Preference of laboratory rats for potentially enriching stimulus objects

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Summary

In an effort to identify suitable stimulus objects which could be placed into standard laboratory cages in order to provide rats with a degree of environmental enrichment, the preference of rats to spend time near 15 diverse objects was measured in a free-choice paradigm. Rats showed no preference for objects such as pipes and partitions which we had reasoned might satisfy a wall-hugging tendency. They also showed no preference for objects which we had reasoned to be potentially interesting as manipulanda. The rats did show reliable preferences for spending time with some, but not all, chewable objects. A block of wood predrilled with holes was the most attractive, and we cautiously recommend that researchers consider providing laboratory rats with such an object to allow them the opportunity to exercise a fundamental, species-typical behaviour—chewing.

Keywords Enrichment, preference, manipulanda, chewing, rat, welfare

The welfare of animals caged as subjects in research laboratories has been given considerable recent attention (Murphy *et al.* 1991). It has been argued that when animals are used in research, steps should be taken to maximize their well-being within the limits imposed by experimental design (Guttman *et al.* 1989). Objection has been raised to the common practice of housing animals in nearly-featureless, box-shaped cages, because such conditions provide animals with little or no opportunity for mental stimulation or for the exercise of species-specific behaviours (Wemelsfelder 1984). Thus, there has been a growing interest in the testing of various aspects of cage environments (e.g. Arnold & Estep 1994, Blom *et al.* 1993, van Rooijen 1984), and the development of stimulus objects which can be placed into cages with research subjects so that they are provided with an element of environmental enrichment (e.g. Huls *et al.* 1991).

To date, this effort has primarily focused on improving the conditions of primates (e.g. Lambeth & Bloomsmith 1992, Reinhardt & Smith 1988, Ross & Everitt 1988), both because of the focus of animal-welfare advocates on these animals and because they are among the more intelligent and cerebrally more complex animals which are utilized in research (Bramblett 1989). It is rodents, however, that make up the majority of mammals and their welfare should also be addressed. Millions of laboratory rats are used in research projects and the scientific objectives would not be affected if the housing conditions of the subjects were altered to allow for a degree of behavioural enrichment.

In our experience, researchers are generally concerned with the welfare of their research subjects, and are open to the possibility of taking steps to improve the housing conditions of their animals (Adams 1981, Guttman 1990). Given the large investment which most scientific institutions have in their

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stocks of standard laboratory rat cages, and the general utility which such cages provide, it is worth exploring whether conditions can be improved within the existing framework. At issue is whether objects could be placed into standard laboratory rat cages to provide enrichment for the animals. Such objects would have to be safe, economical, easily cleaned, and, most importantly, suitable to the purpose. That is, it would need to be 'species appropriate' (Line 1987) and engage the rat in one or more beneficial ways (e.g. by evoking exploratory behaviour, by evoking natural behaviours, by providing mental stimulation).

Using the logic that, when given a choice, an animal will choose conditions which optimize its comfort level (Dawkins 1980), we tested our subjects individually in 2 adjoining cages with various test objects confined to one of the 2 cages. Each animal was free to move between the 2 cages so that it had the opportunity to choose to be with, or away from, a given object. The amount of time that each rat spent with a given stimulus was taken as its preference for that object; that is, the object's desirability from the rat's perspective.

Method

Apparatus

The test enclosures were constructed by bolting 2 suspended-type laboratory-rat cages (41 × 25 × 19 cm each) to each other on their rear vertical walls. The rear and side walls of these cages were made of sheet metal, the bottoms and fronts were made of wire mesh, and the tops (constructed for this experiment) were made of transparent Plexiglas. A 7 cm diam. hole was cut through the adjacent rear walls of the adjoining cages to provide opportunity for the rat to move freely from one to the other. Fresh water and rat chow (Agway brand Prolab Rat Diet) were provided *ad libitum* through food hoppers and water bottles attached to both of these adjoining cages. The joined cages were suspended above a standard litter tray on a framework which allowed them to tip slightly toward one or the other side as the rat moved from one cage to the other. Micro-switches mounted on the framework opened and closed with each tip of the cage structure, and their output was fed to a computer which continuously recorded the amount of time each side of the enclosure was tipped down.

