 days of habituation to the sites (see Fig. 1).

Experimental Procedure

To evaluate the impact of the presence of adults, we subdivided observations into four periods each lasting 10 ± 2 days according to external constraints (Fig. 1). Observations were made before (phase A) and during (experimental phase B) the introduction of adults and after adults had been taken away (phase C). Overall, adult horses remained 19 days in an experimental group. The experimental phase was subdivided into periods of 10 and 9 days (phases B1 and B2) to distinguish immediate short-term effects from later behavioral modifications. No animals were introduced into the control groups. Control groups were observed for the same durations as the experimental groups.

Table 1. Characteristics of Groups and Sites

Group Name	Treatment	Age (in Years)	Sex	*N*	Site
EM1	Experimental	1	Male	8	Pompadour
EF1	Experimental	1	Female	7	Pompadour
CM2	Control	2	Male	11	Pompadour
CF2	Control	2	Female	7	Pompadour
EM2	Experimental	2	Male	9	Chamberet
EF2	Experimental	2	Female	10	Chamberet

N, number of subjects.

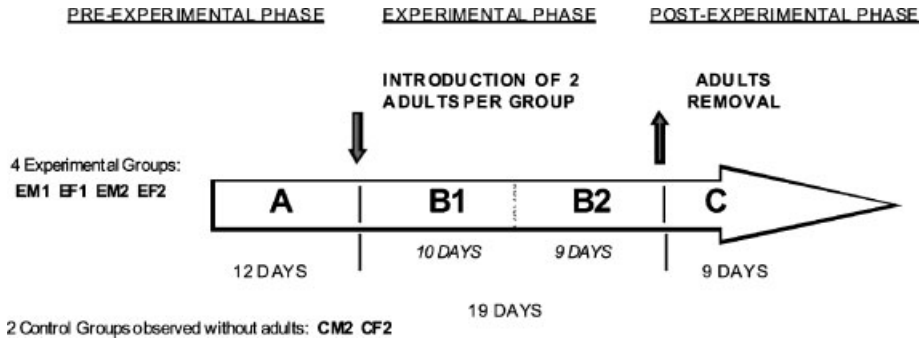

FIGURE 1 Experimental design: During phase A, the young horses were in group without adults; after introduction of two adults into each experimental group, observations were divided into two phases (B1, B2). C corresponds to observations after the adults had been taken away. The duration of the phases was constrained by the availability of adult horses (B1, B2), and pastures (C). Experimental groups: EM1, EF1, EM2, and EF2; control groups: CM2 and CF2; E, experimental; C, control; F, females; M, males; 1, 1-year old; 2, 2-year old.

Behavioral Observations

Observations were done from 07.00 am to 09.00 pm following a rotating schedule so that each group was observed by turns at the different hours of the day. In all, each horse was observed for approximately 190 min, corresponding to 40 ± 20 min per phase according to external constraints.

Each observation session included 10 min focal sampling per horse (Altmann, 1974). Both social interactions and solitary activities were recorded during focal sampling. Thus, the following behavioral categories were scored: maintenance behavior such as grazing, moving, resting standing, lying recumbent (sternal or lateral recumbence), drinking, self-directed behavior (self-grooming, rolling, shaking. . .); observation of the environment; vigilance; and social behavior. Different social interactions were recorded: (i) positive interactions such as social play, social investigation composed of olfactory investigation (sniffs) and approach, and mutual grooming, rubbing, head-body contacts, ''put the head on the back/croup'' usually considered as affiliative behaviors; (ii) agonistic interactions included head threat, bite, chase, kick threat, and kick (Wells, 1978); (iii) ritualized interactive sequences of fecal pile marking, adult-like encounter patterns (rear, strike, head bowing); (iv) snapping (moving the lower jaw up and down usually with the mouth open and lips drawn back, Crowell-Davis, 1985).

