ETHOLOGY

I. Development of Animal Behavior

1. Ontogeny of Behaviour

Behavioral development is the result of the continuous interaction of genetic and environmental factors. The genetic code is fixed, but an animal will not develop appropriately without the right cues from the environment. Some behaviours are innate, such as suckling, standing, running, pecking, etc. In animal embryos there are two inborn behavioral patterns and accordingly they are classified as precocial and altricial embryos.

A. Neonatal roots of behavior or Types of embryos and their behavior:

Precocial Embryo:

In various mammals like horse, buffalo, deer, elephant, hamster etc. the embryo behave like a miniature of their parents. Their movements resemble parent as soon as they born. They start walking, feeding, to some extent protecting themselves from enemies etc. e.g. Goat

Altricial Embryo:

In others the embryos do not resemble their parents called as altricial embryos. These embryos have to modify after birth to resemble their parents. Altricial embryos are dependent on their parents for feeding and protection. In some cases they have to be intensively cared. E.g. Kangaroo

B. Theories of behavioural development:

Preformation:

This is an old concept stating that the animal is complete even if it is in form of sperm or egg, so all the behaviour are present in the individual from these stages naturally. This concept is not accepted now.

Systemogenous behavior:

According to this concept, the movements needed for survival under the particular environmental situation develop before birth, and that the outcome may vary from species to species, depending environmental factors available at birth. But behaviour in different species are pre determined.

Epigenesis:

According to this theory various characteristics along with the behavior are not present in the initial stages (sperms or eggs) but they are formed during the development and become visible. This concept was first put forth by **Needleeem** (1959).

The theory explains how the behavior is affected by the genetic and environmental factors step by step in the embryonic development of the individual. Following is the example of the development of the fowl (hen).

STAGE I **P1 + G1 + E1 = P2 (P2 = young chick)**

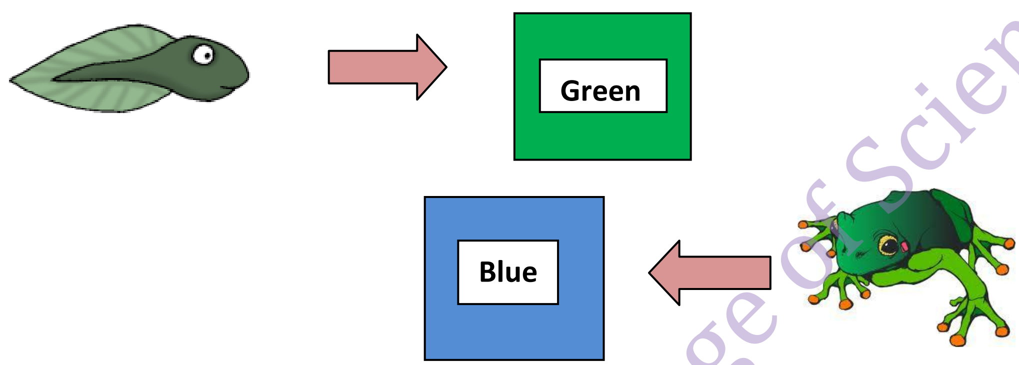
[Where P1 is zygote (phenotype P1) formed after fertilization; G1 is genetic set which is active at zygote stage and E1 is initial environment available inside the egg giving rise to phenotype P2]

SATGE II P2 + G2 + E2 = P3 (P3 = chick juvenile)

STAGE III P3 + G3 + E3 = P4 (P4 = adult fowl)

