TECH-2-TECH

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The development and use of a cage-topper to enhance rat welfare

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Abstract

The welfare of rats used in scientific research is an important concern. Recent studies show that larger, more complex housing improves rat welfare compared to standard conventional cages. However there are typically both practical and financial constraints to implementing this.

We developed a cage topper that can be added to a standard rat cage to provide additional space and complexity and that can be built in-house at a low cost.

Here, we introduce the design of this cage topper and discuss its utility from the perspective of a researcher, a named animal care and welfare officer (NACWO)/lead technician, and a named veterinary surgeon (NVS). We concluded that while the cage topper is likely to provide a welfare benefit that more research is needed to assess if there are any adverse effects of the cage topper on animal health and biosecurity.

At present the cage topper may be most useful to enhance to welfare of rats who are healthy who would otherwise be housed in non-individually ventilated cages (IVCs) conventional cages.

Introduction

Conventional housing for laboratory rats, such as that stipulated by the minimum standards outlined in the United Kingdom (UK) Home Office Code of Practice for Housing Animals used in Scientific Procedures

(henceforth referred to as 'Code of Practice'), can lead to compromised health and welfare. A 2022 meta-analysis found that conventional housing exacerbated disease severity, increased mortality rates and increased anxiety and depression (according to existing rodent models of those disorders) relative to enhanced housing in laboratory rodents.[1] There is some evidence that the lack of opportunity for adult rats to rear in conventional housing can lead to stiffness and postural stress.[2]

There is a large body of research, summarised through data synthesis, on which to base improvements to the housing of laboratory rats. These have highlighted the importance of providing rats with complex spaces that include both larger and smaller areas, and multiple types of enrichment – particularly shelters.[3,4,5]

Moreover, guidelines have been developed for the housing of rats in a pet context through expert consultation and these may provide a useful foundation for thinking about refined housing of laboratory rats.[6] Importantly, the minimum recommendation for vertical and horizontal space within a pet rat cage (at least three body lengths – 80 to 120cm in both width and height, assuming four pet rats housed per cage) far exceed minimum standards for laboratory rat housing in the Code of Practice (minimum 400cm^2 floor area per group housed animal, minimum height of 20cm). The pet rat recommendations also emphasise that cage complexity is necessary and state that a cage should have a minimum of two tiers. There is no requirement for tiered housing in the Code of Practice.

Housing lab rats faces many constraints. There are practical constraints:

- Many animals may need to be housed in a single room.
- Animals need to be easily observable and accessible.
- Cages need to be easy to clean.

There are also financial constraints:

- Cages that exceed the minimum standards are commercially available.
- The cost of replacing all cages in an institution may not be financially viable.
- These are commonly cited as barriers to improving housing for laboratory rats.[7]

Our research group designed a cage topper that provides extra space for rats, including sufficient space for rearing that can be built in-house to be more cost effective.

This article aims to present the cage topper design and examine its implementation and usefulness in the laboratory from the perspectives of a researcher, a named animal care and welfare officer (NACWO)/technician and a named veterinary surgeon (NVS).

Cage topper design

The cage topper is designed to be placed on top of a standard cage, such that it sits on top of the cage base and the standard cage lid fits on top of the cage topper (see Figures 1 to 3).

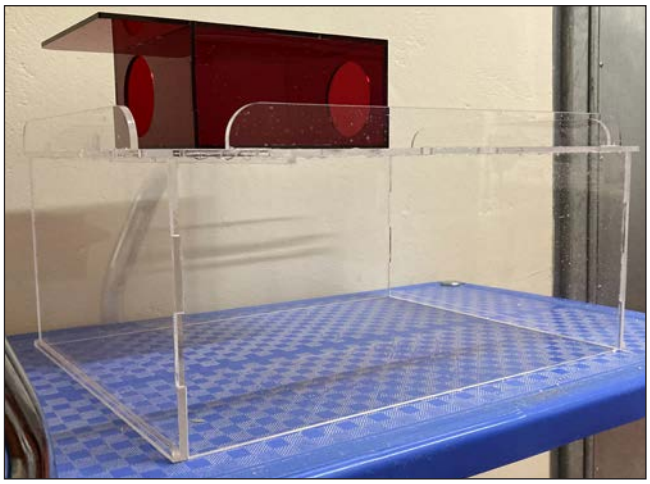

Figure 1. The cage topper prototype (placed upside down for stability).

