RATS DEMAND SOCIAL CONTACT

E G Patterson-Kane*, M Hunt and D Harper

* Animal Welfare Program, Faculty of Agricultural Science, University of British Columbia, 2357 Main Mall, Vancouver, BC, V6T 1Z4, Canada

* Contact for correspondence and requests for reprints: rattitude@angelfire.com

Abstract *Animal Welfare 2002, **11**:* 327-332

There is some evidence that rats benefit from social housing and from some forms of environmental enrichment, such as platforms and shelters. It is less clear whether they benefit from more spacious cages. There is a lack of information about the relative benefits of social contact, enrichment and increased space, because existing studies tend to concentrate on only one of these variables at a time. The current experiment used economic demand procedures as a method to compare, on a single scale, qualitatively different environments with a standard home cage. The data indicate that rats show a high demand for social contact, and a low demand for a larger cage or one containing pillars or novel objects. This finding suggests that social housing of laboratory rats should be strongly advocated.

Keywords: *animal welfare, caging, demand, enrichment, rats, social contact*

Introduction

Rat cages can be made more complex in order to allow rats to behave more naturally and to confer a wide range of physical and behavioural advantages (as reviewed by Renner & Rosenzweig 1987). Complexity is generally introduced in one of three ways: group housing, environmental enrichment, and larger enclosures. Group housing of rats is beneficial to their welfare in that it renders them less fearful (Hughes 1969) and less aggressive (Johnson *et al* 1972); furthermore, they are more normal in terms of their responses to a range of environmental and chemical challenges (eg Hatch *et al* 1963; Morgan & Einon 1975). Non-breeding rats are best housed in stable groups of three to six animals (Brown *et al* 1968; Syme & Hughes 1972). In terms of their caging, rats prefer some sort of opaque division such as a wall, platform or box (Anzaldo *et al* 1994; Bradshaw & Poling 1991; Denny 1975; Townsend 1997). They also prefer access to small novel objects such as wooden blocks with holes drilled in them (Chmiel & Noonan 1996), but are indifferent to many other objects (Chmiel & Noonan 1996; Bradshaw & Poling 1991; Patterson-Kane *et al* 2001).

The issue of the best size of cages for rats has not been properly addressed. American laws and guidelines tend to require that rats have sufficient room to move freely, but this is generally taken to mean only that they should be able to lie, rear and turn around (Lawlor 1990). Enrichment researchers such as Chamove (1989) tend to assume that increasing cage size will normally benefit the captive animal, but whether this is the case with rats has yet to be clearly demonstrated. A person attempting to improve the environment for their rats has a range of options, some with more supporting evidence than others. However, they have no way of comparing between these difference sources of enrichment, as each experiment reported to date covers only one of three main options. The current experiment assesses a number of possible cage improvements: social contact (access to three familiar rats);

environmental enrichment (a cage with four fixed wooden pillars or a cage containing small novel objects); and a larger area (a double-sized cage). Economic demand theory (Hursh 1980) is used to quantify the degree to which rats value access to each of these four cage types as well as their demand for a standard home-cage.

Demand procedures involve making access to a resource contingent upon a specific work response (eg pressing a lever) and then determining how many responses the animal will make in order to gain access to the resource (ie how hard the animal is motivated to work). This basic procedure dates from studies in the early 1970s (eg Hogan *et al* 1970; Roper 1973) and can be analysed using economic theory (Lea 1978; Hursh 1980, 1984). A few laboratories have attempted to apply demand theory to animal welfare questions (eg Matthews 1994; Matthews & Ladewig 1994; Matthews *et al* 1995; Sherwin 1996; Sherwin & Nicol 1995, 1997, 1998), and their approaches are easily modified for use with rats.

The assumption is that options for which the rats will work hardest are those options that would most improve their home-cage environment. This experiment should help to focus the limited resources of animal caregivers and animal welfare researchers onto the enrichment options that rats value most.

Materials and methods

Subjects

The subjects were six female Hooded Norway rats that were 90 days old at the beginning of the experiment. They were kept in 40 × 20 × 20 cm (l × w × h) Macrolon cages with a plastic bottom containing aspen chip (Nepco, Warrensburg, NY, USA) and a wire-mesh top (Lab Products Inc, Seaford, Delaware, USA). Rats were housed in pairs according to a daily rotation so that they were familiar with three other animals (one adjacent pair). Cages were changed twice a week. The cages were in a colony room with an artificial 12 h light–dark cycle with lights on at 1900h, a temperature of 22 ± 3°C, and a relative humidity of approximately 50%. During the whole period, the subjects had *ad libitum* access to tap water and food pellets (Lab Diet 5001, PMI Nutrition International Inc, Brentwood, MO, USA).