Moreover, group scan-sampling was performed after each focal session (Bateson & Martin, 1993) to record activity (same definitions as focal sampling) and identity of nearest neighbor for each horse in the group as spatial proximity is commonly used in horses to estimate affinities between individuals (Crowell-Davis & Weeks 2005; Crowell-Davis, Houpt, & Carini, 1986; Tyler, 1972).

We recorded 1,181 scans and these data provided a good estimate of diurnal time-budgets and distances within the whole group because 10-min intervals guaranteed independence of samples (Wells and Feh, cited in Feh, 1988). Different observers were involved but performed simultaneous observations regularly and reliability was quite high [using the kappa coefficient of Cohen (1960) that rated at $k = 0.95$].

Statistical Analyses

We calculated the diurnal time-budget of horses in percentage of scans recording the different behavioral patterns. Activities such as vigilance or social interactions were expressed in mean occurrences per hr $\pm$ SEM. Preferential spatial partners were based on the spatial proximity to the nearest individual. These spatial preferences were not necessarily reciprocal as if an individual A is the nearest spatial partner of B, A could have either B as nearest neighbor (reciprocity) or C, another individual closer to him than B (non-reciprocity). Preferential spatial partners of individual A were those that were more frequently the closest to A than expected by chance (partitioned Chi-square test for independent samples, see Siegel & Castellan, 1988). Mantel tests for matrix correlations (one-sided) run under *XLstat* software estimated correlations between preferred spatial partners and partners of social play and positive interactions. Coefficients of variation were calculated by groups and between groups, in order to confront intra and inter-group variability. For further statistical analyses, given the high inter-individual variability within groups that in most cases equaled inter-group variability (see Results Section), individuals were considered as independent units.

In addition, Kruskall–Wallis tests were performed in order to evaluate possible group effects as well as to cancel out confounding influences of age and sex of individuals on behavior. When experimental groups and control groups respectively did not differ, groups within each category were pooled. Comparisons between phases were then tested using Friedman two-way analyses of variance by ranks and, when significant, specific changes between two phases ($A \rightarrow B1$, $A \rightarrow B2$, $B1 \rightarrow B2$, $A \rightarrow C$) were addressed using Wilcoxon signed rank tests under *Statistica* 7.0. As four tests were performed each time, Bonferroni correction for multiple comparisons was applied systematically (in text as ''significant at $p < 0.0125$'').

Moreover, we compared young–young relationships with adult–young relationships during phase B2. We calculated frequencies of interactions per hour among young and between young and adults separately and proportionally to the number of

available partners in each category. One-sample permutation tests (R: *exactRankTests* package, http://cran.r-project.org) then compared frequencies of interactions among young and frequencies of adult–young interactions. Except when specified, all statistical tests were two-sided.

RESULTS

The Behavior of Young Horses Kept in Same-Sex and Same-Age Groups (Phase A)

In the present study, time-budget of the young horses was rather similar to that reported for different domestic populations, with high predominance of grazing (76%) and resting (16%), except for resting recumbent that seemed lower (0.3%) (Tab. 2a) (Crowell-Davis, Houpt, & Carnevale, 1985; Kownacki et al., 1978).

In addition, the young horses had on average less than one preferential spatial partner, when mutual grooming was hardly ever observed (from 0.00 to 0.14 in four groups). They also showed high frequencies of agonistic interactions (3.86 per hour) and social play (6.62 per hour) (Tab. 2b).

Intra-group variability was as high as inter-group variability for most behaviors —except grazing and standing resting- allowing us to use each horse of the groups as an independent unit for other behaviors (coefficients of variation, e.g., agonistic interactions: $CV_{INTRA\text{-}EXPERIMENTAL} = 118\%$, $CV_{INTRA\text{-}CONTROL} = 130\%$, $CV_{INTER\text{-}GROUPS} = 122\%$). However, as diurnal time budget, vigilance, self-directed behaviors, and social play differed among groups (Kruskall–Wallis: four experimental groups: $N = 34$, $DF = 3$; two control groups: $N = 18$, $DF = 1$, $p < 0.05$ in all cases), they were not further investigated.

