that feedback on progress was also an important aspect. Based on such evidence, it should now be possible to design a form which takes students’ views into account. This will focus on aspects of extramural teaching as part of a system of quality assurance.

However, quality assurance should not be confined to a narrow view of the learning experience. A major concern of practitioners in Canada and Australia (Taylor 1996b) was that they should be good professional role models for their students. The respondents to the questionnaire shared their concern. They placed a high value on having practical expertise and an active commitment to continuing professional development and, in addition, to establishing a high standard of care for patients and clients and effective working relationships. Paying attention to the appearance of premises and facilities was also rated highly.

The practitioners identified criteria by which the quality of extramural study could be assured which were not confined to the idea of the practitioner as teacher but included him or her as a professional role model. However, in the case of the latter, it is not clear how appropriate evidence could be obtained. The perceptions of students would be of little value and further development will require the establishment of stronger links between the schools and the practising profession. One important step, based on the recommendations of the RCVS (1996), would be the establishment at each school of a post dedicated to the establishment and maintenance of systems for quality assurance. As noted earlier, robust communication and feedback mechanisms are an essential feature of quality assurance systems. Clearly, individual veterinary schools will work in their own way, but the evidence from the questionnaire is that practitioners believe that more should be done. This paper shows that the SILVER Project provides a way forward. It demonstrates the effectiveness of an approach based on students setting their own learning objectives, and on the ability and willingness of practitioners to provide feedback on their progress. Much has also been learned from veterinary practitioners about what would be the features of a quality assurance system for extramural studies. Such a system would provide evidence for the Schools, but there is a need to go further. The commitment of the profession to extramural study cannot be taken for granted and the Schools must find ways to show their appreciation of what is being done. Evidence from the questionnaire was unclear on this issue, suggesting that further work is required.

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Determination of the aversion of farmed mink (Mustela vison) to carbon dioxide

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High concentrations of carbon dioxide are commonly used to kill mink before their pelts are removed. The aversiveness of this procedure was investigated by using a passive avoidance technique. Eight mink were trained to obtain a reward (a novel object) by entering a chamber which could be filled with carbon dioxide, as under commercial conditions (over 80 per cent by volume). In the absence of carbon dioxide, mink entered the chamber within a mean (sd) of 16 (2·1) seconds and spent 45 (12) per cent of the next 10 minutes interacting with the novel object. When there was carbon dioxide in the test chamber, the mink would not enter it and coughed and recoiled from the chamber’s entrance instead. It was conclud-

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ed that the mink detected and avoided high concentrations of carbon dioxide, and that if mink are to be killed humanely, less aversive techniques should be used.

THREE procedures are approved for the killing of fur-farmed mink under the Welfare of Animals (Slaughtering or Killing) Regulations (MAFF 1995). Lethal injection of a drug with anaesthetic properties, exposure to 1 per cent by volume of carbon monoxide or exposure to 100 per cent by volume of carbon dioxide. The regulations were constituted to implement the European Council Directive 93/119/EEC. There are, however, animal welfare concerns associated with the killing of animals with gases, and in particular with high concentrations of carbon dioxide, because it is an acidic gas which can be pungent to inhale (J. J. Cooper, G. J. Mason, personal observations) and because it is a potent respiratory stimulant, inducing a sense of breathlessness before the loss of consciousness (Gregory and others 1990).

Nevertheless, carbon dioxide is used to kill a wide range of domestic animals, including poultry, pigs and laboratory rodents (Smith and others 1986) as well as mink. Hansen and others (1991) showed that 100 per cent carbon dioxide can render mink unconscious in a mean time of 19 seconds, faster than 100 per cent nitrogen (76 seconds) or 1 per cent carbon monoxide (64 sec-
ond). However, maintaining high concentrations of carbon dioxide may be difficult under commercial conditions and Hansen and others (1991) found that lower concentrations of carbon dioxide took longer to render mink unconscious. For example, 70 per cent by volume carbon dioxide failed to result in apparent loss of consciousness within 15 minutes. However, neither aversion nor discomfort were assessed in their study, an important omission because several studies in other species have suggested that the inhalation of carbon dioxide is highly aversive, whereas the inhalation of other gases such as carbon monoxide or argon is not.