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, which was above the lever, was illuminated when further lever presses were required to open the door, and dark at all other times. The response chamber was joined by a 45 × 20 × 20 cm (l × w × h) wooden tunnel to a cage containing the resource being assessed. The tunnel was bisected by a cantilever door, which opened when the rat had pressed the lever the required number of times. At the end of the tunnel a pressure plate operated a switch, which initiated a 5 min timer and immediately re-closed the door to prevent access back to the response chamber.

The cage types offered were based on the standard dimension of traditional environmental enrichment as provided by 32 existing studies (summarised in Patterson-Kane *et al* 1999). These were: contact with other rats; increased floor area; and the two main types of environmental enrichment — novel objects, and fixed cage furniture. The increased floor area was a doubling in cage size accomplished by joining two standard cages together at the longest side. The novel objects were drawn from a set of items including equipment, toys and stationary items, and were changed at the beginning of each session. The fixed cage furniture comprised four wooden pillars that were 5 × 5 cm wide and deep; one was 5 cm high, two were 10 cm high and one 15 cm high. The pillars were glued to the cage floor and painted black. The final condition was a standard home cage.

Procedure

Rats were tested in 90 min daily sessions. During each session, access to one type of enriched cage was provided. The number of lever presses required to open the door and access that cage was stable during the session, and increased between sessions until the rat failed to make enough lever responses to enter the enriched cage. The price would then reduce to one lever press and a different enrichment condition would be provided. In this manner, each rat's response was tested for each enrichment condition on three separate occasions. The order in which the enrichments were presented was randomised across subjects.

The rats were initially trained to lever press and traverse the tunnel, using chocolate chips 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 in each session, until a session occurred in which the requirement was not completed (and access to the cage not obtained within the 90 min session). The procedure was then repeated from the beginning with another cage type.

For subjects 1–3, the price for accessing the cage went up by two lever presses per session and the subjects were tested twice with each cage option (ten times in total). For subjects 4–6, the price was increased in steps of ten in order to investigate whether these larger increments were a valid way of shortening the data-collection process. Because of the time saved by larger price increments, these subjects were tested three times with each cage option (fifteen times in total).

Analysis

The crucial datum in a demand procedure is the highest price a rat will pay for a cage option before giving up. This is quantified as the session when the rats' responding does not increase proportionally to the increased response requirement, and therefore their access to the enriched cage is reduced. If $\log_{10}$ response requirement is plotted on the x-axis of a figure, $\log_{10}$ trips to the cage (per session) plotted on the y-axis, and a line fitted to the data (as in Hursh *et al* 1988), the maximum price paid is the point at which the line has a slope of –1 (called 'pmax'; Hursh 1991).

Results

Although the subjects experienced slightly different procedures in that one group had a response requirement that increased by two lever presses per session and one group experienced increments of ten, this variation had no noticeable effect on the animals' absolute or relative levels of demand, and so the data sets were combined.

Subjects 1–3 (experiencing price increments of two) tended to give up responding very suddenly as the response requirement increased, and so the –1 point could easily be read by eye as occurring between one price and the next. For this reason, and because fitted lines did not adequately describe these data, these subjects' demand levels were best quantified as the highest response cost where the animal still earned at least one trip to the other cage. This provided two data points, the mean of which was used to represent each subject's level of demand for each cage type.

Subjects 4–6 (experiencing price increments of 10) showed a more gradual decrease in response rate with price. For this group, a line was fitted to the data to determine the point where the slope was equal to –1. This procedure is outlined in Hursh (1991), where that point is referred to as 'pmax'. This provided three data points, the median of which was used to represent each of these subject's levels of demand for each cage type.