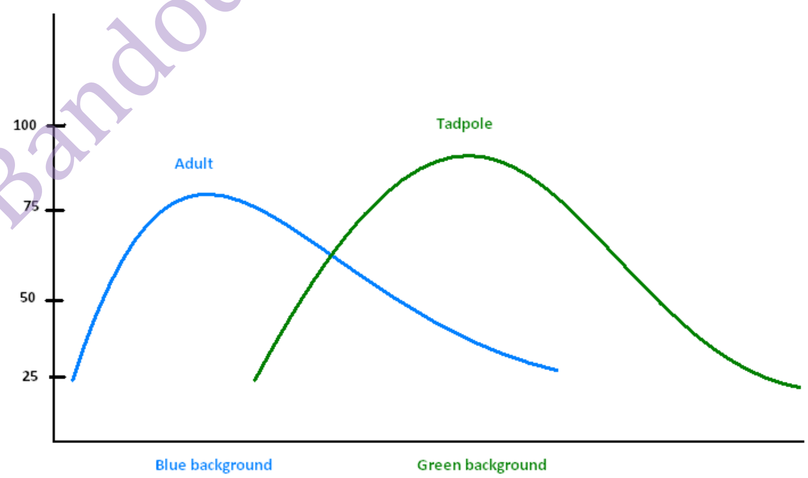
C. Maturation and behavioral changes:

In the animals it has been observed that juveniles behave different as compared to their adult parents. E.g. frog and its tadpole behave differently. When alarmed the frog jumps to blue background whereas the tadpole jumps towards the green background.



The explanation to this difference:- in nature tadpole finds refuge in water behind the aquatic plants (green background) and frog when alarmed on bank of pond then it will find refuge to water (blue background). The phenomenon is also known as **Juvenile Behavior**.

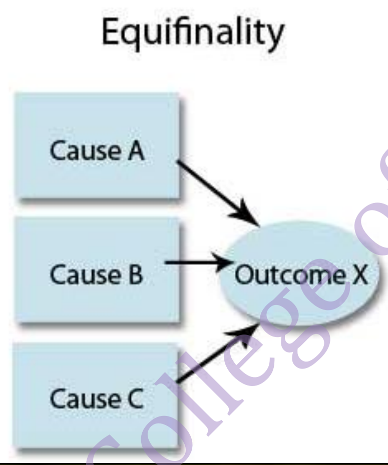
From this it is evident that as the animal grows the behaviour also changes according to its age. The behavior changes due to the epigenetic process.



Graph showing the responses of the tadpole and the frog preferring the background color, as a refuge, differs according to the maturity.

D. <u>Equifinality:</u>

It is the phenomenon by which a structure or behavior pattern may develop by different routes. It is believed that there are a vast number of processes ranging from those that may be influenced or uninfluenced by environmental factors and those that are heavily dependent upon experience. The resultant of all these together finally gives rise to particular personality to the individual of a behavioral pattern is known as **equifinality**.



2. Environmental influence on behavior

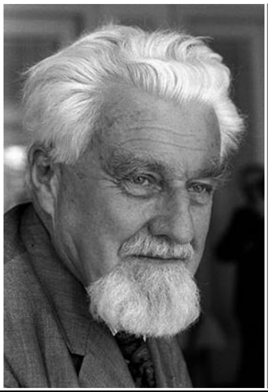
Optimal behaviour development occurs during **critical and sensitive periods** of life subjected to normal environmental conditions.

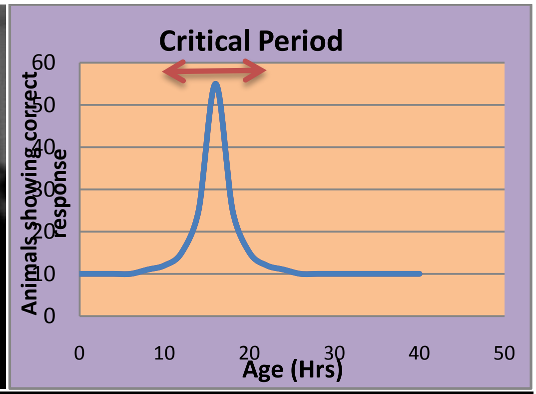
Exposure of newborn to various stimulations encouraging the development of the right skills at the right time is essential during **critical period**. In the wild this often happens as a result of sensitive learning phases and interaction with certain animals at appropriate ages. It has been observed that free and unrestricted environment (enriched environment) between he time of birth and puberty develops problem solving ability in many mammals. On the other hand restricted (deprived) environment has been found to be affecting the performance of the animal in the later stage of life.