Effects of the Temporary Presence of Adults on the Behavior of Young Horses (Phase B1–B2)

Remarkably, behavioral patterns that had not been recorded previously were observed during phase B1. Thus, lateral recumbence, flehmen, mount, kicking, chasing, and snapping at adults were observed in the 1-year-old experimental groups as well as adult-like encounter behavioral patterns such as head bowing, fecal pile display (in males) or striking; these adult-like patterns were performed by two to three individuals in all our experimental groups. None of these behavioral patterns were observed in the control groups.

Moreover, clear social preferences were evidenced by proximity data (Fig. 2) as the number of preferred spatial partners per individual increased from 0.76 ± 0.08 during phase A to 1.23 ± 0.12 during phase B1 and 1.20 ± 0.09 during phase B2 in experimental groups (Wilcoxon test, $N = 34$: (A-B1): $T_{EXP} = 6$, $p = 0.002$; (A-B2): $T_{EXP} = 33$, $p = 0.003$), whereas no change

Table 2. Behavioral Data from Observations of Young Horses Kept in Same-Sex and Same-Age Groups: (a) Diurnal Time-Budget, (b) Occurrences per Hour of Social Interactions and Number of Preferred Spatial Partners per Horse

	Activities					
Groups	Grazing	Moving	Observing	Resting Standing	Resting Recumbent	Others
(a)						
EM1	88.19 ± 1.16	2.08 ± 0.55	3.47 ± 0.74	3.24 ± 0.46	0.23 ± 0.23	2.78 ± 0.78
EF1	71.03 ± 1.14	8.17 ± 0.79	4.13 ± 1.02	14.17 ± 1.09	0.00 ± 0.00	2.50 ± 0.56
CM2	65.90 ± 0.65	4.03 ± 0.60	1.10 ± 0.40	25.31 ± 0.81	0.12 ± 0.12	3.53 ± 0.81
CF2	75.49 ± 1.06	3.03 ± 0.99	1.14 ± 0.41	18.11 ± 0.98	0.59 ± 0.39	1.63 ± 0.65
EM2	75.49 ± 2.10	2.81 ± 0.28	1.50 ± 0.44	19.27 ± 1.66	0.38 ± 0.25	0.56 ± 0.39
EF2	79.64 ± 1.56	3.70 ± 0.52	2.93 ± 0.42	7.72 ± 0.73	0.46 ± 0.24	5.55 ± 0.87
Mean	75.96 ± 3.10	3.97 ± 0.89	2.38 ± 0.53	14.64 ± 3.29	0.30 ± 0.09	2.76 ± 0.70

	Occurrence of Social Interactions per Hour			
Groups	Agonistic	Social Play	Mutual Grooming	No. of Preferred Spatial Partner
(b)				
EM1	3.50 ± 1.36	6.88 ± 2.45	0.00 ± 0.00	0.63 ± 0.18
EF1	4.71 ± 1.13	1.57 ± 0.61	0.14 ± 0.14	0.86 ± 0.18
CM2	2.91 ± 1.09	24.18 ± 10.49	0.73 ± 0.63	0.36 ± 0.15
CF2	4.14 ± 0.91	0.71 ± 0.29	1.57 ± 1.27	0.71 ± 0.30
EM2	4.00 ± 1.30	0.67 ± 0.29	0.11 ± 0.11	0.67 ± 0.17
EF2	3.90 ± 0.81	5.70 ± 3.44	0.10 ± 0.10	0.90 ± 0.18
Mean	3.86 ± 0.25	6.62 ± 3.67	0.44 ± 0.25	0.69 ± 0.08

