

A multisubject rotational stimulator for taste-aversion induction

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A new multisubject rotational apparatus for the induction of motion-sickness-induced taste aversions (TAs) in rats is described. This easily constructed device rotates up to 4 subjects that are individually restrained in plastic cylinders to minimize locomotion while providing consistency of rotational stimulation. The multisubject rotational apparatus, which fulfills the design objective of providing an inexpensive and efficient nonpharmacological approach to TA conditioning, can be modified for use with a variety of small animals and may also be applicable to other areas of motion-sickness research.

A variety of rotational apparatuses have been used to study motion-sickness-induced taste aversions (TAs) in rats. Subjects have typically ingested a palatable solution prior to rotation and thereafter either rejected or displayed a diminished acceptance of that conditioned-stimulus (CS) solution. In most instances subjects have been rotated alone in holding cages attached to commercial turntables (Braveman, 1975; Elkins & Harrison, 1983; Green & Rachlin, 1973, 1976; Haroutunian & Riccio, 1975; Haroutunian, Riccio, & Gans, 1976; Ossenkopp & Frisken, 1982). Simultaneous rotations of multiple subjects also have been reported. Braun and McIntosh (1973) used a turntable with a two-compartment holding cage for the simultaneous rotation of 2 subjects. Hutchison (1973) spun rats 2 at a time by using two single-subject cages that were attached to a miniature lathe assembled in a drill-press configuration. McCoy, Nallan, and Pace (1980) used a centrifuge equipped with radial arms to simultaneously spin 3 rats under differing levels of gravitational force. Mitchell, Laycock, and Stephens (1977) used a Hobart mixer to simultaneously spin 4 rats that were individually housed within a quadripartite cylinder.

The rotation of single subjects is an inefficient TA-induction methodology. It requires either the use of several single-subject rotational devices or an unnecessarily prolonged interval of experimenter involvement. The sequential rotation of single subjects is also contraindicated when the consequences of rotation may interact with circadian effects to such an extent that it is desirable to ro-

tate a number of subjects within a relatively brief temporal interval. The instances of multiple-subject rotation that were cited above usually required adaptations of specialized devices that are not present in many laboratories. A decision was therefore made to develop, from easily available and inexpensive components, an apparatus for the simultaneous rotation of up to 4 subjects.

An additional design consideration during apparatus development involved the control of subject-initiated position and movement tendencies during rotation. Our previously used single-subject rotational restrainer, an aluminum animal-weighting basket (Elkins & Harrison, 1983), was large enough to permit each animal considerable freedom to move its head position and body location relative to the axis of rotation. Variability within and between treatment groups could be influenced therefore by subjects' movement and position tendencies. For example, rotational and gravitational stimulation would be different when an animal's head intersected the axis of rotation than when the head was placed near the wall of the rotating restrainer. Additionally, as emphasized by McCoy et al. (1980), movement during rotation can produce tangential or Coriolis-like accelerations that are also known to induce motion sickness (e.g., Broderson, 1969). Judging from the reported dimensions of animal restrainers, all except one of the rotational experiments that were cited above also used holding devices that allowed subjects considerable postural freedom. Only McCoy et al. (1980) used small restraining cages to specifically minimize possible movement effects.

The present report describes the development and successful behavioral testing of a multiple-subject rotational apparatus. In addition to providing for the simultaneous rotation of up to 4 rats, this device restrains each animal to a relatively fixed position in relation to the axis of rotation. Functionally equivalent reproductions should be

This research was supported by the Medical Research Service of the Veterans Administration and by Public Health Services Grant 1 R01 AA06465-01 of the National Institute on Alcohol Abuse and Alcoholism. Correspondence concerning this article should be addressed to Ralph Elkins, Psychology Research 116-BU, Veterans Administration Medical Center, Augusta, GA 30910.