Impact of environment starts at embryonic stage itself. An embryo of chick was observed by making a window on the egg shell. In the beginning embryo made passive movement of head due to heart beats. Within few days active head movement and opening and closing of beak appeared. On 7th day movement similar to pecking was seen. It is therefore believed that developing embryo responds to the stimuli from environmental cues present outside the egg.

In the experiment the kittens were kept in dark or closing their eyes by suturing for first 2-3 months of life (critical period). Kitten became functionally blind even if their eyes were normal.the result indicated that the visual pathway in the brain disintegrated. Kittens with single eye sutured showed loss of binocular vision.

3. Sensitive Period During Development (Imprinting)





Konrad Lorenz

Konrad Lorenz studied extensively and popularized imprinting with graylag geese. Lorenz demonstrated how incubator-hatched geese would imprint on the first suitable moving stimulus they saw within what he called a "critical period" between 13–16 hours shortly after hatching. For example, the goslings would imprint on Lorenz himself (to be more specific, on his wading boots), and he is often depicted being followed by a gaggle of geese who had imprinted on him.

1. It appears that certain events in animal's life often have to occur at a particular time during life for effects in the animal behavior at a later stage.
2. The period of time during which the event impose their significant impacts on the behavior of the animal is called sensitive period or critical period of animal life.
3. Imprinting occurs during a particular sensitive period of development which varies according to animal species and circumstances.
4. Imprinting may also have long term effects, and in many animals it affects normal life in later phase of life.

There are various types of imprinting such as:

1. Filial imprinting
2. Sexual imprinting
3. Food imprinting
4. Imprinting to odors
5. Imprinting to specific habitat or nesting substrate

1. **Filial Imprinting**: it is the identification of parental object. It has been seen that a young animal forms an impression of its parent soon after hatching or birth, and follows that object for a period of time thereafter.

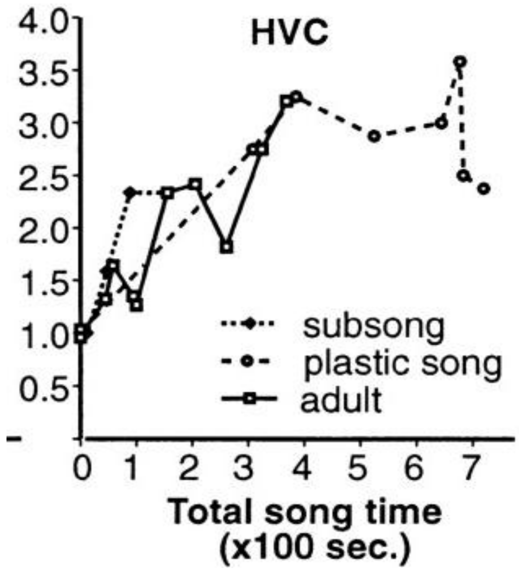
Under natural conditions, the object is the actual parent, and the following is correct. But under artificial conditions, if the true parent is not present , the young animal will follow any other moving object present nearby, including humans and artificial objects like boxes, dummy mother etc.

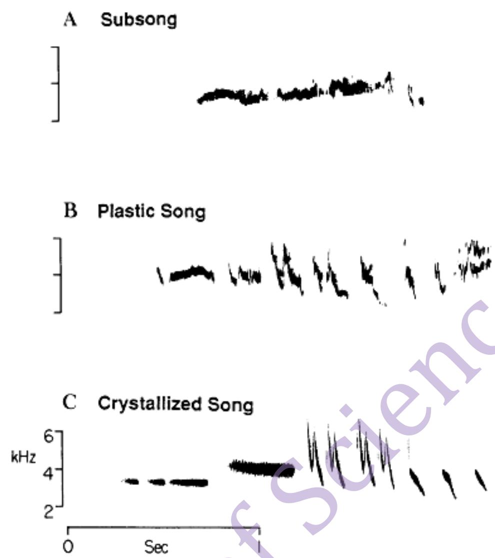
 

2. **Sexual Imprinting**: It is an imprinting that leads to choice of sexual partner. For example Golden eagle males show sexual imprinting with other species females.

