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The motivation of group-housed laboratory mice to leave an enriched laboratory cage

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Animals used in research are often housed in small, barren cages. Providing environmental enrichment should improve their welfare, and a consequence of this might be a reduction in the animal's motivation to leave an enriched cage. I examined this possibility by housing laboratory mice, *Mus musculus*, in a cage that provided cagemates, food, water, large floor area, nesting material, a running wheel, shelter, cardboard tube, food stick and chew sticks. The strength of motivation to leave this cage was assessed in an operant consumer demand test. By pressing repeatedly on a switch, one trained mouse within each of six groups could exit the enriched cage to enter a small, empty cage. As the number of required switch presses was increased, the number of visits to the empty cage decreased, although this was unlikely to be caused by habituation. The mice continued to exit the enriched cage and enter the empty one at all the costs imposed. The slope of the demand function for the empty cage indicated that the mice did not perceive this to be a particularly important resource. I argue that the motivation to exit the enriched cage and enter the empty cage was due to monitoring, patrolling or information gathering, independent of any attraction or aversion to either of the cages. Alternatively, the motivation to leave a presumably attractive environment to enter a presumably less attractive one could be the result of factors beyond our anthropocentric-based understanding of how the mice perceived their environments. The implications for consumer demand studies and their application are discussed.

Keywords: enrichment; information gathering; monitoring; motivation; mouse; *Mus musculus*

Animals used in research, including behavioural studies, are often housed in small, barren enclosures or cages. Such housing can adversely affect the development and biological functioning of the animals, thereby compromising both the quality of science and animal welfare (Poole 1997; Wurbel 2001, 2002; Sherwin 2002, 2004a; Olsson et al. 2003). Therefore, for both scientific validity and welfare reasons, there is a need to improve the standard cages of research animals. Two methods used to ascertain how best to improve cages are preference tests and consumer demand studies. Preference tests allow animals to make a choice between several possible enrichments that might be placed in a cage (e.g. Van de Weerd et al. 1998a, b; Sherwin et al. 2004). Consumer demand studies require animals to pay a 'cost', usually an operant task, to gain access to a potential enrichment. By increasing the required cost (e.g. the number of switch presses) it is possible to determine empirically the strength of motivation, or demand, the animal has for a potential enrichment, and therefore assess its importance as perceived by the animal (Lea 1978; Dawkins 1990). The underlying principle of both these methods is that animals will be more highly motivated to interact with enrichments they perceive to be important and that providing these in a cage is likely to improve welfare more than providing items for which the animal has lower motivation. It follows then, that if we provide a cage with several enrichments for which an animal is highly motivated or that it prefers, the animal will be less motivated to leave that cage. I tested this hypothesis by housing laboratory mice, *Mus musculus*, in an ostensibly highly enriched environment and quantifying the motivation to leave this enriched cage to enter a small, empty cage.

There have been many studies on the preferences and strength of motivation that laboratory mice have for

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resources or enrichments. These indicate that in addition to food and water, mice are highly motivated for, or frequently use, additional space (Sherwin 1996, 2004b; Sherwin & Nicol 1997), conspecifics (Sherwin 2003), manipulable nesting material (Sherwin 1997; Van de Weerd et al. 1997, 1998a, b; Van Loo et al. 2002), running wheels (Sherwin 1998a, b, 2003; Banjanin & Mrosovsky 2000), shelters (Van de Weerd et al. 1998b), tubes (Coviello-McLaughlin & Starr 1997; Wurbel et al. 1998; Van de Weerd et al. 2002; Augustsson et al. 2003) and chewing blocks (Van de Weerd et al. 2002; Augustsson et al. 2003). Therefore, mice were placed in a cage providing all these enrichments, and the strength of motivation to leave this cage was determined with a consumer demand technique.

