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Abstract

Donkeys display a peculiar social structure, dyad based, different from horses. In particular, scarce information are available on their early life after birth, which was hypothesized to represent the most important period in the development of the social behaviour between the jenny and her foal. In the first 24 hours after birth, donkeys develop most of their sensorial, motor and behaviour abilities, typical of the 'follower' species. Because this lack of knowledge contrasts with the increasing multi-factorial interest for the donkey breeding, the present study was aimed to investigate the jenny-and-foal dyad behaviour within 24 hours after birth, with the final purpose to provide the basis for a specie-specific ethogram, in the Martina Franca endangered donkey breed. The observed behaviours were simplified in seven clusters in order to highlight the most representative categories. The most represented behavioural clusters observed during the night and day time in both jennies and foals were defined, according to the Pareto statistical analysis, '*vital few*'. The results represent a preliminary behavioural database about Martina Franca donkey breed jenny-and-foal dyad in the first 24 hours after delivery, useful for the future ethogram description and for deep investigations of behaviour related maternal or neonatal problems and for the prompt recognition of foals eligible for the Animal Assisted Activity and Therapy.

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Key words: jenny-and-foal dyad, neonatal, behavior, bonding, olfaction

Introduction

In the donkeys the social structure is composed of complex hierarchies within the groups in which the rank does not simply depend on age, sex, body weight or aggressive behavior (McGreevy, 2012). The social organization of both feral and free-ranging donkeys shows a territorial-based system (Klingel, 1977; Woodwart, 1979; Henry et al., 1991), unlike the harem system of horses (Klingel, 1975; Smith-Funk & Crowell-Davis, 1992). Moreover, the donkey's behavioral repertoire is peculiar in comparison to horses (e.g.,social play is infrequent in donkeys (McDonnell & Poulin, 2001)). Within the donkey social structure, the only permanent union is the one between the mother and her foal. The bond between each jenny and her foal is strong, and represents the key for understanding donkey behavioral development. Jennies may travel over large territories with their foal as dyads, or in small groups of dyads loosely affiliated each other (Poindron & Schaal, 1993; McDonnell, 1998), or can remain almost resident in a given territory with their foals (McDonnell, 1998). This behavioral trait has a profound effect on the interaction between each jenny and her foal (McDonnell & Poulin, 2001). The jenny's activities are related to the foal's response, which decreases as the foals mature, regardless of their sex (French, 1998). Interestingly, in wild contexts, the mother-to-foal separation process begins with weaning (Moehlman, 1998), while in domestic contexts, characterized by confinement, unlimited resources, and reproductive inactivity, the dyad does not separate at weaning, but, reverts to the close one observed between jennies and newborn foals (French, 1998). This finding largely reflects a shift in the jenny's behavior from "leaving" to "approaching" and, to a lesser extent, can be attributable to an increased number of approaches by the foal. Thus, related adult donkeys often stay very close together and are equally active in maintaining contact. Because it can lead to separation anxiety, this close relationship may be undesirable for owners when the pair need to be separated. On the other hand, it may provide many benefits, including mutual grooming, and the potential for the pair to develop a coalition for future support, for example, in mutual defence (French, 1998; McGreevy, 2012).

In donkeys, as in other domestic mammals, the process of birth and the early phase of development immediately after delivery play a pivotal role in the process of adaptation to the extra-uterine life for the newly born individual. The donkey, like other *Ungulates*, is a precocious mammal, because of the rapid motor and sensory development of the foal after birth. In precocious newborns, the active care provided by the mother results in a phase of intense reciprocal stimulation after birth. In turn, maternal responses are elicited by the complex of movements, odors and vocalizations provided by the foal, so that the mother uses visual, tactual and vocal stimuli to elicit and direct the foal activities (Crowell-Davis & Houpt, 1986). Because of their economic and commercial importance, far more attention was paid to reproductive physiology in horses than in other *Equidae*. As a result, much less is known about species-specific aspects of breeding in other *Equidae*, including the donkey (Ginther et al., 1987; Canisso et al, 2010), which is then often wrongly managed (Perez-Marin et al, 2016). There is a need to improve the donkey-specific reproductive behavioral knowledge for population and biodiversity programs (Carluccio et al., 2013; Perez-Marin et al., 2016). A large number of donkey breeds are currently considered as endangered and, among them is the Martina Franca donkey breed.

The study of jenny-and-foal dyad deserves scientific interest for several reasons: 1. scarce information are, in general, available for donkey dyad behavior, and the authors are not aware of specific data about the Martina Franca endangered donkey breed; 2. the definition of the normal jenny-and-foal dyad behavior will be useful for the prompt recognition of every sign of abnormalities; 3. foal temperament, excitability, mood and affective behavior, since birth, could help to start the selection of subjects for Animal Assisted Activity and Therapy, that represents one of the most important present use of donkeys.

The present study investigated the behavior of Martina Franca jennies and their foals within the first 24 hours after delivery, in order to provide preliminary basic data for the future description of a Martina Franca donkey breed specific ethogram, and for a better selection of subjects for Animal Assisted Activity and Therapy.

Materials and Methods

Animals and housing

The study was performed on 11 Martina Franca jenny-and-foal dyads.

