



Social dominance and wheel running in females of Djungarian hamster (*Phodopus sungorus*)

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ABSTRACT

Wheel running is a behaviour that has a rewarding effect on animals. There are not numerous papers investigating potential relationships between social rank and wheel running in mammals kept in groups, and the majority of published researches were conducted on male house mice (*Mus musculus*). The aim of our study was to investigate if social dominance and wheel running are related in female Djungarian hamsters (*Phodopus sungorus*). Hamsters were kept in groups, and social position of every animal was expressed as dominance index calculated on the basis of agonistic behaviour. We found significant positive correlation between dominance index and wheel running ($r_s = 0.809$, $n = 18$, $P < 0.0001$), thus dominants used wheel more often than subordinates. Our results are consistent with those published on male mice. In conclusion, we claim that in majority of mammals (independent of their sex) kept in groups with restricted possibility of wheel running, dominants use wheel more often (or in optimal time) than subordinates, what is consistent with the fact that dominants have priority of access to resources.

KEYWORDS

rodent; activity; behavior; Syberian hamster; exercise.

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INTRODUCTION

Wheel running is a behaviour that is very often observed in captive rodents. Running-wheels are provided for both laboratory animals and those kept as pets in private homes. Moreover, wheel running was proved to be performed also by wild animals in nature (Meijer & Robbers 2014). Majority of the investigated mammals voluntarily perform this behaviour and they are highly motivated to do it (Sherwin 1998). Although wheel running is widely used in rodent studies, interpretations of this behaviour are controversial (e.g. Richter et al. 2014; Mason & Würbel 2016). Wheel running has rewarding effects on animals that are dependent on brain reward systems (Werme et al. 2002; Novak et al. 2012). Animals perform more wheel running after stress of different nature: social stress (Uchiumi et al. 2008) as well as foot shocks (Sibold et al. 2011). Wheel running can cause a decrease in the occurrence of stereotypies (e.g. Howerton et al. 2008). There are hundreds of papers published on wheel running and its connections with different aspects of

animals' physiology and behaviour, for example, brain activity (e.g. Rhodes et al. 2003), reproduction (e.g. Gebhard-Henrich et al. 2005) and open field activity (e.g. Bronikowski et al. 2001). However, papers investigating potential relationships between social position and wheel running in mammals kept in groups are not numerous (de Kock & Rohn 1971; Mondragón et al. 1987; Howerton et al. 2008; Vargas-Pérez et al. 2009; Howerton & Mench 2014). Majority of them were conducted solely on the same species, namely, different laboratory strains of house mouse (*Mus musculus*). Moreover, only male mice were studied as, in general, male animals are studied definitely more often in neuroscience (Beery & Zucker 2011). The aim of our study was to investigate if social dominance and wheel running are related in females of another small rodent often used as laboratory animal and kept as a pet: Djungarian hamster (*Phodopus sungorus*) (Pallas 1773). Our results indicated that running-wheel use in female hamsters was positively correlated with social rank.

1. MATERIALS AND METHODS

Randomly, 20 female Djungarian hamsters aged 3–4 weeks were bought at the animal market where animals for pet shops are sold. They were randomly divided into four groups (five hamsters per cage). To simulate pet hamsters' life conditions, all animals were kept in a private home at a temperature of about 23°C. Animals were fed with seeds, vegetable and fruits as well as protein rich food (e.g. cheese). Hamsters were fed once a day in afternoon, and water was always available for them. Dimensions of cages were: 36.5 × 25 × 38, 44.5 × 27.5 × 24, 36.5 × 25 × 20 and 44 × 27 × 35 cm. Sawdust was used as bedding, and all cages were equipped with one hamster wheel.

Animals were marked with nail polish to make it possible to individually recognise them.

Body weight was measured four times (every two weeks) during observations.

Observations were conducted from 14 December 2010 to 25 January 2011 by one person. For every group, 30 h of observation were carried out (0.5–4 h per group per day of observation). Continuous recording method and sampling all occurrences of some behaviour were applied (Altmann 1974). Occurrence of climbing, wheel running and agonistic encounters as well as their outcomes were noted by hand. On the basis of agonistic behaviour, dominance index was calculated for every individual using the following formula:

$$di = a/a + b$$

where

a = number of animals dominated by the given hamster

b = number of animals dominating over the given hamster.

Spearman rank correlation and partial correlation were used to evaluate the potential relationships between social status (dominance index), body weight and wheel running and climbing. Two specimens died before the end of observations, and data about the behaviour of these animals were not included in the analysis.