Golden Eagle

3. **Singing in Birds**: Development of song in birds is also an example of imprinting that has taken place when young bird hears the song of its parents and memorizes it for later rehearsal. When the young one gets mature it starts singing with scattered small bits and notes. The bits and notes are arranged by time close to parental song but is not exact song called as **sub-song**. With a further practice the sub-adult slowly gets closer to *adult-song* by rearrangement of bits and notes, called as **rehearsed song or plastic song**. And finally makes the *adult-song* called as **primary song**.



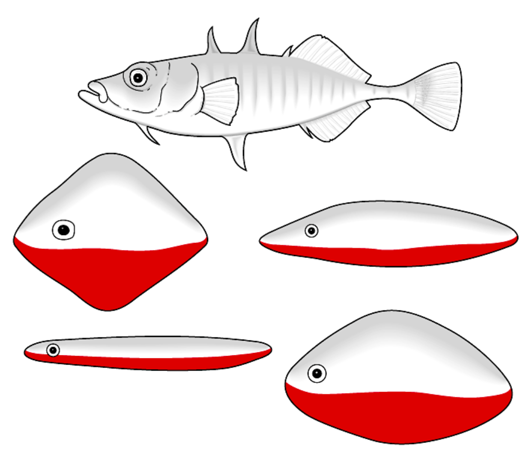


4. Innate Behavior

The behavior present in an individual right from birth is known as innate behavior. This concept was proposed by Lorenz (1939) and Tinbergen (1942) and others. It is determined by heredity and therefore not affected by environmental other factors.

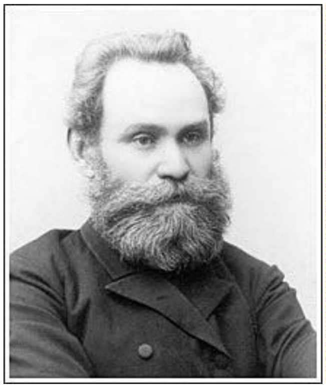
The sequence of innate behavior occurs as follows:

1. The external stimulus triggers the behavior in an animal.
2. Stimulus brings about the **internal reaction** in the body of the animal. The mechanism is known as **innate releasing mechanism** (IRM).
3. IRM finally brings about the external behavior in an animal called as Fixed Action Pattern (FAP).
4. Example: three spined stickleback male protecting its nest from rival male, well known as Tinbergen's experiment.