The jennies, 4-12 (mean ± SD: 8.8 ± 4.1) years old, 350-370 (mean ± SD: 360 ± 10) kg body weight, were kept in open paddocks at the Veterinary Teaching Farm, University of Teramo, Italy, and daily fed with 6-8 kg of good quality polyphite lawn hay, and 1.5 kg of commercial food for pregnant or lactating mares.

The jennies were healthy, dewormed before breeding, and regularly vaccinated.

They were reared under a conservation grant project of 'Regione Puglia' 2009-14 on endangered Martina Franca breed, in collaboration with the 'Martina Franca donkey genetic heritage conservation centre', Crispiano (Taranto, Italy). Institutional and rare breed guidelines for the care and use of animals were followed in full accordance to guidelines for the treatment of animals in behavioral research (ASAB, 2012).

The 11 pluriparous jennies were fully monitored by routine clinical and ultrasonographic examinations from the time of breeding until parturition, in order to assess the general health status, the normal pregnancy course, and the normal fetal development and well-being.

At approaching parturition, when the udder enlargement was detected, the jennies were moved to individual 3.50 x 3.50 m delivery boxes, and monitored by four infrared cameras DVMR Kalatel DVMRe Store Safe Digital Video Recorder Multiplexer Sony, Tokyo, Japan).

Foaling

All the jennies were allowed to foal spontaneously, under surveillance, but without interference. Foalings were defined as normal and spontaneous, and donkey foals defined as mature, healthy and viable, according to the criteria reported for the Martina Franca donkey breed (Carluccio et al., 2008; Veronesi et al., 2011; Panzani et al., 2012b; Carluccio et al., 2015).

Jenny-and-foal dyads behavior

All the dyad behaviors were video-recorded, and imagines were retrospectively analysed continuously, during the first 24 hours, by using a focal sampling method, starting at birth, (Altmann, 1974), (Fig.1).

Mutually exclusive behaviors were analysed, and the following behavioral clusters were considered in both day- and night-time: interaction, including lactation, licking, grooming and touching, playing together; activity: the total movement (excluding the interaction ones); resting were all considered as static behaviors.

Sensorial behaviors were also evaluated as olfaction (smell: itself or the body of the counterpart, excretions, straw and environment, characterized by clear sniffing movements), and observing (watch: itself or the body of the counterpart, surrounding environment, characterized by clear head movements and eye pointing). Other behaviors, such as autogrooming (scratch and licking itself), and excretion (urine and feces) were also considered.

All the behavioral clusters were expressed as rates, considered as the total numbers of events, divided by the duration expressed in seconds.

Data were expressed as means ± SD.

Statistical analysis

After a preliminary analysis by MANOVA, significant data were analysed by repeated measure ANOVA and one way post hoc ANOVA.

One of the useful mathematical formulas that could be applied in behavioral studies to identify the most important events in a group of data, is represented by Pareto analysis (Beirlant et al., 2006; Carluccio et al., 2013). In particular, 70% of the total cumulative percentage of the behavioral categories represent the most important behavior observed. These categories are termed the '*vital few*' according to Pareto formula. In the present study, this analysis was used to highlight the most represented behavior in the first 24 hours after birth in the dyad.

The data analysis was performed with Excel, Origin, SPSS and MatLab software.

Statistical significance was set for $\alpha < .01$ or $< .05$.

Results

Clinical findings

All the jennies foaled spontaneously and unassisted, at the physiologic term of pregnancy. All the eutocic deliveries occurred between 10:00 pm and 04:00 am, and in all cases the fetal and placental expulsion times fulfilled the criteria previously reported for normal parturition in Martina Franca donkey breed (Carluccio et al., 2008; Veronesi et al., 2011; Panzani et al., 2012b; Carluccio et al., 2015).

The 11 foals were mature, healthy and viable, with Apgar score, body weight, time for standing and for first suck within the ranges previously reported for this donkey breed (Carluccio et al., 2008; Veronesi et al., 2011; Panzani et al., 2012b; Carluccio et al., 2015).

The clinical findings, expressed as mean ± SD, about the jennies, foaling and neonatal characteristics of the 11 dyads examined, are summarized in table 1.

Table 1- Mean (± SD) clinical data about jennies, foaling and neonatal characteristics in the 11 dyads examined in the present study.

	Jennies age (years)	Pregnancy length (days)	Foal expulsion time (min)	Placental expulsion time (min)	Apgar score	Foal birth weight (Kg)	Time for standing (min)	Time for first suck (min)
Mean ± SD	10.2±3.84	368±4.37	18.3±5.87	40.4±16.56	9.1±0.89	30.3±2.95	62.3±25.07	87.1±29.15

Behavioral data

Behavioral data are shown in Figs. 2-8. Pareto analysis allowed us to highlight the most representative behavioral categories in jennies, foals and dyads, the so-called *'vital few'* behaviors.

In jennies, the most representative behavioral categories were 'observing' and 'olfaction'. Interestingly, these sensorial behaviors reached the 70% of the total displayed behavior, associated with 'autogrooming' during the day-time, and associated with 'excretion' during night-time. In foals, the most representative behavioral categories were 'observing' and 'autogrooming'. The 70% of the total behavior was represented by 'observing' and 'autogrooming', associated with 'activity' during the day-time, and with 'olfaction' at night-time. In the dyads, the most represented behavioral categories during day-time were 'observing' and 'autogrooming', followed by 'olfaction' for jenny and 'activity' for foal. During night-time 'observing' and 'olfaction' represented the 70% of behavioral categories in both jennies and foals, but in jennies they were associated with 'excretion', while in foals they were associated with 'autogrooming'.

