Applied Animal Behaviour Science 135 (2011) 110–120

Contents lists available at SciVerse ScienceDirect

Applied Animal Behaviour Science

journal homepage: www.elsevier.com/locate/applanim

# Two's company? Solitary vixens' motivations for seeking social contact

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ARTICLE INFO

*Article history:*
Accepted 4 October 2011
Available online 24 October 2011

*Keywords:*
Social behaviour
Fox
Motivation
Operant method
Aggression
Play

ABSTRACT

The flexible social organisation in red foxes (*Vulpes vulpes*) suggests that social contact could enrich the housing of silver fox vixens (a selected line of red foxes) farmed for their fur. To investigate their social motivation, adult vixens housed in an operant apparatus were allowed to pull a loop for full physical contact with a same-aged vixen. The access cost was increased daily and their maximum price paid (MPP) measured. Five test and five stimulus animals were pair housed long-term in separate apparatuses over 5 weeks in November/December wherein each pair could have 12 h daily physical contact in a shared compartment. Prior to the operant trials, two food competition tests were completed to establish dominance relations within pairs. To examine vixens' motives for contact, social behaviour during interaction was also recorded. Subsequently, the test foxes' MPP for a comparator resource, food, was also measured and their relative price paid (RPP, %) for contact calculated. When access to the resource cage was free (FR1), at the start and end of the experiment, time spent in contact averaged approximately 1/6 (2 h) of the available time; this was stable between these periods. Neither visit rate to nor time spent in the shared compartment differed between the start and the end of the trial, indicating that the test subjects' social motivation remained stable during the experimental period. The MPP (mean ± SE) for social contact averaged at 560 ± 160.6 pulls; this was significantly lower ($P = 0.015$) than the MPP for food (2108 ± 526.6 pulls), representing a RPP of 24.8 ± 3.36%. During social interaction agonistic gaping signals occurred (though never serious fights requiring intervention), but there were also bouts of play, social exploration and high levels of synchronous resting. Aggressive behaviour during the second food test predicted the levels of aggression during operant trials. RPP positively correlated with the total time spent together ($r = 0.87$, $P = 0.054$), and with the time spent resting together ($r = 0.89$, $P = 0.046$). Differences in RPPs for contact and levels of agonism between pairs illustrate that social contact between adult vixens is enriching for some, but may put welfare at risk for others, especially if they have no opportunity to retreat from aggression. However, levels of agonistic behaviour during, e.g. food competition tests may be a possible indicator of the compatibility between potential cage mates. Due to the low number of animals the result must now be replicated with further animals.



## 1. Introduction

Silver foxes (*Vulpes vulpes*) are kept commercially for their fur and are typically housed in wire mesh cages with access to gnawing objects, shelves and sometimes also nest

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doi:10.1016/j.applanim.2011.10.005

boxes. Adult vixens kept for breeding purposes are, except for the whelping season, housed singly throughout their entire lives. These traditions may be based on assumptions that farmed adult vixens have limited needs for social contact, especially since they are housed in transparent cages that allow visual, olfactory and auditory communication between conspecifics. Furthermore, full contact between adult vixens kept in connected cage systems can sometimes result in severe fights, due to, e.g. competition for social dominance, causing injuries and stress to the animals (Hovland et al., 2010). However, red fox vixens in the wild often live in social groups consisting of both related and unrelated females (Iossa et al., 2009), and here females' social interactions include amicable allo-grooming and play (Macdonald et al., 2004), although aggressive displays can still escalate into fights (White and Harris, 1994). The social dynamics within free-living groups of foxes depend on factors like food predictability and resource competition (e.g. Baker et al., 2000), as well as seasonal fluctuations in reproductive hormones (Harris and White, 1992). That red fox vixens can naturally establish positive social relations in female groups forms a basis for examining whether social contact could enrich the housing environment of farmed silver fox vixens. However, due to the variation in natural sociality – some red fox vixens live just with a male (Cavallini, 1996) – it is important to establish to what extent adult vixens are motivated for full social contact when housed in a farm environment, how variable this is, and what their motives are for seeking contact. If motivation for contact is low and/or motives for seeking contact are competitive and aggressive, we can infer that social contact would compromise welfare (e.g. Hovland et al., 2006). On the other hand, if motivations for contact are high and/or are followed by positive interactions such as play (Oliveira et al., 2010), mutual grooming (Feh and de Mazieres, 2003) or social resting (Van Loo et al., 2004) then we can infer that social contact would enhance welfare.