Figure 2. The cage topper in use and viewed from the front.

Figure 3. The cage topper in use and viewed from the front.

The cage topper is stackable – several cage toppers could be added to a single standard cage although we have not tried this. This also means that cage toppers can be stacked while in storage. The cage topper has flooring across most of the base except a narrow strip (8cm) along one of the short sides. This allows a considerable amount of extra floor space (approximately 1400cm^2), and the gap provides sufficient space for a rat to rear fully (maximum height between floor and lid = 40cm). To further enhance the cage topper, we added a removable red-tinted suspended nest box. The nest box has holes at both ends providing access and has a projecting edge that provides a mezzanine platform for the rats between the floor of the standard cage and the floor of the cage topper. The cage topper therefore provides additional complexity, with multiple areas for the rats (i.e. top level, bottom level, and within suspended nest box) that are of different widths and heights.

The prototype cage topper is made using acrylic, with comb joints and acrylic glue used to connect individual pieces of acrylic. The cage topper was built by the University of Bristol Science Workshop based on a design provided by three of the authors. Building the cage topper in-house meant that costs could be minimised (£55 per cage topper in May 2024).

Discussion

Researcher perspective

We have now conducted five separate studies in which we have housed rats in cages that have been extended using the cage topper, with a total of 120 rats having been housed in these cages (104 males and 16 females, all were same-sex pair-housed). In four of those studies, removal of the cage topper for a period of one to three weeks was used as a manipulation designed to induce a poorer welfare state so that we could study potential novel measure of rat welfare. One of these studies has been published and provides evidence that temporary removal of the cage topper has a significant impact on rat behaviour.[8] The cage topper has therefore been highly valuable both for enhancing the welfare of rats and for studying the welfare of rats.

From a practical perspective, the cage toppers do increase the total weight of the cage and so removing cages from the shelving has been more difficult. Even so, the weight of the cage has not been prohibitive for our team. The initial stages of handling habituation were more time consuming because the cage topper often had to be removed to handle rats. However, over a period of a few weeks the majority of rats learnt to move to the top of the cage to be handled such that removing rats from the cage for handling or research purposes did not seem any more laborious or time-consuming than with standard cages.

NACWO/technical perspective

When these toppers were first introduced the main areas of concern were the additional time it would take to clean the cage and the additional weight these toppers would add to the cage.

It was found that once the technicians had adjusted to the weight of the cages, the time to undertake the cleaning was not adversely affected. By having both the new and old cage side by side, the rats would usually just climb straight into the new cage which resulted in some savings on time as the technicians were not required to catch the rats.

Working with these toppers, the following benefits have been observed:

- The technicians were still able to observe the rats daily.
- With the toppers giving extra height and space at the front of the cage allowed the rats to stretch fully.
- With an increased space it provided the rats with multiple places to sleep.

These have been a benefit to the rats' welfare. The rats love having the extra space allowing them to stretch, climb and play.

The only negatives are that it is difficult to properly clean the red tinted box and the edging of the cage itself is delicate making the edging vulnerable to breakages.

If these changes/improvements could be made these would be good addition to the standard rat cage.

NVS perspective

As an NVS, biosecurity, Welfare and Animal Health are my top priorities. We know that more than 95% of a laboratory rat's life is spent in their home cage, so improving space can have significant welfare improvements but often higher welfare cage alternatives and enrichments come with a concession of increased biosecurity risks or increased risk of injury. Working with these cage toppers, there were a number of concerns I had:

- The cage topper adapts conventional caging which has poor biosecurity control, an adaptation for an IVC would be preferable but would come with its own set of challenges and problems.
- Maintaining biosecurity and ensuring thorough cleaning: although the cage topper can go through the cage wash, it is difficult to clean corners (particularly in red house) which poses a risk for disease transfer.
- Rats were often observed playing by hanging to the top shelf or play fighting over the ledge. However, although they were often seen falling to the bottom level often onto their backs rather than their hindlimbs no injuries were noted in any studies which have used this design and I was not made aware of a higher incidence of fighting.