Discussion

In precocious animals, the neonatal period is recognised as a phase of intense interactions between the mother and the infant, important for bonding, and characterized by all behaviors expressed in the 24 hours after delivery, allowing the achievement of the newborn autonomy, including motor, sensorial and cognitive processes. Early in life, these relationships are characterized by close proximity (Barber & Crowell-Davis, 1994; French, 1998), a common pattern of spatial distribution seen in draft mares with mule foals (Smith-Funk & Crowell- Davis, 1992), Welsh ponies (Crowell-Davis, 1986) and New Forest ponies (Tyler, 1972). In fact, problems in behaviors and in social interactions were reported in several *Ungulates* when newborns are separated from their mothers for two and a half hours after birth (Scott, 1945; Rossdale, 1968). In some species, such as the donkey, horse and wild boar, these interactions could continue beyond weaning, and are responsible for the social organization, while are uncommon in feral asses (Waring, 1970; McDonnell, 1998; French, 1998).

175 However, studies investigating the early maternal or neonatal normal behaviors must take into
176 consideration the physiologic characteristics of the process of foaling, from both the maternal and the
177 neonatal point of view. About 50 years ago, Rossdale (1967) reported some maternal and neonatal
178 physiologic parameters in horses, such as the gestational length, the duration of the second stage of
179 delivery in multiparous and primiparous mares, the time of delivery in recumbent position, the foals
180 time to stand. Those parameters provided the first reference data for normal parturition and neonatal
181 early physiology in the horse, followed by numerous papers that completed those reference data in
182 the subsequent decades.
183 Similar data in donkeys were lacking until about one decade ago, when donkey-related research was
184 performed and data about normal foaling and neonatal physiologic behaviors for the Martina Franca
185 donkey breed were provided (Carluccio et al., 2008; Veronesi et al., 2011; Panzani et al., 2012b;
186 Carluccio et al., 2015). The present study aimed to describe, for the first time, the behaviors of
187 Martina Franca donkey breed jenny-and-foal dyad in the first 24 hours after birth under normal
188 maternal and neonatal physiologic conditions.
189 In the present study, because all the 11 jennies and their 11 foals fulfilled the requirements for normal
190 pregnancy length, normal spontaneous, unassisted eutocic vaginal delivery, giving birth to mature,
191 healthy and viable foals (Carluccio et al., 2008; Veronesi et al., 2011; Panzani et al., 2012b;
192 Carluccio et al., 2015), data obtained from all the 11 dyads were analysed and reported. In detail,
193 when the foals physiologic characteristics are concerned, the time to stand up (62.3±25.7 min) was
194 superimposable with data previously reported (Carluccio et al., 2015) on a large number of subjects
195 (n=142) of Martina Franca donkey foals (61.2±38.4 min). These data were in agreement of those by
196 Rossdale et al. (1984) and Koterba (1990),and with the 62.4±42.63 min observed for the horse foals
197 by Panzani et al. (2012a). The time to first suck (87.1±29.15 min) was in agreement with the time
198 (101±40.8 min) previously reported for the same donkey breed by Carluccio et al. (2015). Data from
199 donkeys were similar to those reported for the horse foals (94.7±53.01) (Panzani et al., 2012a) and in
200 agreement with literature on horse foals (Rossdale et al., 1984, Koterba, 1990).

Although 11 jenny-and-foal dyads could seem a small number, it must be underlined that the Martina Franca donkey breed is an endangered population, so that 11 dyads can be considered a suitable and representative sample size, especially for a preliminary study.

As a first consideration, in the present study, all the births occurred during the night-time. This night synchrony is well known among ungulates (Estes, 1976), and has been supposed to be useful for maximizing the neonatal survival by reducing the risk of predation (Estes & Estes, 1979). The times for foals standing, walking and sucking observed in the present study agreed with the ranges reported for wild equids (Klingel & Klingel, 1966), suggesting that, in donkeys, domestication does not seem to have affected the foal's motor development in the neonatal period. In the Martina Franca breed this finding could be supposed to be also related to the characteristic environment, the Italian South East very rural area, in which this donkey breed was raised.

The dyad's behaviors were clustered into seven main categories.