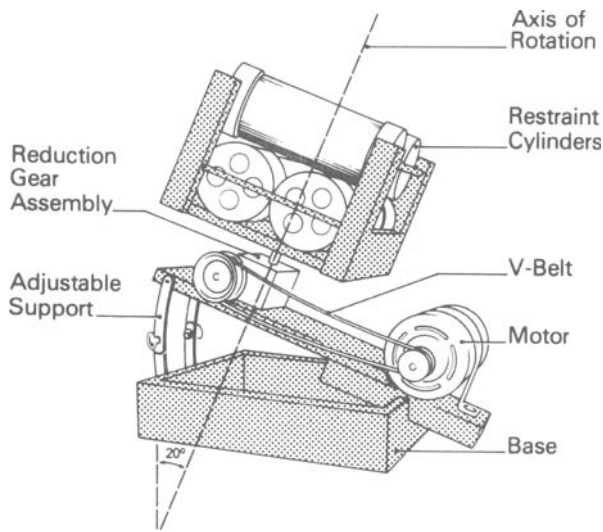


Figure 1. A schematic representation of the multisubject rotational apparatus. A wooden safety guard that normally covers the belt and pulleys is not shown in order to increase the clarity of the mechanical illustration.

easy to construct from readily available and inexpensive components.

METHOD

Apparatus

Figure 1 provides a general schematic representation of the multisubject rotational device. As with the previous single-subject device, the axis of rotation is tilted to produce a plane of rotation that is 20° from horizontal.

The base, the motor and gearbox support, and the cylinder/supporting platform of the apparatus were constructed of wood, as indicated by the shaded regions of Figure 1. An electric motor drove a reduction gear assembly (from a self-powered lawn mower) by means of a V-belt. A platform for holding the restraint cylinders was attached to the output shaft of the reduction gear assembly. The platform was designed to hold four restraint cylinders on two levels. The lower-level cylinders were held just to each side of the axis of rotation. The other two cylinders were placed atop the first two with their long axes perpendicular to those of the two lower cylinders. The restraint cylinders consisted of 22.2-cm lengths of 7.6-cm (i.d.) PVC pipe. The ends were closed with standard commercial rubber end-caps into which four 15.9-mm-diam circular holes had been punched for air exchange. These caps were protected from gnawing by a 6.4-cm-thick, 7.3-cm-diam sheet plastic disk that was attached to the inside face of each cap. These disks all had eight small (6.4-mm-diam) circular air holes that were drilled to underlie, in a two-to-one ratio, each of the four larger holes in the end-caps. The rotational device, as used within our laboratory, was constructed to spin at

110 ± 5 rpm and was operated on an intermittent basis, with power being turned off for the final 3 sec of every 30-sec interval of rotation. This power interruption was controlled by standard electromechanical programming devices to produce a brief period of deceleration and acceleration during each 30 sec of rotation. The speed of rotation can be adjusted by the use of other gearing and/or pulley designs and the temporal parameters of rotation are limited only by the constraints of available programming equipment.

Behavioral Testing

Rotationally induced TAs were studied within strains of Sprague-Dawley derived rats that had been selectively bred within this laboratory as efficient or inefficient learners of a cyclophosphamide-induced TA to a saccharin solution (Elkins, 1986). As hypothesized, rotation following ingestion of the saccharin solution produced reliable TAs within the TA-prone strain, but had no comparable effect on TA-resistant rats. Pseudoconditioning- and restraint-control procedures supported a conditioning-based interpretation of strain differences in TA acquisition. Methodological procedures and detailed results of this behavioral testing appear in Elkins, Harrison, and Albrecht (in press).

DISCUSSION

The rotational device has fully satisfied our design requirements. It restricts subject-initiated movement while providing an efficient, inexpensive, and nonpharmacological mode of simultaneous TA induction in up to 4 rats. Given a sufficiently strong motor and gearing arrangement, subject capacity could be increased by the use of additional sets of restrainers. The device can also be adapted to rats of various ages and to other small animals by adjusting the size of the restraint cylinders. The device may prove to be of particular value when the experimenters wish to eliminate unwanted and/or unknown side effects of pharmacological TA induction. It may also be applicable to other aspects of motion-sickness research.

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(Manuscript received for publication December 12, 1986.)