2. RESULTS

We found significant positive correlation between dominance index and wheel running ($r_s = 0.809$, $n = 18$, $P < 0.0001$; Fig. 1), it was still highly significant if body mass was controlled in partial correlation ($r = 0.754$, $df = 15$, $P < 0.0001$). However, to test how another kind of behaviour was related to dominance index, we also tested the correlation with climbing, and it was not statistically significant ($r_s = 0.207$, $n = 18$, $P = 0.41$).

3. DISCUSSION

De Kock and Rohn (1971) studied bank voles (*Clethrionomys glareolus*, presently referred rather as *Myodes glareolus*) and Norway lemmings (*Lemmus lemmus*) and stated that 'the lower the rank of animal the more it uses the wheel'. This statement is in striking contrast with later studies on domestic mice. Findings of de Kock and Rohn (1971) are very exceptional amongst the studies on wheel running not only because of statement on negative relation of social rank and wheel running but actually Sherwin (1989) listed them as one of the very few examples of reports on animals that do not use running-wheels when provided. Individually kept females in study by de Kock and Rohn (1971) used a wheel only when in oestrus and before parturition. It is unclear why wheels were not attractive for individually kept and dominant animals studied by de Kock and Rohn (1971).

Howerton et al. (2008) stated that after provision of running wheel-igloo, male house mice (CD-1) were more aggressive and social structure of groups were probably disrupted. Yet we do not know if wheel running was related to social status of mice.

Mondragón et al. (1987) observed that in one of the three investigated inbred strains (namely, C57Bl/6j) dominant male mice showed higher rates of wheel running activity than subordinate ones. Vargas-Pérez et al. (2009) studied groups of males of laboratory mice (Balb/c) and stated that dominants ran more than subordinates when only one wheel per group was provided but subordinates ran more if two wheels were available. Howerton and Mench (2014) found that aggression of male mice (C57BL/6J) increased as the mice-to-wheels ratio increased. Moreover, mice of higher competitive ability had species typical nocturnally biased activity and wheel running patterns, whilst individuals of lower competitive ability were more active and use wheels during light phase. Thus, animals losing in aggressive interactions used wheels in suboptimal photophase, possibly to avoid aggression. Former studies did not reveal temporal partitioning of running-wheel use. How-

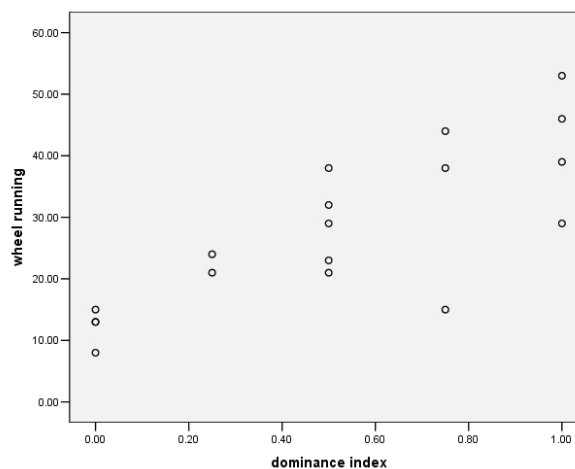


Figure 1. Social position (dominance index) and wheel running (number of entries to a wheel) in female Djungarian hamsters.

ever, all the above cited studies on male house mice demonstrated that animals compete for possibility of running.

Our results are consistent with observations mentioned earlier, and we provided data showing that also in another species of small rodents, namely, Djungarian hamster, social dominance can influence wheel running. The effects shown in our study are correlational, but we are convinced that calculated correlations reflected causal relationship. Such an interpretation can be based on published literature and knowledge on social dominance, especially in the context of its influence on wheel running. Our results are in agreement with the results of studies cited earlier. We also stated that dominants used wheel more than subordinates but social status had no effect on another form of exercise, climbing. Interestingly, Vargas-Pérez et al. (2009) wrote that 'it is possible [...] that wheel running is not reinforcing in hamsters'. It was a trial of interpretation of results by Davis et al. (1987) who stated that opposite sex Syrian hamsters (*Mesocricetus auratus*) kept in the same cage but separated by a wire mesh barrier did not synchronise their activity. Contrary to this suggestion, our results testify that wheel running is rewarding for Djungarian hamsters. Moreover, our data on female hamsters are in agreement with observations of male mice (Mondragón et al. 1987; Vargas-Pérez et al. 2009). In conclusion, we claim that as wheel running, in general, is rewarding for mammals, in majority of mammals (independent of their sex) kept in groups with restricted possibility of wheel



Figure 2. Wheel running

running, dominants use wheel more often (or in optimal time) than subordinates, what is consistent with the fact that dominants have priority of access to resources. More studies carried out on other mammalian (especially non-rodent) species would verify this suggestion.

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