Layer hens, turkeys and pigs can detect the presence of carbon dioxide, and given a free choice, they will avoid it (Raj and Gregory 1991, 1995, Raj 1996). For example, the aversion of pigs to the inhalation of carbon dioxide is greater than their motivation to obtain a food reward (apples), even after 24 hours fasting (Raj and Gregory 1985). In addition, the inhalation by pigs of a high concentration of carbon dioxide or their prolonged exposure to low concentrations of the gas results in hyperventilation and signs of respiratory distress, with some animals attempting to escape (Raj and Gregory 1996). Simonsen and others (1981) also found that the inhalation of carbon dioxide by cats caused behavioural changes indicative of discomfort, including defensive postures and attempts to escape. All these results contrast with the animals’ response to argon or to carbon monoxide, which cause death by anoxia but which do not seem to be aversive (Simonsen and others 1981, Raj and Gregory 1995, Raj 1996).

It is very likely that the inhalation of carbon dioxide would be aversive to mink, but the possibility has not been tested. The aim of this study was to assess whether mink find the presence of carbon dioxide aversive by measuring the extent to which the presence of the gas in a localised part of a test arena would inhibit a highly motivated behaviour that could only be performed within it, such as interaction with a novel object. Previous work has shown that mink value novel, non-food items that are renewed each day (Cooper and Mason 1996, 1997, J. J. Cooper, G. J. Mason, unpublished observations). This approach, based on passive avoidance, is a powerful means of measuring aversion (Rushen 1986), first because it provides the animal with a choice of enduring the aversive conditions to obtain a reward or avoiding it completely (Raj 1996), and secondly because it allows the extent of the aversion to be measured in terms of the reduction in consumption of important environmental resources (Rutter and Duncan 1992).

Materials and methods

Eight wild type mink (five female and three male) were used as subjects; they were housed in a test arena (Fig 1) for a period of four weeks. The arena consisted of eight wire compartments (length 600 mm, width 300 mm and height 450 mm) encircled by a wire corridor of width 150 mm and height 200 mm. One-way doors restricted entry to and exit from each compartment. A reed switch on each door allowed the number of visits made to each compartment during an experiment to be recorded automatically. All eight mink had been individually housed in the test apparatus for a period of four months before the experiment. During this time the minks’ behavioural priorities had been assessed by placing a weight on the access door. All eight mink pushed open door weighted with up to 1250 g (compared with an average body weight of 800 g for females and 1600 g for males) to gain access to chambers containing novel objects. The mink did not, however, push as hard to enter empty chambers, or chambers containing similar but familiar objects (Cooper and Mason 1996, 1997).

For this experiment only two compartments were used. One compartment contained food, water and a nest box (home cage) The second compartment (novel cage) allowed access to a chamber of length 1600 mm, width 600 mm and height 400 mm which was placed beneath the test arena and fitted with a clear perspex roof. Access to the chamber was via a wire tunnel 150 mm long and the novel object was placed at the end of the chamber. From the entry point. The remaining six compartments were empty and locked. Eight test arenas were used so that the home cage and novel cage could be represented in each of the eight positions. During training and testing the colony room was maintained under natural daylight (07.30 to 17.30) and ambient temperature (±2.6°C).

At the beginning of the study, the mink were first trained to expect a novel object to be placed in the chamber. This was done by locking the mink in its home cage for a period of five minutes before the object was placed in the chamber and the mink was released from its home cage. Within four days of training the mink consistently approached the novel object in less than 20 seconds.

After they had been trained, the mink’s response to carbon dioxide was investigated in two, three-day test runs (carbon dioxide and control). In the carbon dioxide run, the chamber contained air on the first test day, carbon dioxide on the second day and air on the third day. In the control run, the chamber contained air on all three test days. On each test day the mink were first locked in the home cage for five minutes, the novel object was placed in the chamber, and when appropriate the chamber was filled with carbon dioxide to a gas concentration in excess of 80 per cent by volume measured at the entrance with an infrared sensor (Servomex). Carbon dioxide was taken from a liquid supply and trickled into the chamber from a rubber hose in its base to minimise mixing with air and ensure a high concentration of carbon dioxide throughout the chamber. The mink were then released and the following events were recorded: the time taken to leave the home cage (out); the time taken to enter the novel cage (in); the time to reach the tunnel descending to the chamber (tunnel); the time to descend so that all four feet were on the floor of the chamber (down); and the time to reach the novel object. The time spent in the chamber and the time spend interacting with the novel object in each test, and the number of coughs and recoils (rapid backwards retreats) performed in the chamber tunnel were also recorded. The test was terminated 10 minutes after the release of the mink, and the carbon dioxide was removed from the chamber. The times taken to complete each section of the route, and the times spent in the chamber and interacting with the novel object, and the number of coughs and recoils were analysed by using a non-parametric Friedman analysis of variance with data block by mink, and the six test days as factors.