Among them, significant differences were found between jennies and foals for all kind of reciprocal interactions, such as licking, lactation, grooming and touching, and dyad playing. When compared to horses and Welsh ponies (Crowell-Davis 1985), no differences in lactation behavior were observed during the first 24 hours after delivery.We do not know if there is a relationship between lactation reduction and aggression, previously described in horses (Crowell-Davis 1985). In jennies the interaction rate was higher than that forfoals, and it resulted the fourth most representative behavioral parameter (see Pareto analysis), remaining almost constant during the neonatal period. In foals, at this stage of development, the interaction rate was expressed slightly more during the night-time. This finding could probably reflect a behavior retained from the pre-domestication state. In fact, in the wild environment, night-time is highly risky for the newborn foal, and the interactions with mother contribute in providing safety to the foal, keeping it calm. Furthermore, equids, some bovine species, sheep and related genera, the musk ox and the caribou, are defined as '*follower*' species. Those species tend to be associated with grassland or tundra habitats. Usual '*follower*' species are characterized by great seasonal movements. In contrast to hiders species like cervids, gazelles, and

antelopes living in forested or bush habitats, that are characterized by infant isolating hiding behavior to avoid predation, the '*follower*' species do not display this ontogenetic phase. In the '*follower*' species, in fact, mothers and infants generally maintain close spatial relationships and frequent communication after delivery. In horses and ponies maternal bonding decreases with time because it reflects a different social structure herd-based (Tyler, 1972; Crowell-Davis, 1986; Barber & Crowell-Davis, 1994). The donkey's strategy provides defence against predation by maternal protection and allows extensive movements of mothers and infants groups during the early stages of infancy (Lent, 1974). Immediately after birth maternal licking increases the neuro-excitability of the foal, promoting rapid motor development. Thus, there may be a speculative association btween the range of cellular events, for instance neurogenesis, controlled in a time-of-day dependent fashion by the endogenous circadian clocks (Hastings et al., 2003). The lack of reciprocal interaction has been reported to affect the post parturient behavior when stillbirths occur in caribou (Lent, 1966), goats (van der Hammen & Schenk, 1963) and merino ewes. In those cases, the absence of the newborn stimulation leads the mothers to adopt the young of other mothers (Alexander, 1960).

The first neonatal activity seemed to be represented by the struggles of the foal to coordinate itself. The foal activities during the first 24 hours after birth were distinctive for the '*follower*' species (Lent, 1974). The activity rate was higher in foals than in jennies, both during night- and day-times. However, the present study analysis of data did not allow to represent the real circadian distribution of the activity rate of the foals. In the Pareto analysis, activity was found to be the third most represented behavior during day-time, and among the last ones during the night-time in foals, while in jennies it was almost constant during the first 24 hours after delivery. Hence, this interpretative bias must be taken into account when statistical results about the evaluation of '*vital few*' behaviors of foals during the first 24 hours of age are considered.

Resting, which includes all kind of static behaviors, was significantly higher in foals than in jennies during night-time, in agreement with the resting time-budgets of Welsh ponies' foals (Crowell-Davis, 1994). In ponies, in fact, foals were more likely to engage in recumbent rest than the adults, while

253 upright resting was not commonly observed in foals during their first days of life, which is typical of
254 adult behavior (Crowell-Davis, 1994). Increased resting in foals during the night-time is in
255 accordance with paradoxical sleep function maturation of the nervous system, as suggested by
256 Crowell-Davis (1994).
257 Furthermore, the lower resting behavior of jennies in the night-time could be related to the
258 requirement of foal protection. Olfaction, including smelling itself or the body of the counterpart,
259 smelling urine and feces, straw and environment, were significantly different within the dyad. In
260 jennies it was the second most represented behavior, while in foals it was the third at night- and the
261 fourth during the day-time. Interestingly, the olfactory behavior toward maternal feces was also
262 observed in horses, with foals able to discriminate between maternal or another females' feces
263 Crowell-Davis & Caudle, 1989). Those data are in agreement with the imprinting of the olfactory
264 mechanism. Within few minutes after delivery, jennies rapidly built a close bond with their foals, and
265 this time is usually referred as the 'critical period'. The maternal bonding, in mammals, is essentially
266 driven by olfactory cues; odours provide the basis for individual recognition, responsible for the deep
267 changes of the neural structures of the main olfactory bulb, involved in memorization and long-term
268 maternal experience (Klopfer et al., 1964, Lévy et al., 2004). Conversely, foals are considerably
269 slower in building a stable bond and in fixating their behavior on their mother (Lent, 1974). Foal
270 bonding to the jenny seems to be more opportunistic, and less linked to the olfactory cues (Leon,
271 1992; Moriceau & Sullivan, 2004).
272 The observing behavior, considered as watching itself or the counterpart and the surrounding
273 environment, was the highest rated in the dyad. Jennies displayed observing behavior more than
274 foals, in particular at night-time. This difference could be explained as the effect of the foal visual
275 stimulation on the jenny's condition of maternal awareness and activity. Moreover, this behavior was
276 considered as vital in the '*follower*' species, like the donkey, because it is used by jennies and foals to
277 maintain reciprocal responses and reinforce bonding. Visual recognition was reported to be used in
278 ungulates to identify the mother (Tschanz, 1962); although it is not clear whether this identification is

based on individual physical characteristics, or instead on the perception of specific maternal behavioral patterns (Schloeth, 1958).

The autogrooming rate, scratching and licking itself, showed no statistical differences within the dyad during the neonatal period. However, it was the second most represented behavior in foals, while in jennies it was the third during day-time and the fifth during night-time. This behavior in foals may help to develop body cognition, which could be useful for spatial orientation.