Strength of motivation is commonly examined by allowing animals to work for access to resources (Kirkden and Pajor, 2006; Jensen and Pedersen, 2008), for example, pushing weighted doors or performing learned operant responses like lever pressing. These resources may also include potential social partners (e.g. Holm et al., 2002; Patterson-Kane et al., 2002; Seaman et al., 2008). One measure of motivational strength is the maximum price paid (or 'reservation price'): the highest price the animal is willing to pay for a single visit to the resource (e.g. Mason et al., 2001; Kirkden et al., 2003). To calculate the relative importance of a resource food is sometimes used as a 'yardstick' or comparator resource (e.g. Pedersen et al., 2002). Using this approach, Hovland et al. (2008) examined the strength of social motivations in sub-adult female silver foxes using a 'closed-economy' operant apparatus in which animals were housed continuously and able to decide their own interaction time with conspecifics after paying an access fee that was increased daily until the maximum price was reached. In the present study, we modified the same set-up to measure the strength of social motivation in these vixens as adults, relative to their motivation for food. We also examined the vixens' motives for seeking social contact by recording in detail their agonistic and affiliative behaviours during interactions with the companion animal. Finally, we collected data to assess the stability of social responses over time, and the degree and causes of variation in social motivation between subjects.

## 2. Material and methods

### 2.1. Experimental animals, feeding and housing

Ten 3.5-year-old vixens originating from a standard commercial line participated in the study. They were randomly separated into five pairs that had had no previous physical contact. In the social operant test, five vixens acted as test subjects while the other five were companions or stimulus animals. All foxes had previously participated in a similar operant experiment as sub-adults/juveniles and details on their training as cubs is described in Hovland et al. (2008). Then, they were tested in different pairs from the ones they were placed in as adults. Prior to food competition tests (see below) and testing in the operant apparatus, vixens were housed singly in a traditional uninsulated fox house in a standard cage (1.20 m × 1.06 m × 0.76 m) made of plastic coated wire mesh with access to a nest box, resting shelf and wooden gnawing stick. Food (food paste for fur animals: Pelsdyrfôr Hamar AB) was provided *ad libitum* once daily and water was freely available from drinking nipples. During food competition tests each pair was housed inside one standard cage for as long as the test lasted (see Section 2.2); while during the operant testing they were housed continuously inside the apparatus.

### 2.2. Testing dominance relations: the food competition test

Since dominance relations may influence foxes' social preferences (Akre et al., 2010a,b), one goal was to investigate whether dominance relationships affected foxes' motivation to work for social contact. To assess dominance relations within each of the 5 pairs, food competition tests (Bakken, 1993) were completed before the onset of the operant experiment. This test consisted of a contest between two foxes over a restricted amount of food. Prior to testing, vixen pairs were housed in a single cage (1.20 m × 1.06 m × 0.76 m) with access to a food tray, drinking nipple and a resting shelf. In each pair, one fox was individually marked by removing a small amount of fur from the tail tip. Animals were fed *ad libitum* the first day but to ensure high feeding motivation they were starved the second and fourth day before the first (3rd day) and second (5th day) competition test. The food competition test was performed by one observer who positioned a small amount of food paste (100 g) on the food tray before withdrawing 2.5 m from the cage for the total test duration (1.5 min). The fox that defended and ate all the food was recorded as the winner and thence the dominant. Agonistic behaviour was also recorded by direct observation during the first day after pairing (6 × 20 min) and on the evening of the second day (3 × 20 min). The observer was visible to the animals and positioned outside the fox house, 5–7 m from their cages. Prior to the start of recordings there was a 5 min period for habituation to