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Short Communication: Rat's Demand for Group Size

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Social isolation compromises the welfare of rats. However, it is not clear how many rats should be housed together under laboratory conditions. Pair housing, sometimes recommended over group housing, may help avoid aggression and disease transmission. Female rats, however, showed the highest average demand for a group size of 6 (versus 1, 2, 4, and 12) when stocking density was maintained at 20 cm^2/rat. This finding contributes to work suggesting that rats should be group housed. This article shows that further studies are required into the actual risks of disease and injury associated with group versus pair housing.

Social housing of rats generally is found to have positive effects such as reduced fearfulness and improved cognitive abilities (Hatch, Wiberg, Balazs, & Grice, 1963; Hughes, 1969; Johnson, DeSisto, & Koenig, 1972; Morgan & Einon, 1975). There is some indication that groups of more than 2 and up to 12 animals may be beneficial (Brown, Down, & Wyatt, 1968; Patterson-Kane, Hunt, & Harper, 1999; Syme & Hughes, 1972), but this conclusion, drawn by comparing a number of disparate studies, requires replication. On the other hand, it is sometimes argued that groups larger than pairs experience higher incidences of disease and aggression (Lawlor, 2002). Also, rats in large groups sometimes show reduced weight gain (Lawlor, 1990).

These data were collected in an effort to clarify rats' preferences for social groups of different sizes. The rats' preference for 0, 1, 3, 5, or 11 cagemates was measured, with stocking density held constant. This was done using an economic demand procedure in which nonhuman animals were required to work a lever for

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access to cage options (Matthews & Laedwig, 1994; Patterson-Kane, Hunt, & Harper, 2002; Sherwin & Nicol, 1995).

It was expected that the rats would show the highest demand for 3 or 5 cagemates and lower demand for 0, 1, or 11, based on indirect evidence from Brown et al. (1968); Hurst, Barbard, Nevison, and West (1997); Lawlor (1990); and Syme and Hughes (1972). Such a finding would establish a basis for recommending group housing over isolation, pairs, or large groups and provide a basis for going on to investigate empirically the health risks that might be associated with group versus pair housing of rats in laboratories.

METHOD

Subjects

The data were collected from four subjects who experienced all of the conditions and six subjects who experienced the 0- and 3-rat conditions (Patterson-Kane, Hunt, & Harper, 2002). The addition of the 6-subject group did not alter significantly the shape of the relation between demand and group size. The advantage of including these rats (from another experiment) was that it substantially reduced the standard error of the mean for the data relating to these two conditions. The two subject groups were used concurrently, employing the same equipment and housing, allowing them to be considered as equivalent. All subjects were female Hooded Norway rats who were 1 year old at the beginning of the experiment. They were kept in 20 × 20 × 40 cm Macrolon cages with plastic bottoms containing aspen-chip (Nepco, Warrensburg, NY) and wire mesh tops (Lab Products Inc., Seaford, DE).

Rats were housed in pairs according to a daily rotation between two cages so that they were familiar (spent one third of their time) with each of three other animals. This was done to reduce aggression in the conditions with smaller floor areas and smaller group sizes. It was not practical to extend this precaution to conditions with 5 or 11 other rats, so these animals were encountered only during testing and were the same for all subjects.

Bedding was changed twice a week. The cages were in a colony room with an artificial 12-hr light/dark cycle with lights on at 7 p.m., a temperature of 22°C ± 3°C, and a relative humidity of approximately 50%. During the whole period, the subjects had access to tap water and food pellets (Lab Diet 5001, PMI Nutrition International, Inc., Brentwood, MO) ad libitum.

Apparatus

A Commodore PC–10 computer with Pascal software was used to schedule experimental effects. The computer was connected by a custom-built interface to a small response chamber containing one lever and one light. The light, above the lever, was lit only when further lever presses were required to open the door. The response chamber was joined by a 20 × 20 × 45 cm wooden tunnel to a cage containing the resource being assessed. The tunnel was bisected by a cantilevered door, which opened when the rats pressed the lever the required number of times. At the end of the tunnel, a pressure plate operated a switch that began a timer and immediately reclosed the door to prevent access back to the response chamber until 5 minutes had elapsed.