Figure 1 summarises the demand shown by the rats for each of the cage types. The first bar indicates that demand for a standard home cage averages 41 lever presses. This represents the value of escaping the small, barren chamber housing the lever and exploring the cage option, even if it is no better than the home cage in which they spend 22 h per day. The second bar shows that the rats made an average of 73 lever presses if the cage contained three familiar rats. The rats worked significantly harder for a cage containing other rats than they did for an empty home cage (Wilcoxon signed-ranks test, $z = -1.992$; $P < 0.05$), and the cage containing other rats was the option that five out of the six rats worked hardest to obtain access to. Demand for the other cage types (the larger cage or the cages containing objects or pillars) was no higher than that for the standard home cage (Wilcoxon signed-ranks test, $z = -0.105, -0.105, -0.406$, respectively; $P > 0.05$).

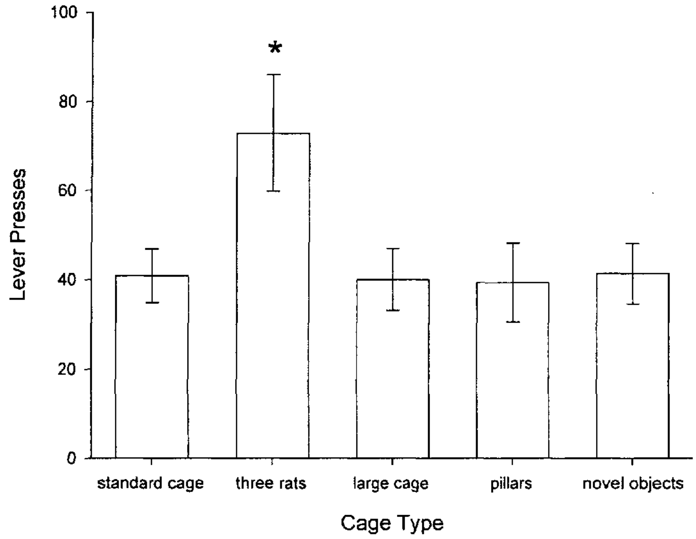

Figure 1 **Maximum number of lever presses made, expressed as a function of the type of cage to which lever pressing gave access. The data are means and standard errors for six rats. The rats were significantly (*$P < 0.05$) more motivated to work for access to a cage containing three rats than they were for access to an empty home cage.**

Discussion

The rats showed demand for extra space, novel objects and pillars that was not consistently higher than their demand for a standard home cage. They showed demand for contact with a group of familiar rats that was significantly higher than their demand for the standard home cage. This result suggests that social contact may be the most important environmental factor for rats, and that social enrichment should be explored in preference to the use of 'toys' or the provision of larger cages.

This recommendation for increased social contact is still tentative in the light of a number of possible objections. The increased space and novel objects used here may not have been particularly effective examples. For example, the space provided was an open area with a square floor surface. It is well documented that rats avoid open spaces and prefer space that is narrow or complex (as discussed in Bantin & Sanders 1989). They might, therefore, show a stronger demand for extra space if it were presented in the form of extra cage length rather than cubic space. The objects provided were novel and supported investigation, but had no other functional relevance to the rat. This lack of functionality may have limited their effectiveness. Preference data (Bradshaw & Poling 1991; Chmiel & Noonan 1996; Patterson-Kane *et al* 2001) suggest that rats are indifferent to the vast majority of 'toy' objects that researchers have thought to provide, and prefer only a few specific types suitable for use as nesting or gnawing substrates.

Although the current experiment suggests that social contact is important for rats, it does not indicate what group size would be optimal. Rats seem to grow and survive best when housed in small stable groups of three (Brown *et al* 1968) to six (Syme & Hughes 1972).

Finally, it must also be kept in mind that although the data for each rat are extensive (collected daily for over a year) there are marked differences between rats, and only six individuals of one strain and sex are used here. It is likely that not all rats would benefit uniformly from social enrichment, even if it were beneficial on average. Subject number 4, for example, showed low levels of demand for social contact (31 lever presses, when she would do 35 lever presses for a standard home cage). The reason that this subject showed low social demand is not currently known, but may relate to social dominance.

The data collected using price increments of 10 did not differ from those collected using increments of two in terms of demand levels detected, and data can be collected more rapidly with larger increments. Measurement increments of 10 result in a more gradual change in demand across sessions, but demand levels can still be determined easily using Hursh's (1991) formulation for pmax.

Conclusions and animal welfare implications

In conclusion, most of the rats in this experiment showed a persistent demand for social contact but not for physical cage improvements. These data suggest that social enrichment should be given the highest priority as a source of environmental enrichment for laboratory rats.

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