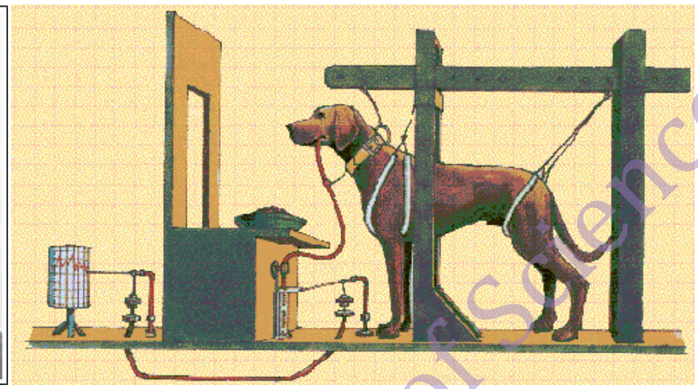


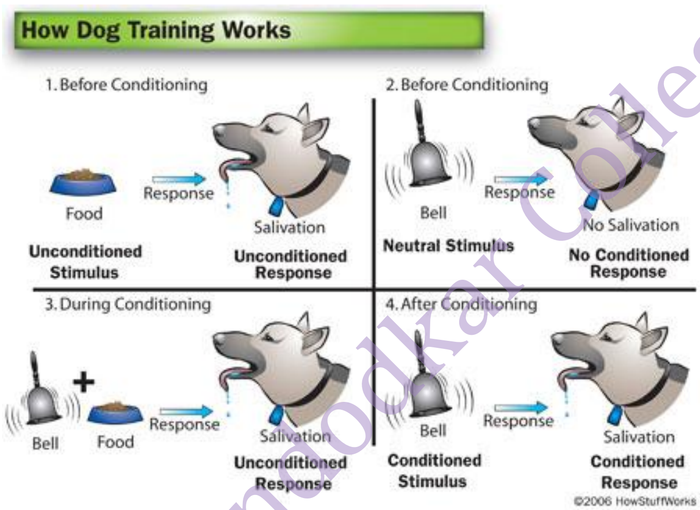
II. Animal Learning

1. Classical conditioning (Pavlov's experiment)



Ivan Pavlov



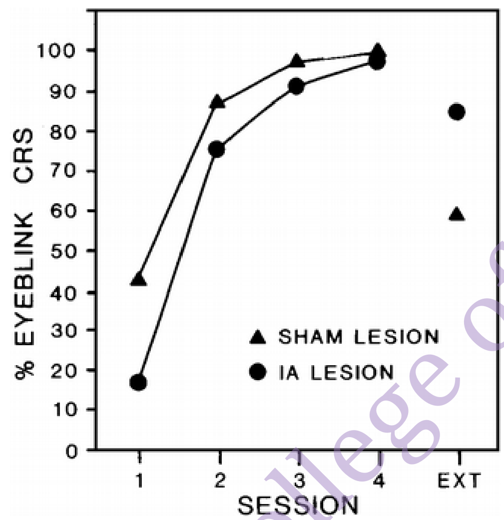


Classical conditioning refers to change in stimuli that bring about normal behavior. It is based on stimulus-response system. Bell food salivation experiment was demonstrated by **Ivan Pavlov**. In this a basic stimulus such as food is referred to as **unconditional stimulus** (UCS) and basic response like salivation is considered as **unconditional response** (UCR). If other unnatural stimulus such as a sound of bell is produced there won't be salivation. But when food (UCS) is properly paired with sound of bell then after several attempts the dog starts correlating the bell sound with food. After acquisition the dog salivates by merely a sound of bell. At this point the sound of bell is called **conditional stimulus** (CS) and salivation is known as **conditional response** (CR).

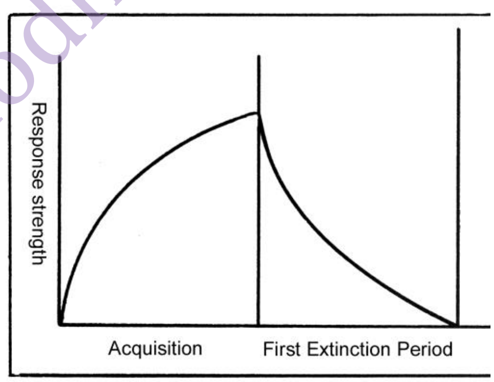
In other example if the bell is now paired with light several times then dog will also exhibit salivation merely with light. In such case when one CS is paired with other CS then it is called as **second order conditioning**. The food is considered to be reinforcer in conditioning.

Conditioning in which positive reinforcers are used such as food are known as **positive conditioning**. When negative reinforcers are used such as puff of air on rabbit's eyes is known as **negative conditioning**.