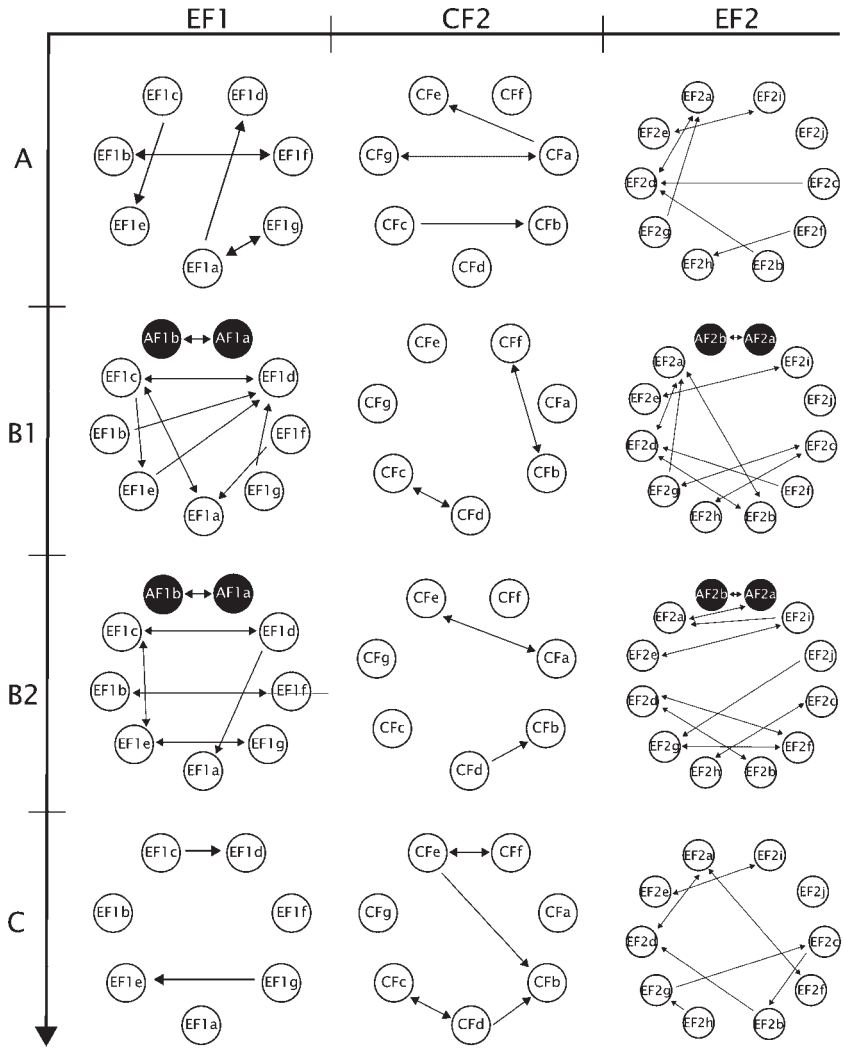

FIGURE 2 Sociogram of preferential associations among young females based on proximity. Associations were called ''preferential'' when ''associations'' were more frequent than expected by chance [partitioned Chi-square tests for independent samples ($p < 0.05$)]. Arrows: the receiver is a preferential partner of the sender; white circles: young females; black circles: adults. A, pre-experimental phase; B1 and B2, experimental phases; C, post-experimental phase. EF1 and EF2, 1- and 2-year-old experimental groups; CF2, the female control group. Note: Similar increases of preferential relationships during B1 and B2 were observed for males.

occurred in the control groups (Friedman analysis of variance: $F3 = 1.57$, $N = 18$, $p = 0.667$) (Fig. 3). These new spatial preferences were correlated with preferences for partners of positive social behaviors in all groups [Mantel tests (one-sided): $p < 0.05$ in the four experimental groups for phases B1 and B2]. None of these correlations were significant in the control groups [Mantel tests (one-sided): $p > 0.05$ in all cases].