Excretion of urine and feces, interestingly, showed an inverted significantly different rate within the dyad: at night-time it was lower in foals, and higher in jennies. This finding could be explained by two different hypotheses: the reduction of odours release at night by the foals could decrease cues for predators, or it could be the simple consequence of decreased activity. According to the Pareto analysis, excretion was the third most represented behavior during night-time in jennies, and second to last during day-time. A speculative interpretation of this behavior could be related to the foal protection during night-time, when predators recognise preys by smelling. For this reason, an intense excretion activity and odours production by the mother could represent a defence mechanism based on the possibility to confound predators by covering the odours of the foal with the maternal ones. Conversely, the 24-hours periodicity has been reported to influence some parameters linked to urine formation, such as renal blood flow, glomerular filtration, tubular reabsorption, and tubular secretion. The origin of these rhythms has been attributed to reactive response to rest/activity and feeding/fasting cycles or circadian clock self-sustained mechanism, because renal excretory rhythms persist for long periods of time, even in the absence of periodic environmental cues (Firsov & Bonny, 2010).

In precocious '*follower*' mammals, motor, sensory and learning processes are rapidly set (Leuba, 1955; Lent, 1974). In the particular social structure of donkeys, the dyad represents the only one, and basic, social system. In this system, jennies provide maternal cares like nutrition, thermoregulation, passive immunity transfer and protection, as well as appropriate stimuli, education and socialization to their foals. This system was probably induced by predation, which has modelled maternal and

social behavior. Consequently, there must have been a strong selection for rapid development and frequent reinforcement of close jenny-to-foal contact within the dyad.

Conclusions

In conclusion, the description of the '*vital few*' donkey dyad behaviors in the neonatal period provides useful information to the behavioral studies of precocious '*follower*' species, making available first data for a future donkey ethogram description. The first behavioral base for the tight jenny-to her foal dyad bonding, pivotal for their long-lasting interaction as demonstrated in previous studies (French, 1998), was recorded. The depiction of the normal behavioral patterns is useful for the future early detection of abnormal behaviors in both mother and foal dyad components. Moreover, the assessment of foals' behavior in the first 24 hours after birth could be useful for selecting subjects for Animal Assisted Activity and Therapy.

At last, the tight bond between jenny-and-foal as soon as the first 24 hours after delivery could be also useful under an animal welfare perspective, reducing the stress of dyad's separation by postponing it, or developing focused specie-specific strategies.

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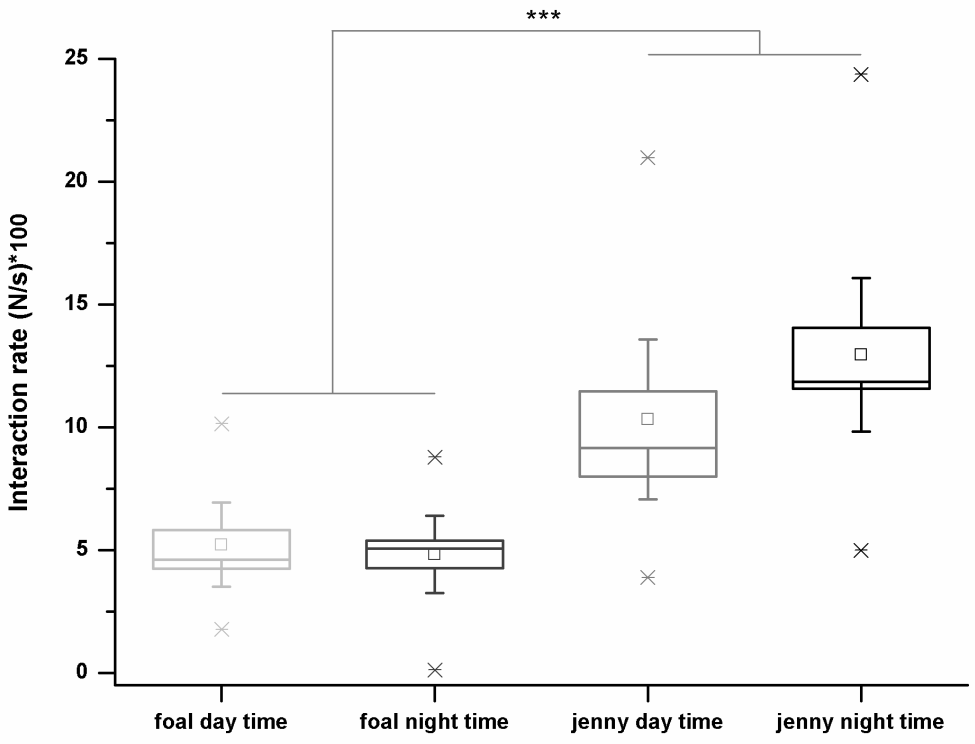