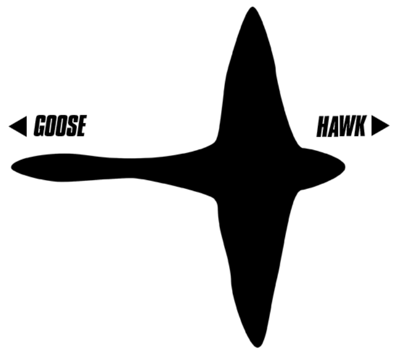
Acquisition: In conditioning when animal starts giving conditional response with conditional stimulus then it is said to be acquisition point. Acquisition increases with number of trials.



Extinction: as animal acquires the conditional stimulus at the same time if the pairing of CS is stopped with UCS then animal CR decreases gradually and finally no CR occurs. This phenomenon is known as extinction.

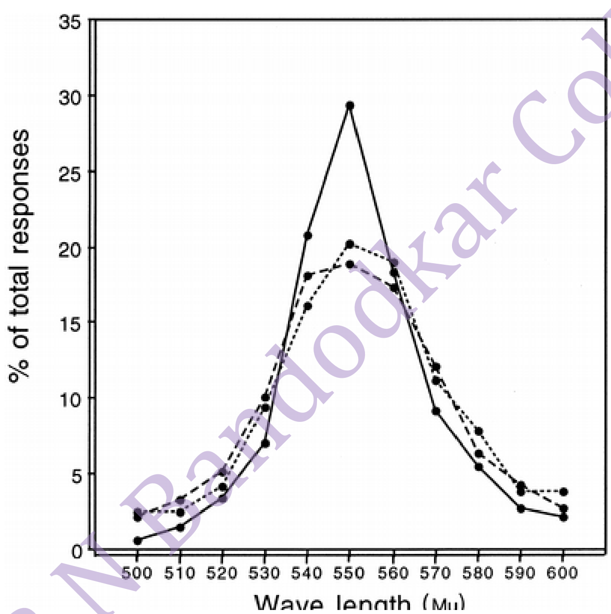


Habituation: When the stimulus is unknown or unfamiliar, the various animals responds to it vigorously and exhibit the behaviors associated with danger like, hiding, remaining motionless, jumping, fleeing etc. but after repeated occurrence without any significant meaning the stimulus loses its importance or novelty and is ignored by the animals.

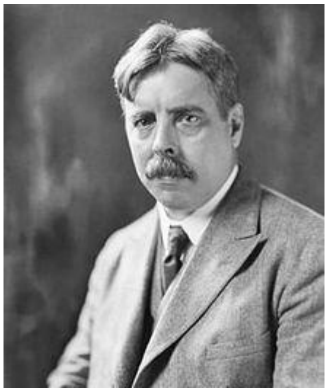


The classic example is of **Hawk-goose** model experiment in which when the **silhouette** was flown in hawk direction the young chicks of turkey were alert and tried to escape whereas when the silhouette move in goose direction the chicks didn't react. This indicates that the turkey chicks were habituated with goose shadow since geese are very common in nature and they often fly over head. But the shadow of hawk was strange for the chick and hence they were frightened.

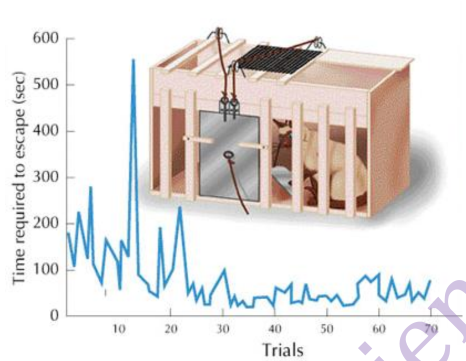
Generalization: is a phenomenon by which an animal after learning a particular response to a particular stimulus may same reaction to another similar stimulus. This means animal learns to response in a similar manner to similar stimuli. Thus generalization refers to the perception of common characteristics. E.g. human beings can easily differentiate the tone of 1000 hertz from that of 300 hertz but pigeons which are trained to respond to 100 hertz will treat 300 hertz as similar that means they generalize the two tones.