Affiliative behavior and social investigation increased in experimental groups during adults' presence [Wilcoxon test, $N = 34$: social investigation, (A-B1): $T = 122$, $p < 0.0125$; (A-B2): $T = 59$, $p < 0.0125$; affiliative behavior, (A-B2): $T = 78$, $p < 0.0125$], while agonistic interactions decreased [Wilcoxon test, $N = 34$: (A-B1): $T = 82$, $p < 0.0125$] (Fig. 3). None of these changes were observed in the control groups for the same time period (Friedman analysis of variance: $N = 18$, $p > 0.05$ in all cases). In all cases, the low levels of agonistic interactions per dyad made it impossible to establish a hierarchical order.

To summarize, when adults were present young horses showed more social preferences as their affiliative

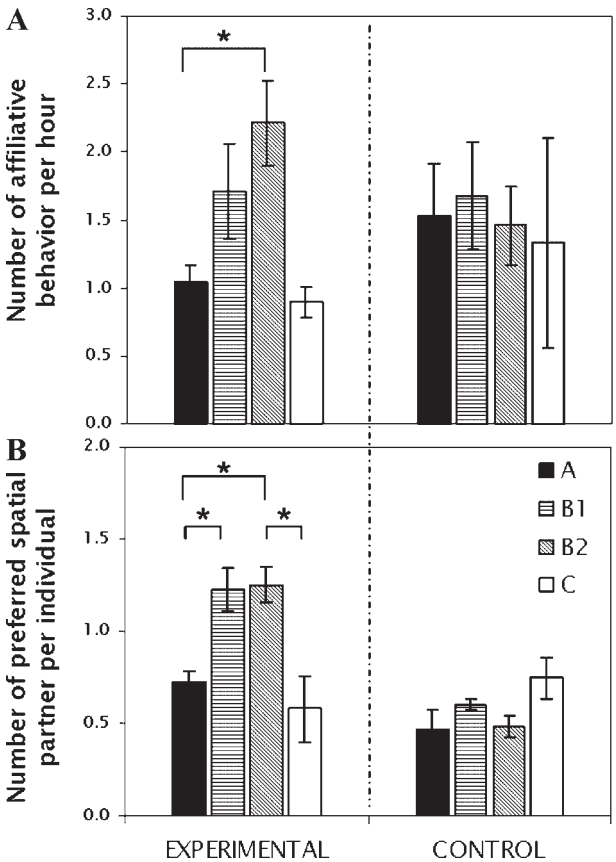

FIGURE 3 Preferred spatial partner (mean ± SEM) per individual and frequency of affiliative behaviors (mutual grooming, rubbing, head-body contacts, ''put the head on the back/croup'') in experimental and control groups: Wilcoxon signed-rank test: $^{*}p < 0.0125$.

behavior, their social bonding in different social contexts increased and their agonistic interactions decreased.

Nature of Young–Young and Adult–Young Relationships (Phase B2)

In three of the four groups, young horses modified their social behavior both toward adults and toward other young after the introduction of adults. Agonistic interactions and social investigation occurred more often between young and adults than among young (One sample permutation test: agonistic interaction: $t_{EM1} = 33$, $N = 8$, $t_{EM2} = 28$, $N = 9$, $t_{EF2} = 20$, $N = 10$; social investigation: $t_{EM1} = 42$, $N = 8$, $t_{EM2} = 50$, $N = 9$, $t_{EF2} = 88$, $N = 10$; $p < 0.03$ in all cases). Conversely, in EM1, where social play and affiliative behaviors were observed between young as well as between young and adults, these behaviors occurred more often among young than between young and adult (One sample permutation test, $N = 8$: affiliative behavior: $t_{EM1} = 30$, $p = 0.020$; social play: $t_{EM1} = 20$, $p = 0.020$).

Persistence of Some Behavioral Changes after Removal of Adults (Phase C)

Some of these behavioral changes persisted after the adults had been taken away such as the newly expressed behavioral patterns (flehmen, kicking, snapping...) and the same social preferences for spatial and affiliative behavior partners in 2-year-old experimental groups (Mantel tests: EM2: rs = 0.45, $p < 0.004$; EF2: rs = 0.33, $p < 0.02$).