Subjects

The subjects were male Long-Evans rats weighing between 476 and 750 g. (Heavy adult male rats were used to ensure positive cage tipping when the rat moved back and forth.) Prior to this investigation, the subjects had been housed individually in standard 41 × 25 × 19 cm suspended-wire cages. Ten rats were tested for each stimulus object in 2 cohorts of 5 rats simultaneously undergoing identical tests in 5 test enclosures. The same 10 rats were tested on all stimulus objects, except that one of the rats in the second cohort became ill and was replaced part way through the testing sequence. Except during the bright-light test described below, the rats were housed on a 12:12 white:red light cycle. Ambient room temperature was maintained throughout the study at 22 °C.

Procedure

Fifteen objects were tested and they are listed in Table 1 in the order in which they were presented to the first cohort. The objects were chosen because they were reasoned to satisfy one or more of the following criteria: (a) potentially interesting as manipulanda, (b) potentially satisfying to a wall-hugging ('thigmotaxic') tendency, (c) potentially suitable for chewing. In addition, taking advantage of the well known tendency for rats to avoid bright lights (or conversely, the preference of rats for dark enclosures), to assure ourselves that our apparatus reliably measured rats' preferences, we also tested the presence of a bright light above one of the two adjoining cages. Each stimulus was tested over an 8-day period in which the object was placed on one side of the enclosure for the first 4 days and then moved to the other side of the enclosure for the remaining 4 days. Each 8-day testing period immediately followed the preceding one without pause. The

Table 1 Stimulus objects and F statistic associated with side of object

Stimulus objects	Description	Order for 2nd cohort	F(df)	p
Wooden block	9 × 9 × 2 cm block (spruce[1])	1	0.94 (1,8)	ns
Plumbing fixture	PVC Y-shaped, 6 cm diam. tunnel; 13 × 11 cm	8	0.64 (1,8)	ns
White light	25 watt bulb above cage	3	122.12 (1,8)	0.0001
Large soup can	17.7 cm long, 10.4 cm diam. steel can; open at one end	12	4.30 (1,8)	ns (0.072)
Metal walls	9 cm high, L-shaped walls, 16.5 cm × 8.5 cm	5	0.0 (1,8)	ns
Golf ball	4.5 cm diam.	11	5.86 (1,8)	0.042
Two acrylic balls	2.5 cm diam.	16	1.14 (1,8)	ns
Two acrylic blocks	2.5 cm sq.	15	3.81 (1,8)	ns (0.087)
Sandwiched mango pit	dried seed wrapped tightly in wire mesh 0.3 cm openings	13	1.20 (1,7)	ns
Small soup can	11 cm long, 7.7 cm diam. steel can; open at both ends	2	1.79 (1,8)	ns
Bone-shaped rawhide	7 cm long (Hartz brand 'chews') tied to cage floor with copper wire	4	0.30 (1,8)	ns
Wood block with holes	6.2 cm sq. block (fir[1]); 2 cm hole in each face	14	6.66 (1,8)	0.033
Caged peach pit	dried seed loosely held in wire mesh cube 4.5 cm on each side; 1.2 cm openings	7	1.88 (1,8)	ns
Large wood ball	7.6 cm diam. smooth wooden ball (birch[1])	6	0.38 (1,8)	ns
Wood dowel	17.5 × 2.4 cm dowel (ramen[1])	10	0.33 (1,8)	ns
Small wood ball	4.5 cm diam. smooth wooden ball (birch[1]) tied by copper wire to cage floor	9	21.30 (1,8)	0.002

[1]Information on types of wood was provided by our suppliers and is presented here with only partial confidence

side receiving the object first was the same for each rat in a cohort and was counterbalanced between cohorts. The total time spent on one side of the apparatus was recorded for each 4-day period, and served as the dependent variable in a 1-between (cohort), 1-within (side of stimulus) analysis of variance conducted separately for each stimulus object. That is, a repeated-measures ANOVA was used to compare the amount of time spent on a given side when the stimulus was present on that side with the amount of time spent on the same side when the object had been moved to the opposite side.

Results

There were no significant differences between the 2 cohorts for any of the stimuli tested, and their data were therefore combined. For each object, Table 1 presents the *F* statistic associated with the main effect of side-of-stimulus along with the associated probability value.