Consumer demand functions are generally quantified by plotting the regression line relating the reinforcements gained by the animal to the cost, usually plotted on log–log coordinates to provide a straight-line relation (e.g. Matthews & Ladewig 1994; Sherwin & Nicol 1997; Kirkden et al. 2003; Sherwin 2003, 2004b; Warburton & Mason 2003). This function typically takes the form $Y = b + aX$ where the absolute value of the slope, a (which is typically negative), is termed the elasticity coefficient and b is a constant. Several characteristics of this function have been suggested as indicators of motivation strength. First, the elasticity coefficient can indicate the relative strength of motivation for resources (Lea 1978; Dawkins 1990; Matthews & Ladewig 1994; Mason et al. 2001; Hansen et al. 2002; Sherwin 2003, 2004b). Resources that are more important to animals will have slopes closer to zero than less important resources, which will have more negative slopes. Second, the Y-axis intercept (Holm et al. 2002; Pedersen et al. 2002; Jensen et al. 2004a) indicates the intensity of the response when the cost is zero. A higher intercept indicates the animals are more highly motivated across the range of costs, provided the slopes are equal. Third, it has been argued that the strength of motivation can be represented as the area under the regression line (Ng 1990; Kirkden et al. 2003). A greater area indicates a higher motivation for the resource across the range of costs studied. Since there is debate (e.g. Kirkden et al. 2003; Warburton & Mason 2003; Jensen et al. 2004a) about which of these characteristics is the more valid, and each brings its own practical and interpretive difficulties, I used all three.

METHODS

Study Animals

Twenty-four CB57 female mice were obtained from a commercial breeder at 6 weeks of age. They were housed as groups of four in standard laboratory home cages (37 × 21 cm and 15 cm high) with wood shavings as a floor substrate, shredded paper for nesting material and ad libitum access to standard laboratory rodent food pellets and water. The lights were switched off automatically between 1100 and 2300 hours, but a dull red lamp and radio in one corner of the room remained turned on constantly. Room temperature was maintained between 20 and 22°C.

One mouse from each group was arbitrarily selected for training to perform operant switch pressing (see below). To mark them I bleached a small patch of dorsal fur.

Apparatus, Operant Response and Training

The apparatus (Fig. 1), operant response and training are described in detail by Sherwin (2003). Each marked mouse from the six groups was trained to activate the entry switch a required number of presses, RP, without a set period of time elapsing between any two presses (the 'maximum delay', MD). When the RP was completed, the door was unlocked. To return to the start cage, the mouse had to press only once on the second switch and move through the door before the MD elapsed. If she did not return before the MD elapsed, the door was locked thus again requiring her to press the switch once. If the mouse completed the RP to enter the empty cage but did not push through the door, it was locked when the MD elapsed after the last press, thus preventing the cagemates from entering the empty cage and requiring the trained mouse to perform the RP again.

For training, water was made available only in the start cage and standard laboratory food pellets (the same type as offered in the home cage) only in the empty cage. Initially, the door remained unlocked and the mouse was allowed to move between the cages until it pushed through the door several times each day without obvious apprehension. The RP was then set at 1 press with an MD of 10 min. This was imposed until the mouse was moving between the start cage and the empty cage several times each day. On successive training days, the MD was then gradually decreased to 15 s, and then the RP gradually increased to 22 presses. Each training day began at the start of the dark phase and continued for between 11 and 23 h

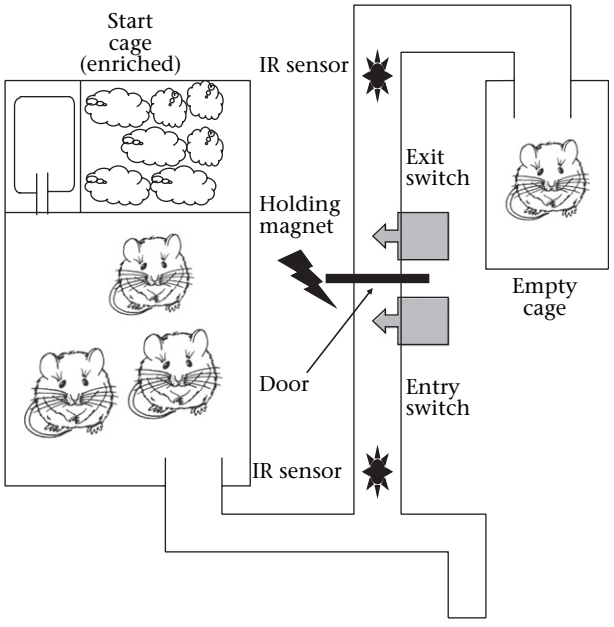

Figure 1. The apparatus used to test the strength of motivation of group-housed laboratory mice to exit a highly enriched cage and enter an empty cage. IR = infrared.