An inexpensive silent unlocking device for manipulanda¹

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An electromagnetically controlled armature was developed which silently unlocks manipulanda (shuttle box doors, wheels, levers) for response control in discrete trial situations. The device was found to produce no cue to Ss as to when responding was possible in a shuttlebox situation.

Certain experimental procedures require periods where animals must be prevented from responding. For example, discrete trial avoidance conditioning may require (a) that the response be put under some S^D or conditioned stimulus control; (b) that S^Δ and intertrial responding be eliminated; or (c) that non-escape or non-avoidance trials be introduced. Attempts to introduce such controls have included putting shock on the opposite side of the shuttle box or presenting a shock through the manipulanda. This technique introduces punishment into the experimental situation which may interfere with avoidance acquisition. Other techniques have utilized the lowering of a guillotine door in the shuttle box or the withdrawal of the wheel or lever during the intertrial interval. These techniques have the disadvantage of necessitating the raising of the door or the re-introduction of the manipulanda at the onset of the responding period. Consequently they become an important part of the warning stimulus complex, and may themselves become the S^D. It is therefore not possible to measure the effects of a tone or light warning stimulus unconfounded by this additional stimulus change.

To overcome this difficulty, an inexpensive locking device has been developed which precludes intertrial responding but which does not itself present any cue to the animal when the avoidance-escape response is permitted to occur. This device has been tested on both shuttle box and wheel-manipulanda avoidance conditioning and is easily adapted to the locking of a lever.

In the bi-directional shuttle box the mechanism is used to lock and unlock a swinging door which divides the two compartments. The door is pivoted 4 in. above the grid floor. A gap of 1/2 in. between the bottom of the door and the grid floor was found empirically to be optimal in avoidance and escape responding. A metal block extends above the pivot along one side of the door. This block swings in the opposite direction to the door with a smaller arc. The locking mechanism is an armature having a flanged U at its base. When the armature is in its vertical position the flange engages the metal block and prevents the door from being opened in either direction. At the top of the armature a long steel screw is bolted for adjustable counter weighting. The top of the armature rests against the metal core of an electro-magnet (solenoid) when the armature is in the vertical position. In this particular application a 24 V dc extended usage solenoid with a 60 oz pull was found to be optimal. The pivot point of the armature and the counterweight bolts on the screw can be adjusted so that turning off the current to the electromagnet allows the flange to clear the metal block, allowing the door to swing freely. The armature should not be allowed to swing beyond the magnet field of the core. Turning on the current pulls the armature back into the vertical position, locking the door.

The armature and solenoid are contained in a widened area above the door separating the two compartments in the shuttle

Fig. 1. Unlocking device.

box. The working model currently in use is silent when it releases the door lock. If any noises should be made by metal-on-metal parts, oil or moleskin padding can be introduced at the contact point.

A pilot study was conducted to determine if the release of the door lock provided any discriminable cue for the rat. Ten rats were trained with a light warning stimulus, a 5-sec warning interval, and a .3 mA constant current shock in a bi-directional shuttle box. The intertrial interval was varied with a mean of 30 sec. The door locking mechanism was used throughout. After the animals had reached a criterion of four out of 10 avoidance responses in standard avoidance acquisition, the light CS was no longer presented. The locking mechanism, which unlocked the door simultaneously with the onset of the light, continued to unlock the door 5 sec prior to shock onset. In the next 80 trials no animal made an avoidance response. It was concluded that the unlocking of the door provided no discriminable stimulus for avoidance conditioning.

This device has also been used to lock a manipulandum wheel in an operant box. The locking device was modified by substituting a metal wedge for the flanged U used in the shuttle box. The wedge locked the wheel by resting in grooves on one side of the wheel. Empirical tests similar to that described above again demonstrated that the locking device provided no cue to the animal's. Similar modifications can adapt the locking device to levers and other manipulanda.

NOTE

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