However, the number of preferred spatial partners, the frequency of social investigation, affiliative behaviors and agonistic interactions came back to their initial level [Wilcoxon test (A–C): $N = 34$, $p > 0.0125$ in all cases] (Figs. 2 and 3).

DISCUSSION

This study highlights two main results concerning the expression of social behavior in young horses. Firstly, young horses reared in same-age and same-sex groups since weaning had no real preferred partner, a reduced behavioral repertoire; they displayed many agonistic interactions and social investigation, whereas affiliative behavior such as mutual grooming was relatively infrequent. Secondly, when adults were introduced into a group, the young modified their behavior in different ways. The number of their preferred spatial partners increased and they often kept the same partners in different interactions. These new social preferences among young were associated with an increase of affiliative behaviors in the experimental groups. New social and non-social behavioral patterns appeared. Some of these changes persisted after the adults had been taken away, such as some newly observed behavioral patterns and social bonding through different contexts. An introduction of new same-age horses in similar groups of young is now required to prove the relevancy of the adult status (vs. novelty) in these behavioral changes.

Behavior of Young Horses Reared among Young

Comparisons with data for horses living in groups under socially natural conditions indicate that keeping young horses in homogeneous groups may affect their behavioral characteristics. Although the diurnal time-budgets of our young horses agreed with those of domestic horses under natural conditions (Kownacki et al., 1978) and with those of feral horses (Berger, 1986; Salter & Hudson, 1982), time spent lying recumbent seemed lower. Indeed, lying recumbent occupied 0.30% of our horses' time, whereas feral and free-ranging domestic horses spent 4–6% of their time lying recumbent

(Kownacki et al., 1978; Salter & Hudson, 1982). Reduced occurrences of lying down has been suggested to be an indicator of nervousness (McCann, Heird, Bell, & Lutherer, 1988) and poor welfare in horses (Benhajali et al., in press).

Overall, the greatest differences concerned social behavior. Our groups were characterized by a low tendency to form stable partnerships, high levels of agonistic interactions, and an almost total absence of mutual grooming in four groups. Thus, this lack of preferential spatial partners differed from the situation found in other studies of social relationships when each horse had between one and three preferred spatial partners (*domestic horses in mixed groups*: Clutton-Brock, Greenwood, & Powell, 1976; Sigurjónsdóttir et al., 2003; van Dierendonck et al., 2004). Likewise, frequencies of mutual grooming tended to be lower than those reported in the literature (*domestic horses*: Christensen, Zharkikh, Ladewig, & Yasinetskaya, 2002b; Clutton-Brock et al., 1976; Crowell-Davis et al., 1986; *feral horses*: Wells, 1978). Conversely, our hourly frequencies of agonistic interactions (3.86 ± 0.25) were higher than those in other reports whatever the characteristics of the groups (0.17–1.90 interactions per hour in *domestic horses*: Araba & Crowell-Davis, 1994; Christensen, Ladewig, Sondergaard, & Malmkvist, 2002a; Clutton-Brock et al., 1976; Houpt & Keiper, 1982; Sigurjónsdóttir et al., 2003; Weeks, Crowell-Davis, Caudle, & Heusner, 2000).

Introduction of Adults Induced Changes in Behavior

To our knowledge this study is the first to examine the effects of adult influence on young horses' behavior. Two main types of behavioral changes were observed in groups of young after introduction of adults: in behavioral patterns and in social relationships. One major feature of the behavioral changes was the enlargement of their behavioral repertoires; a greater diversity of behavioral patterns was expressed in all experimental groups: lying recumbent -indicating quiet state (McCann et al., 1988)-, adult-like patterns such as sexual behavior or encounter patterns and juvenile behavior displayed toward adults (such as snapping) were observed. None of these activities had been observed before the adults were introduced. Presence of new adult individuals may have favored the expression of new behavioral patterns by accelerating developmental processes, as for aggressiveness in rodents (Delville et al., 2003; Korpela & Sandnabba, 1994; Sachser & Lick, 1991), by acting as social models or ''tutors,'' as for song birds (Bertin, Hausberger, Henry, & Richard-Yris, 2007; Galef & Laland, 2005; Henry, Hemery, Richard, & Hausberger, 2005) or by inducing internal states underlying some behavioral patterns (e.g., snapping, Crowell-Davis, 1985).