Procedure

Rats were tested in 90-minute daily sessions. Initially, the rats were trained to press the lever and traverse the tunnel. Chocolate chips were used as rewards. For each condition, completion of the required number of lever presses opened the door and gave the rat access to the resource, presented in an otherwise standard cage. For the first two sessions, one lever press was sufficient to open the door to the other cage. The lever-pressing requirement was then increased by 10 lever presses each session until a session occurred in which the requirement was not completed (and access to the cage not obtained within the 90-minute session). The procedure was repeated from the beginning with another group size. The subjects were tested three times with each social group size (0, 1, 3, 5, and 11; 15 times in total).

The rats' lever presses per session were plotted versus the lever presses required (price) for that session, and the data points had a line fitted to them (Hursh, Raslear, Shurtleff, Bauman, & Simmons, 1988). Thus, three demand curves were generated for each rat, for each group's size. Lines were fitted using Sigmaplot software (SYSTAT, 2004) and the data were analyzed using SPSS (Version 13). Given that the rats worked until they reached a price where no responses were made, the relationship between response rate and price was always found to be curved (ending at a response rate of zero). The rats' "demand" for each group size was defined as their median *pmax* (Hursh, 1991) from these three demand curves. *Pmax* is the point in which the relationship between responses made and rewards earned has a slope of –1 and is equivalent to reporting the elasticity of straight-line data (Hursh, 1991).

RESULTS

Figure 1 shows the mean demand of the rats for a cage holding varying numbers of rats at a constant stocking density of one rat per 20 cm^2 of floor area. Demand was the highest for five cagemates (a group size of 6). For group sizes of 0 to 6 there is a positive linear correlation between group size and demand (linear regression, $p < .05$, $R^2 = 0.15$). When the group size of 12 is taken into account,

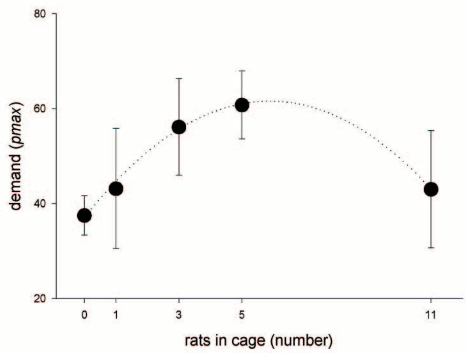

FIGURE 1 Demand for a cage (*pmax*) as a function of the number of rats in the cage (*M* and *SE*). The dotted line shows a quadratic regression.

the relationship between group size and demand is curvilinear with a peak at a group size value of 5.9 (quadratic regression, $p < .05$, $R^2 = 0.15$).

DISCUSSION

We found that rats showed the highest demand for access to a small group of rats. In this case, this equated to a peak demand for 5 rats (vs. 0, 1, 3, or 11). The limited number of options used here does not allow us to determine confidently the optimum group size but does suggest that it would be greater than 2 and lower than 12. Further studies using a wider range of group sizes would help clarify this point.

Although the disadvantages of isolated housing of rats are widely known (Patterson-Kane, Harper, & Hunt, 2001; Renner & Rosenzweig, 1987), few comparisons have been made between groups of various sizes (pairs vs. larger groups).

It may be that some psychological advantages are conferred by living in rather large groups. Rats housed in groups of 12 were found to be less fearful and better maze runners than those housed in groups of 1, 2, or 4 (Patterson-Kane et al., 1999). However, housing in small groups produces better growth rates and lower mortality (groups of 3, Brown et. al., 1968; groups of 5, Syme & Hughes, 1972).

The deleterious effects of large group sizes reported by Lawlor (1990) are linked to the higher stocking densities for these conditions. To investigate the effects of group size on welfare, a controlled study would need to be carried out, with consideration of the roles of many other variables, such as sex and cage design. A useful first step might be to investigate the growth rates and health of rats raised in laboratories and breeding facilities that employ group, pair, or single housing of their stock.

It must be remembered that this experiment used a small number of female animals during 90-min sessions. The advantages of group housing are highly likely to depend on sex, strain, frequency of mixing, housing, and handling conditions—they certainly cannot be treated as a welfare panacea. However, the data to date seem most consistent with a recommendation to house rats in small groups of approximately three to six animals and to monitor these groups for aggression and disease.

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