Use of Electric Shock in Research Animals

Purpose: Electric shock is used as an aversive stimulus in behavioral testing with humans and other animals, including invertebrates. Aversive stimuli function as a type of negative reinforcement: The frequency of a measured behavior increases in order to end or avoid the aversive stimulus. Electric shock is favored as an aversive stimulus because it is easily quantifiable; can be manipulated to have discrete or gradual onset and offset; and (at levels typically used in research) does not cause physical damage to the subject. The disadvantage of electric shock includes the fact that it can be painful and is an "unnatural" stimulus (i.e., not normally experienced outside the laboratory). Electric shock stimulates uncontrolled muscle contractions and will result in (increasing) pain as intensity increases.

Species used: Many species although rodents are most commonly used. Impaired motor coordination due to musculoskeletal or other abnormalities will affect performance if animals are expected to coordinate movements to escape the electric shock.

Important considerations

Shock Intensity

The level of shock intensity used must be sufficient to elicit a reaction in the animal but not enough to injure or create unnecessary pain or distress.

The investigator must be familiar with the capacity of their equipment and the shock levels typically applied in the species under study. Devices designed for larger animals (e.g., rats) may not be suitable for mice.

Some authors recommend that the shock intensity being used be evaluated daily by placing a hand onto the electric grid while the shock is being delivered. No more than a "mild tingling" should be felt.

Shock delivered in pulses provides for "shock-free intervals" that allow more effective escape attempts by the animal.

Water decreases the electrical resistance of skin and other tissues. The presence of urine or other sources of moisture will increase the shock intensity experienced by the animal.

Electric current delivered to a small area of skin is perceived as more aversive than the same current applied to a larger area. An animal standing on a rough surface may perceive greater shock intensity than one standing on a smooth surface.

Species, genetic background, and other intrinsic variables may influence an animal's degree of sensitivity and type of response to shock and must be considered. Please consult the references listed at the end of this section for additional information on how to design and set up experiments using electric shock (in rodents).

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Test procedures

Do not require animals to perform complex or skilled maneuvers to escape shock.

Mice show two primary reactions to electric shock: Jumping and running. Genotype will influence which reaction predominates in a strain. Investigators may want to consider the typical reaction pattern of the strain(s) they are using when planning what type of escape response will be required by the animal (e.g., a strain that responds to shock by running may have difficulty learning to escape if jumping is required to leave the shock chamber).

If animals can retreat to non-electrified areas within the apparatus (e.g., chamber edges) they may be able to avoid the shock. This is more likely to occur when tasks are too difficult and cannot be learned quickly.

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Alternative types of aversive stimuli or methodology: Air puffs, loud noises, bright lights or ultrasonic tones. Alternative training methods include the use of a reward (e.g., preferred food) for correct responses instead of punishment (electric shock) for incorrect responses.

For more information on test procedures and experimental design please consult the following references:

Graham JH and Buccafusco JJ (2001). Inhibitory Avoidance Behavior and Memory Assessment. In Buccafusco JJ (ed.), Methods of Behavior Analysis in Neuroscience, p.141-151. Boca Raton: CRC Press.

Wahlsten D (2011). Mouse Behavioral Testing: How to Use Mice in Behavioral Neuroscience. London: Academic Press.

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