- Whilst we did not see increased fighting incidences, the ability to remove the topper and fit two cages in the same space would be useful in case pairs need to be separated into singly housed animals due to injury/disease.
- It is not clear whether airflow within the cage is affected causing an increase in ammonia levels in the more enclosed lower portion which may adversely affect rodent health. We were unable to determine this during the trial.
- We do not use environmental swabbing in our facility but it would be worth considering whether there is a suitable location within the expanded cage to collect swab samples.
- We did not receive reports of increased aggression/biting during any of the trials but it would be useful to assess whether bites are more likely because of the increased difficulty of retrieving animals from the topper leading to a greater risk of zoonotic diseases.

Conclusions and future directions

The clearest benefit of these cages is the extra space and cage complexity that they afford the rats. This is achieved at a very low-cost compared to more spacious alternatives to standard caging that are commercially available. The cage toppers do not overall affect staff's ability to observe or handle rats and therefore they do not require more time or labour than use of a standard cage alone. From a welfare and cost perspective, these cage toppers are beneficial.

However, the current design of the cage could be improved. A moulded cage topper would likely be more durable than one made from glued acrylic sheets. This would undoubtedly impact the cost though. Omission of the suspended red box would also be preferable for easier cleaning and accordingly improved biosecurity. Ideally, this would be replaced by another form of enrichment that would provide shelter and a step between the two levels (although we have noted that both male and female rats can move between the top and bottom levels without a ledge). Alternatively, an easily removable red box could be designed with some thought to allow simple disassembly of the cage topper for cleaning purposes.

There also remain a number of questions around the potential impact of these cage toppers on animal health and biosecurity. While during our studies we did not note any increase in injuries, diseases, or biting relative to animals housed without a cage topper, it would be useful to assess this formally and objectively before ruling it out as a potential concern. We also do not have any data on airflow or ammonia levels within the cage when these cage toppers are used.

In sum, the cage topper may be most useful to enhance the welfare of healthy rats who would otherwise be housed in non-IVC conventional cages. Until more research has been conducted to address potential health and biosecurity concerns, we would not recommend that these cage toppers are used for infirm, immunocompromised, or specific pathogen-free (SPF) rats.

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References

1 **Cait, J., Cait, A., Scott, R.W., Winder, C.B., Mason, G.J.** Conventional laboratory housing increases morbidity and mortality in research rodents: results of a meta-analysis. BMC biology. 2022 Dec; 20:15.

2 **Makowska, I.J., Weary, D.M.** The importance of burrowing, climbing and standing upright for laboratory rats. Royal Society open science. 2016 Jun 29; 3(6): 160136.

3 **Neville, V., Lind J., Mendl, E., Cozma, N.E., Paul, E.S., Mendl, M.** A mapping review of refinements to laboratory rat housing and husbandry. Lab Animal. 2023 Mar; 52(3):63-74.

4 **Cait, J., Winder, C.B., Mason, G.J.** How much 'enrichment' is enough for laboratory rodents? A systematic review and meta-analysis re-assessing the impact of well-resourced cages on morbidity and mortality. Applied Animal Behaviour Science. 2024 Jul 26: 106361.

5 **Patterson-Kane, E.G.** Enrichment of laboratory caging for rats: a review. Animal Welfare. 2004 Feb; 13(S1): S209-14.

6 **Neville, V., Hunter, K., Benato, L., Mendl, M., Paul, E.S.** Developing guidelines for pet rat housing through expert consultation. Veterinary Record. 2023 Feb; 192(3):e1839.

7 **Mazhary, H., Hawkins, P.** Applying the 3Rs: A case study on evidence and perceptions relating to rat cage height in the UK. Animals. 2019 Dec 9;9(12):1104.

8 **Neville, V., Finnegan, E., Paul, E.S., Davidson, M., Dayan, P., Mendl, M.** You are How You Eat: Foraging Behavior as a Potential Novel Marker of Rat Affective State. Affective Science. 2024 Sep; 5(3):232-45.