

Science Education Collection

Fear Conditioning

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Abstract

Fear Conditioning is a type of learning in which an association is established between a negative unpleasant event and a harmless stimulus. This leads to a fear of the harmless stimulus. This process is largely mediated by the amygdala, which is a brain region involved in emotions and stress reactions. Fear conditioning can be utilized in several ways to understand different aspects of learning and memory.

This video presents an overview of the principles behind fear conditioning, discusses the equipment and a generalized procedure used for this type of experiment. Finally, we'll review some real world applications of fear conditioning in behavioral neuroscience research today.

Transcript

Fear conditioning is a type of learning in which an association is established between a negative, unpleasant event, and a harmless stimulus, thereby leading to a fear of the harmless stimulus. Throughout the animal kingdom, fear of other animals, people, and objects is learned through fear conditioning. The process is largely mediated by the amygdala, a brain region involved in emotions and stress reactions.

This video will present an overview of the principles of fear conditioning, the general procedure of a fear conditioning experiment, and a few real world applications.

Let's begin by exploring some of the principles behind fear conditioning.

There are two main classes of learning: non-associative and associative. Associative learning is further classified into two forms, namely operant conditioning and classical conditioning. Fear conditioning falls under the classical conditioning form of learning.

It has three main components. First, there is a neutral, harmless stimulus, such as a pleasant tone, which is referred to as the conditioned stimulus. The second component is an unpleasant, aversive stimulus, like a mild electric shock, that is paired with the conditioned stimulus. This is known as the unconditioned stimulus, which causes a reaction, such as a startle response, called an unconditioned response. Several such sessions, which involve pairing of conditioned stimulus with the unconditioned stimulus, are conducted. This process is called conditioning.

The third component is the learned fear response to the conditioned stimulus when it is presented after conditioning. This is the conditioned response, and it has a stereotyped physiological response, such as the freezing behavior demonstrated here by the mouse upon hearing the conditioned stimulus in anticipation of the foot shock.

Now that we have reviewed some of the principles behind fear conditioning, let's go over the procedure for a typical fear conditioning experiment in mice.

Experiments are usually performed in a conditioning chamber that is sometimes placed inside a larger sound-attenuating chamber. It is important to calibrate the auditory tone that will be used as the neutral conditioned stimulus. In addition, the electric shock system used to provide the unconditioned stimulus should also be verified as working and calibrated.

Once the equipment is ready, it is time for the association between the conditioned and unconditioned stimulus to be learned. Begin by transferring a mouse to the conditioning chamber. Start the equipment control data acquisition software. Allow the mouse to explore the chamber for some time, in order for it to acclimatize to the conditioning chamber.

For this experiment, a neutral conditioned stimulus tone of 20 seconds is presented. This is followed either immediately, or with a short delay, by a mild electric foot shock that acts as the unconditioned stimulus. In order to reinforce the association, the conditioning trial, consisting of the tone followed by the shock, should be repeated several times after regular intervals. Once training is completed, let the mouse explore freely for two to three minutes before returning it to its home cage.

As a final step, measure the conditioned response after a gap of four to 24 hours. To do this, return the mouse from its home cage to the conditioning chamber; as before, allow the mouse to acclimatize. For this experiment, there will be three neutral conditioned stimulus tone presentations separated by 200 seconds. It is important to remember that no shocks are given. Monitor the mouse for the conditioned response, in this case the freezing behavior upon hearing the conditioned stimulus. Analyze the conditioned response during the testing phase to confirm that the mouse acquired a fear of the harmless stimulus.

After seeing how a fear conditioning experiment works, let's look at some of the ways it is used in research today.

Scientists can apply fear conditioning to study the neural mechanisms of learning and memory. In this study, fear conditioning was combined with functional magnetic resonance imaging to investigate the brain regions involved in acquiring and maintaining the conditioned fear response. In a second experiment, fear conditioning and magnetoencephalography, or MEG, are combined to study the neurobiology behind fear conditioning.

Scientists are not only intrigued by fear conditioning, but also by fear extinguishing, where a learned fear is lessened or eliminated.

Virtual reality settings are used to provide realistic complex customizable settings. In this study, scientists use stimuli, like snakes, which are associated with wrist shocks, in order to condition a fear response in a virtual 3D environment. Once a fear acquisition is complete, scientists

present the conditioned stimulus in different, or the same, environment and study participant's response without giving them wrist shocks. The results reveal fear extinction was greater in participants experiencing a change in environment.

Finally, scientists interested in improving auditory prosthetics are also using fear conditioning to further their research.

Here, rats were trained to fear audible tones, and their heart rate was measured during the conditioned response. The auditory cortex was then electrically stimulated with implanted electrodes to simulate the tone, and the rat's heart rate was again monitored for the conditioned response. Results indicated that the rats perceived the tones without actually hearing them. These findings may be useful in advancing the capabilities of auditory prosthetics.

You've just watched JoVE's introduction to fear conditioning. We presented a brief overview of the principles of fear conditioning, described how a fear conditioning experiment is run, and finally discussed some current applications of this technique. As always, thanks for watching!