Results

After they were released the mink travelled rapidly from the home cage to the chamber entrance in both the control and carbon dioxide trials (Table 1) and there were no differences between the

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<td>Out</td>
<td>4</td>
<td>3.5</td>
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<td>4-5</td>
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<tr>
<td>In</td>
<td>13</td>
<td>11</td>
<td>12</td>
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<td>1-43</td>
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<td>Tunnel</td>
<td>14</td>
<td>12</td>
<td>14</td>
<td>15</td>
<td>16</td>
<td>16</td>
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<tr>
<td>Down</td>
<td>15</td>
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<td>16</td>
<td>15</td>
<td>600</td>
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<td>17.9*</td>
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<tr>
<td>Novel</td>
<td>16</td>
<td>31</td>
<td>19</td>
<td>13</td>
<td>600</td>
<td>26</td>
<td>18.8**</td>
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The stages are defined in materials and methods. **P<0.01
times taken to leave the home cage, to enter the novel cage, and to reach the tunnel in the two trials. The times taken to descend the tunnel, and to approach the novel object were both strongly affected by the presence of carbon dioxide. With air, the mink rapidly descended into the chamber and spent much of the 10 minute test period interacting with the novel object (Table 1). Only one mink, which remained in its nest box throughout one entire test period, failed to reach the novel object in any of the air tests. None of the mink reached the novel object and only one mink made a single visit to the chamber when carbon dioxide was present. This visit lasted less than 10 seconds, and the animal only placed its front two feet on the chamber floor and did not interact with the novel object. The presence of carbon dioxide reduced both the time spent in the chamber and the time spent interacting with the novel object (Table 2).

The presence of carbon dioxide also had a marked effect on the minks' behaviour in the tunnel (Table 3). In the presence of carbon dioxide, they sneezed or coughed in the tunnel and made rapid reflex withdrawals from it. All eight mink showed one of these responses to carbon dioxide in the tunnel. Six mink coughed in the tunnel when carbon dioxide was present in the chamber, whereas only one mink coughed when air was present, and this occurred when it was in the corridor. Six mink also recoiled from the tunnel when there was carbon dioxide in the chamber, whereas none of the mink recoiled when descending the tunnel when the chamber contained air.

### Discussion

The ideal euthanising agent should result in a rapid loss of consciousness with minimum discomfort for the animal (Smith and others 1986). Carbon dioxide does render mink unconscious relatively rapidly (Hansen and others 1991) but these mink would not endure carbon dioxide concentrations of 80 per cent in order to interact with novel objects, a behaviour which previous studies (Cooper and Mason 1996, 1997) had shown them to value. Combined with their response to inhaling the gas (rapid withdrawal of the head, coughing) this behaviour shows that they were able to detect carbon dioxide, find it aversive and avoid it. This would mean that mink killed with high concentrations of carbon dioxide would be exposed to the discomfort caused by the inhalation of the gas for short periods. The practice is, therefore, questionable on welfare grounds, especially as potentially less aversive alternatives are available.

The induction of unconsciousness with carbon monoxide delivered from a source of 100 per cent carbon monoxide, rather than exhaust gases, is an alternative to using carbon dioxide (Lamboov and others 1985). This procedure is already widely used for killing mink in the Netherlands (Lamboov and others 1985, de Jonge and others 1986). When mink were exposed to 100 per cent carbon monoxide, they apparently lost consciousness on average after 64 seconds (Hansen and others 1991). It is not known whether mink find this slow induction of unconsciousness as aversive as exposure to carbon dioxide, nor has the aversion to other means of killing mink such as lethal injection been studied. Further investigation is, therefore, necessary to determine whether other slaughter techniques are more acceptable on welfare grounds than carbon dioxide, using passive avoidance techniques to assess the degree of aversion.

### References


### Abstract

Effects of 7.2 per cent hypertonic saline in normovolaemic heifers

A SMALL volume (5 ml/kg) hypertonic saline solution (HSS) can be rapidly and safely given to cattle to expand the plasma volume without inducing hypernatraemia. Nine heifers (three per group) were monitored for 120 minutes after initiating fluid replacement with a small volume of HSS solution (7.2 per cent), a large volume of HSS solution (15 ml/kg, 7.2 per cent) or an isotonic saline solution (5 ml/kg, 0.9 per cent). The relative plasma volume progressively increased to 137.7 per cent and 145.2 per cent by five and 15 minutes after HSS infusion. While the small volume HSS infusion induced a transient high osmotic effect and hypernatraemia, the large volume HSS caused a persistently high osmotic effect and hypernatraemia throughout the experimental period. The large volume HSS infusion resulted in a significant drop in PaO₂. The recommended flow rate in these heifers (mean 270 kg) of the HSS solution was 200 ml/min.


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