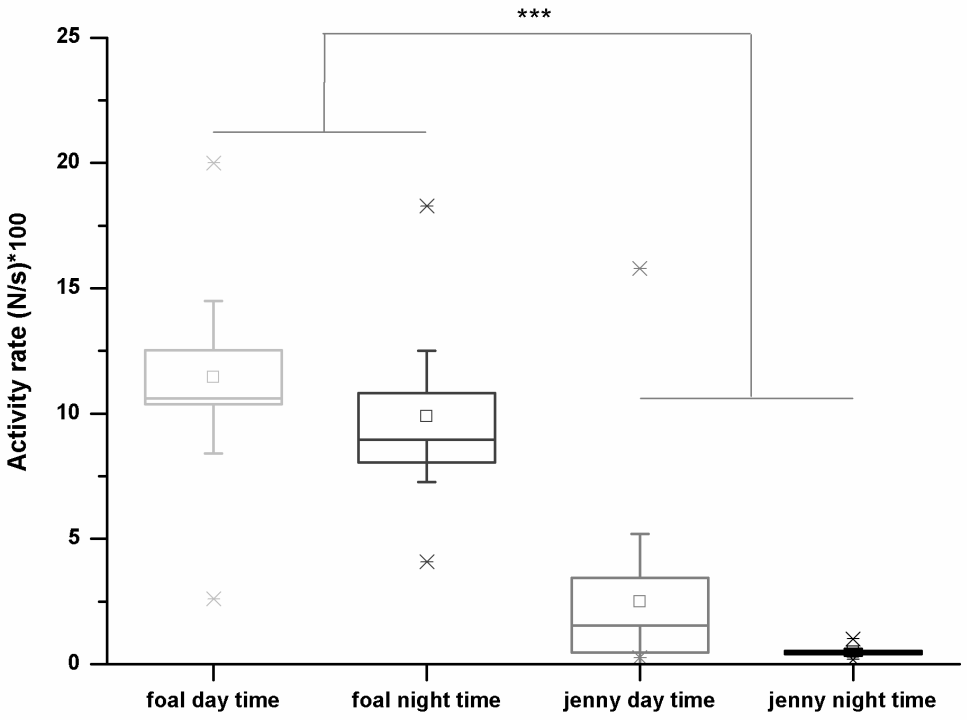

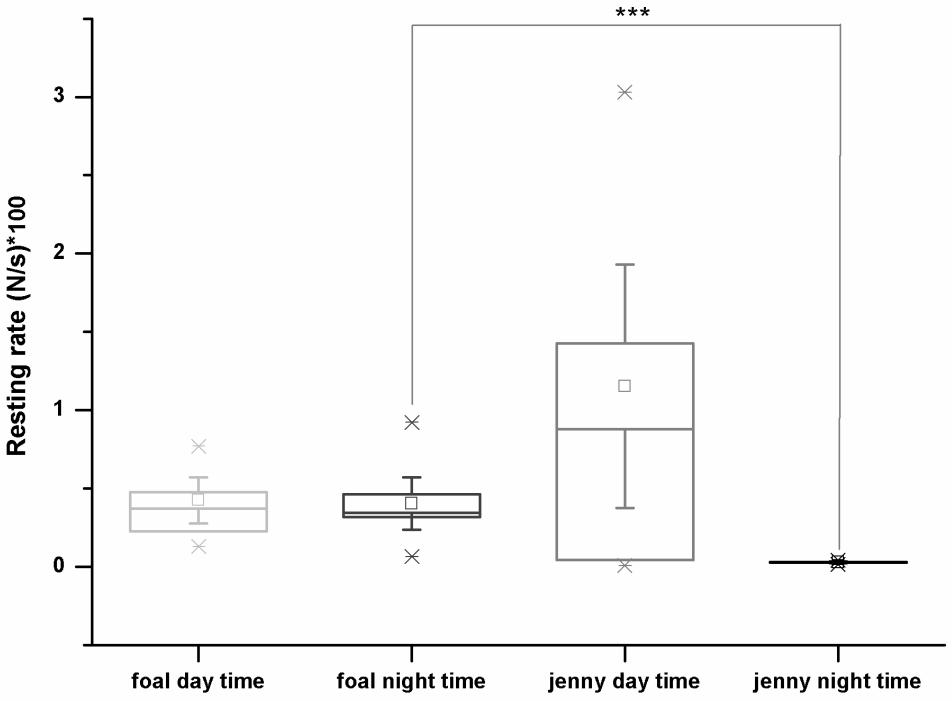

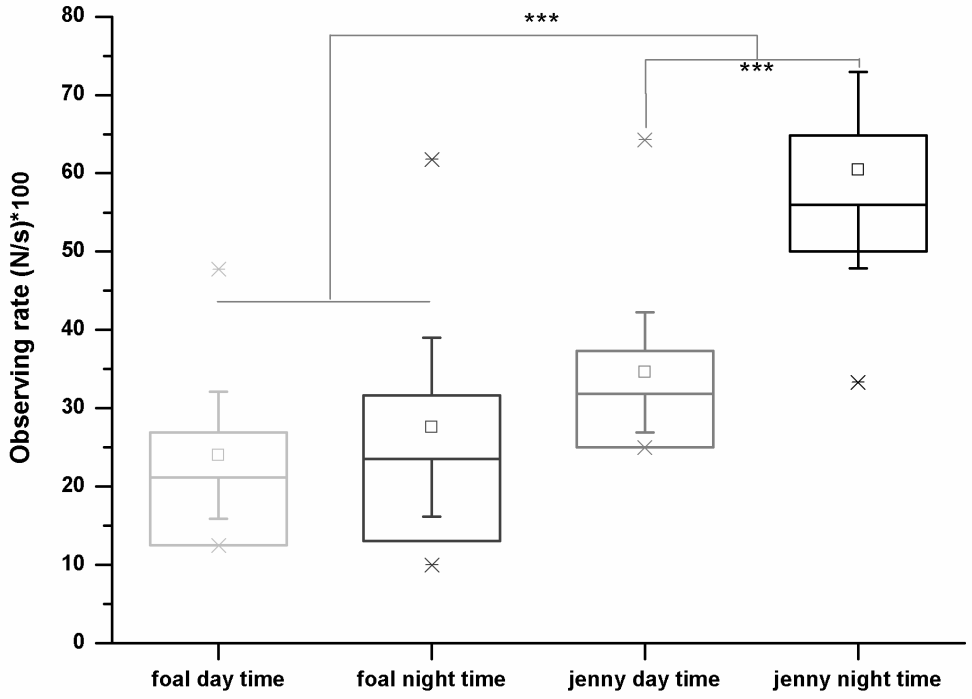

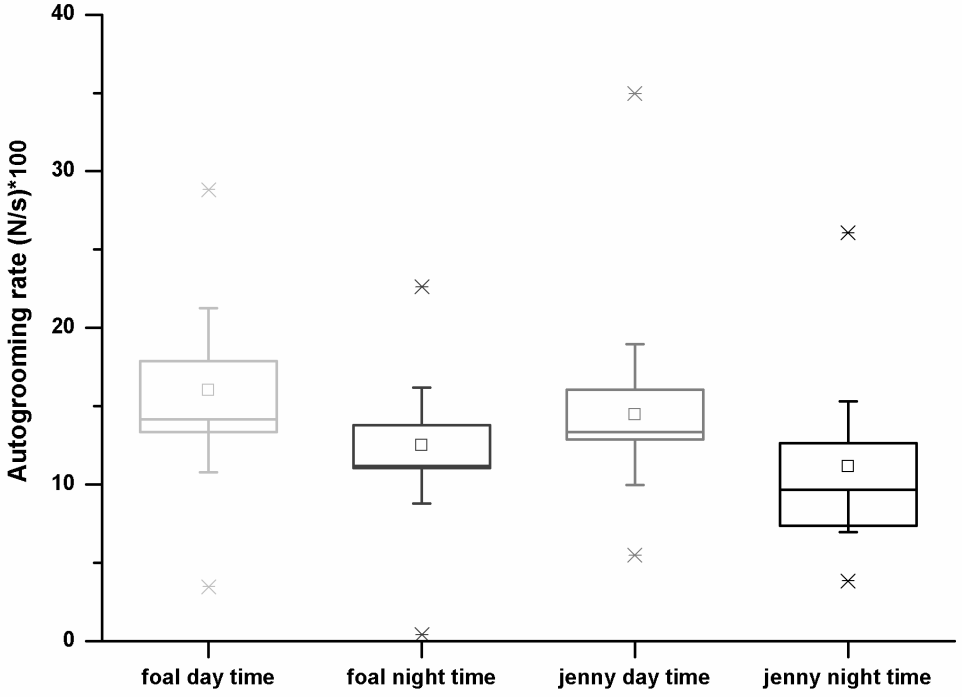

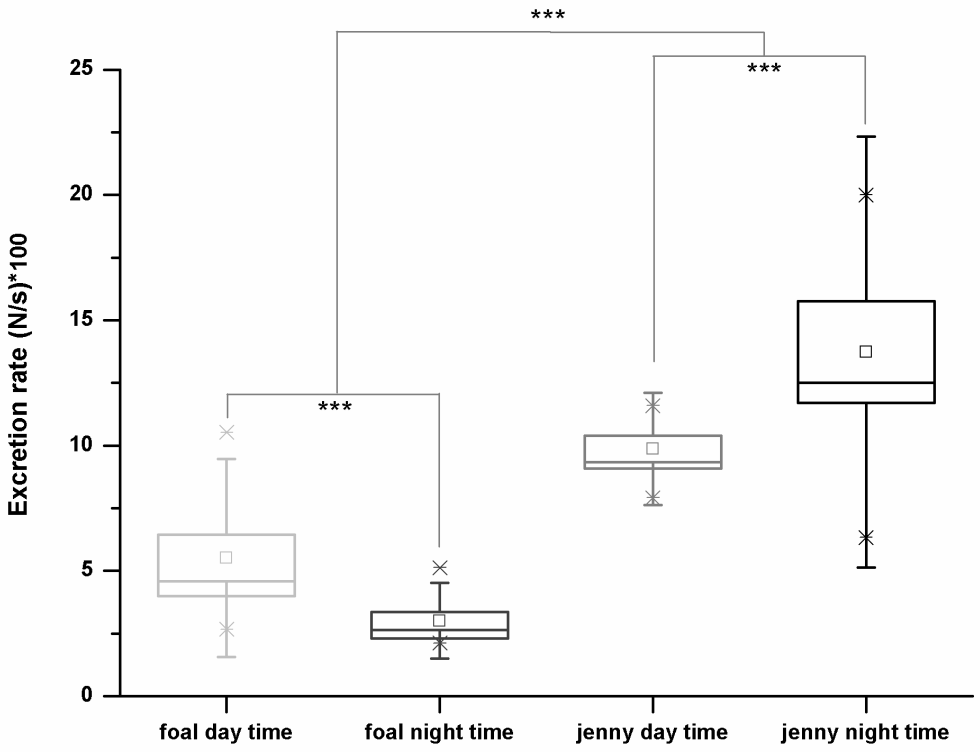

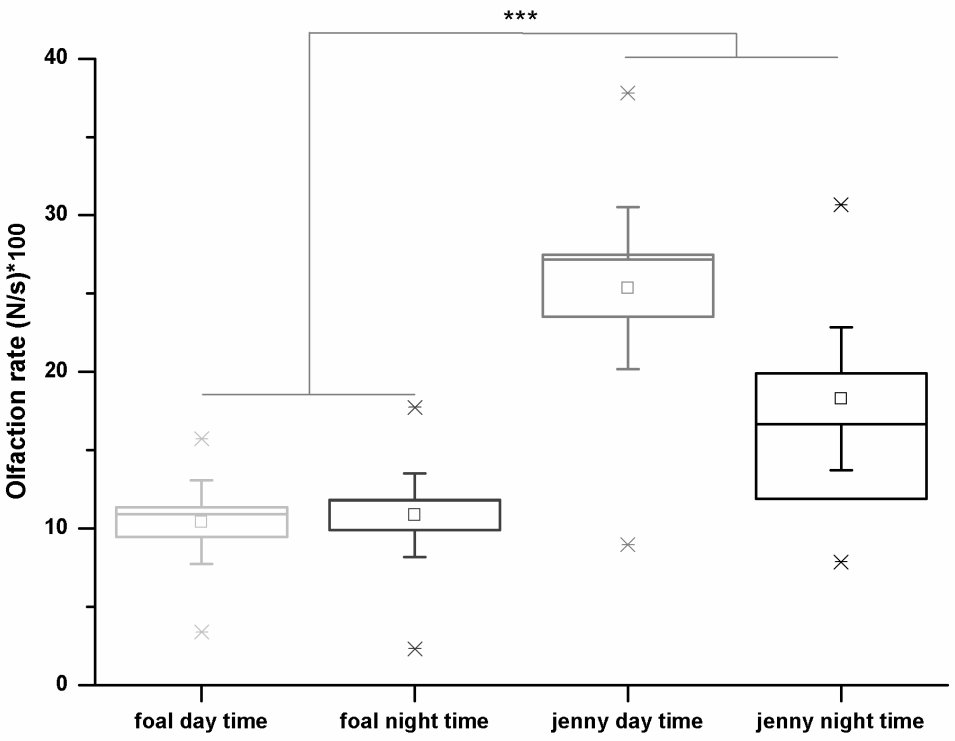

Fig. 1. Jenny-and-foal dyad. A selection of images describing some events and behaviours during the neonatal period (in the sequence from left to right: birth and placenta rupture; first sight; first stand up attempt with mother assistance; playing; jenny liking the foal; jenny smelling the foal; foal suckling).

Fig. 2. Interaction rate. It represents all social behaviours in the dyad, significantly ($p<0.001$) higher in jennies, in particular during night-time.

N: total number of events observed in the 24 hours of behavioural sampling; s: is the sum in seconds of the specific behavioral event duration along the 24 hours

Fig. 3. Activity rate. It is the rate of all movement, excluding the social ones, significantly higher in foals, mainly during day-time ($p<0.001$).

N: total number of events observed in the 24 hours of behavioural sampling; s: is the sum in seconds of the specific behavioral event duration along the 24 hours