The strongest effect occurred when the light bulb was the stimulus. On average over the 8-day test, the rats spent 78% of their time on the darker side of the apparatus. The rats also showed lesser, but statistically significant, attractions to wooden blocks with holes (60% of their time on average), golf balls (56%), and small wooden balls (54%). None of the other objects influenced the rats' movements with statistical reliability.

Discussion

Despite their well known reputation for preferring to remain near walls and avoid open spaces, our rats were not reliably attracted toward those stimuli which we had presumed would satisfy such a tendency (stationary L-shaped walls, Y-shaped plumbing fixture, steel soup cans). Indeed, the large soup cans were associated with a non-significant tendency to avoid them. It is possible that the instability inherent in the cans' tendency to roll, combined with their large size, evoked a degree of fear on the part of the rats. Our test also revealed no reliable attraction on the part of the rats to those objects which we had conceived of as potentially interesting manipulanda (caged peach pit, sandwiched mango seed, and acrylic balls and blocks).

By contrast, two objects which did prove to be reliably attractive were among those which we had conceived of as potentially of interest for chewing (wood block with holes, and small wood ball). In addition, one object which we had originally chosen as a potentially interesting manipulandum, but which turned out to be chewed extensively (golf ball) also proved to be attractive to the rats. (For most of our rats, the golf balls were gradually reduced to small bits which fell through the mesh into the litter trays during the course of each 4-day period). Even the difference in attractiveness between the acrylic cubes and the acrylic balls (both non-significant; but nearly significant for the blocks while clearly not for the balls), appears to be due to the rats' ability to gain purchase with their teeth on the edges and corners of the cube contrasted with their inability to do so with the balls. Cognizant of the fact that *Rodentia* translates from the Latin as 'gnawers', we should probably not be surprised by these findings. Evidently, rats like to chew, and, if given the opportunity, they seek out and spend time with objects which they can chew on. This finding is consistent with similar findings recently obtained with rabbits (Huls *et al.* 1991), and guineapigs (Scharmann 1991).

None the less, even on this issue, caution seems warranted in making assumptions about what would constitute a suitable object for chewing. All wooden objects are presumably chewable, but not all of the wooden objects which we tested were equally preferred by the rats. The different wooden objects were derived from wood cut from different species of trees, and we wonder if differences in the types of wood (hardness, palatibility, etc.) might have made a contribution. We think it will be worthwhile to test this possibility directly in future work by measuring the relative attractiveness of wooden blocks of identical size and shape cut from different species of trees.

We are sympathetic to the complaint that laboratory rats typically endure barren environments which do not optimize their well being. We feel that the insertion into existing cages of potentially enriching objects merits serious consideration, and is a practice which we would cautiously encourage. We feel that our results provide guidance for the development of suitable, rat-preferred, stimulus objects. Our results appear to rule out objects such as cans, pipes and non-chewable balls. We also have had no success at developing potentially attractive manipulanda. Based on our results, we do recommend that rats be provided with an object to chew on. A small block of wood drilled with holes is presently suggested by our data to be ideal. Hygiene can be a concern with wooden objects, but if the block is chosen of a sufficiently small size, the concern may be minimized. In our experience, wood is chewed into small bits that are discarded with the faeces before it has been in the cage long enough to become significantly soiled.

We realize that our study is only a beginning and that measuring time spent with objects provides only limited information (Duncan 1978). We recognize that our method could not have revealed whether a given stimulus provoked a cyclical pattern of time spent, such as might occur if there were an initial period of avoidance due to neo-phobia followed by an attraction due to curiosity. Only direct observation of the animals will reveal details of the particular responses of the animals to given stimuli. We know too that the long-term effects of exposure to any object would need to be carefully evaluated, and recognize that a given object may benefit, or harm, a rat in ways that are not revealed by the time data used in the present study. None the less, if these concerns can be satisfactorily addressed in future investigations, the provision to laboratory rats of a block of wood for chewing will at the very least occupy their time, and will allow them to exercise a behaviour which is fundamental to their nature. We hope that this would offer some relief from the considerable boredom which they are inferred to endure in captivity (Wemelsfelder 1984).

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