Social relationships are the second major feature of the changes induced after adults were introduced. Interestingly, young horses studied by Christensen et al. (2002a) displayed unusual social behavior when they were housed singly. Our young horses, reared without mixed social partners, showed the same tendency, emphasizing that young horses' behavioral development requires the presence of different social stimulations. Thus, when adults were present, increase of the number of preferred spatial partners per horse was associated with preference for these same partners in different social contexts (e.g., affiliative behavior). This supports Christensen et al.'s (2002a) results showing that domestic group-housed stallions were more likely to keep the same social partner than singly-housed stallions after release in groups and suggesting an effect of group housing on group structuring. In the same way, the presence of adults in our experiment could have led to a socio-spatial structuring of groups of young horses. Indeed, social investigation and affiliative behavior increased when adults were present and they are known to be involved in the reinforcement of bonds (Feh & de Mazieres, 1993; Feist & McCullough, 1976; Kimura, 1998). Moreover, our young horses, as do young elephants (Slotow et al., 2000), also reduced their agonistic interactions and reacted differently to adults and to other young in all experimental groups. Young interacted preferentially with other young when playing and interacting affiliatively, as in Icelandic horses (Sigurjónsdóttir et al., 2003), whereas adults were more involved in agonistic interactions and social investigation. Similarly, young cowbirds differed in their social interactions and spatial associations according to the presence or absence of adult birds in their groups (White et al., 2002a). In horses, the diversity of age classes may generate a clearer hierarchy (Christensen et al., 2002b; Sigurjónsdóttir et al., 2003) and therefore induce such a socio-spatial structuring in groups, as both age and hierarchical rank are considered important factors in group structuring, particularly in spatial structuring (Clutton-Brock et al., 1976; Kimura, 1998). Adult horses could act as external stimuli favoring social interactions both towards adults and other young. Moreover, adults of wild animals as cowbirds (West, King, & Freeberg, 1997), or elephants (Slotow et al., 2000), seem to channel social behavior, regulating aggression and modeling the behavior of their young even in absence of direct contacts between young and adults (Snowdon & Hausberger, 1997; White et al., 2002b). Overall, following these social modifications, social behavior of these young horses became more similar to that described in other reports on domestic horses in more varied social groups such as

Icelandic horses (Sigurjónsdóttir et al., 2003) even if partners' diversity still could increase.

Introducing Adults May be a Useful Procedure

Although at this stage, only a further study using same-age young horses would tell us whether the important modifications observed are really due to ''adult status,'' these results show that using socially experienced adults and introducing them into groups of young horses could be a useful procedure to provide essential social stimulations for the social development of young horses. Probably some traits would not have been produced by young horses after an introduction of same-age peers such as the adult-like behavioral patterns or the snapping behavior known to be directed toward adults (Crowell-Davis, 1985). However, in this study, the introduction of foreign individuals (young or adult) could have increased social tensions and partly explain some results, highlighting the importance of developing experiments in which adult's presence or absence is determined from weaning. Persistence of the effects would probably have been enhanced too by a longer introduction of adults. Other questions arise such as the importance of the age of the young (1- or 2-year old) or the importance of the adult/young ratio, as demonstrated in other species (Bertin et al., 2007). Further studies are required here. Therefore, these findings have important implications for the management of horses and indicate that adults may present important social stimulations for young's development (see Henry et al., 2005) that could be used to improve the behavior of horses in domestic situations.

NOTES

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