Fig. 4. Resting rate. It embraces all static behaviours, almost constant in the dyad, excluding foal particularly inactive at night-time in comparison to jenny ($p<0.01$).

N: total number of events observed in the 24 hours of behavioural sampling; s: is the sum in seconds of the specific behavioral event duration along the 24 hours

Fig. 5. Olfaction rate. It includes smell itself, smell the counterpart, smell urine and faeces, straw and environment. It was higher in jennies ($p<0.001$).

N: total number of events observed in the 24 hours of behavioural sampling; s: is the sum in seconds of the specific behavioral event duration along the 24 hours

Fig. 6. Observing rate. This rate include watch itself or the counterpart, the surrounding environment, and it was higher in jennies ($p<0.001$).

N: total number of events observed in the 24 hours of behavioural sampling; s: is the sum in seconds of the specific behavioral event duration along the 24 hours

Fig. 7. Autogrooming rate. It is represented by scratch and licking itself. No statistical differences between jennies and foals were found.

N: total number of events observed in the 24 hours of behavioural sampling; s: is the sum in seconds of the specific behavioral event duration along the 24 hours

Fig. 8. Excretion rate. It was significantly lower in the foal ($p<0.001$), especially at night ($p<0.001$).

N: total number of events observed in the 24 hours of behavioural sampling; s: is the sum in seconds of the specific behavioral event duration along the 24 hours

Apo-natal (first 24 hours) behaviors of jennies and their foals are described.

Interaction, activity, resting, olfaction, observing, autogrooming, excretion studied.

Behavioral clusters were considered in both day- and night-time in jennies and foals.

Pareto analysis of '*vital few*', for foal and jenny during day- and night-time.

Differences between jennies and foals, and related to time of the day were found

The authors have no competing interests to declare.

No conflict of interest exist.

All the authors contributed equally to study design, data recording, results discussion and presentation and manuscript writing.