2. Instrumental Learning



Edward Thorndike



When animal learns that by making particular response the reward is obtained is known as instrumental learning. Giving appropriate response is instrumental to gain a particular reward. Thorndike (1898) described this type of learning as **'trial, error and accidental success'.** Instrumental learning is therefore, commonly known as **trial and error learning. Thorndike** first analyzed instrumental learning using a puzzle box with a cat. He kept a hungry cat inside box and place food outside it. Hungry cat initially tries different ways to reach the food including reaching through the slat of the box. After a series of trials cat accidentally presses the pedal to open the door. Cat could get food as reward. On subsequent trials, the cat's activity gradually concentrates near the pedal and finally learns to open the box by pressing the pedal.

In this experiment Thorndike observed that the response followed by rewards increased the probability of occurrence he called them as **reinforcers**. On the contrary when response followed by averting or annoying consequences would decrease the occurrence, he called them as **punishments**. Thorndike called this phenomenon as **'Law of Effect'**

Whenever any animal modifies its behavior in the course of obtaining a reward, such as food, mate, or a nest, it indicates that the instrumental learning is involved.

1. Reinforcement:

Reinforcement is a term used in the study of animal learning in which probability of response is increased. **Responses from the environment that increase the probability of a behaviour being repeated or increased.** Responses can be made highly resistant to extinction by training up to very high reinforcement schedules. Reinforcers may be positive or negative.

a. **Positive Reinforcement** a particular behavior is strengthened by the consequence of experiencing a positive condition.
   For example: A hungry cat presses a pedal in its cage and receives food. The food is a positive condition for the hungry cat. The rat presses the pedal again, and again receives food. The cat's behavior of pressing the pedal is strengthened by the consequence of receiving food.
b. **Negative Reinforcement** a particular behavior is strengthened by the consequence of stopping or avoiding a negative condition.
   For example: A cat is placed in a cage and immediately receives a mild electrical shock on its feet. The shock is a negative condition for the cat. The cat presses a pedal and the shock stops. The cat receives another shock, presses the pedal again, and again the shock stops. The cat's behavior of pressing the pedal is strengthened by the consequence of stopping the shock.

If we carefully examine the behavior dog in the classical conditioning and the behavior of cat in the instrumental learning it is seen that the two different cases of reinforcement are involved.
In classical conditioning the contingency occurs between CS (the bell) and the UCS (the food). In this case the food is the reinforcer and it is applied regardless of response of animal (dog). In instrumental learning the food (reinforcer) is awarded only after an appropriate response (pressing the pedal).

2. Punishment:

Punishers: Response from the environment that decrease the likelihood of a behaviour being repeated or increased. Punishment weakens the behavior. In Punishment a particular behavior is weakened by the consequence of experiencing a negative condition. So that behavior is made less likely to occur in the future as a result of that bad consequence. Punishment is a way of learning that occurs when some sort of unpleasant, annoying or aversive consequence that weakens a behavior. **Punishment could be positive or negative.**

Positive punishment:

Positive punishment is something unpleasant that is applied to reduce a behavior. Positive punishment, when applied correctly, is the most effective way to stop unwanted behaviors.

For example: A cat presses a pedal in its cage and receives a mild electrical shock on its feet. The shock is a negative consequence for the cat. The cat presses the pedal again and again receives a shock. The cat's behavior of pressing the pedal is weakened by the consequence of receiving a shock.

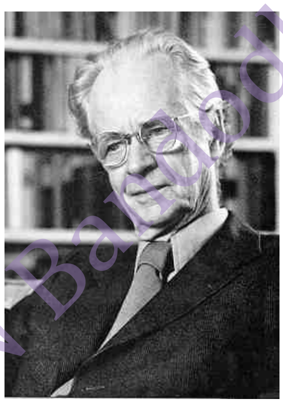
Negative punishment:

Negative punishment is reducing behavior by taking away something Good. If the animal was enjoying or depending on something Good she will work to avoid it getting taken away.

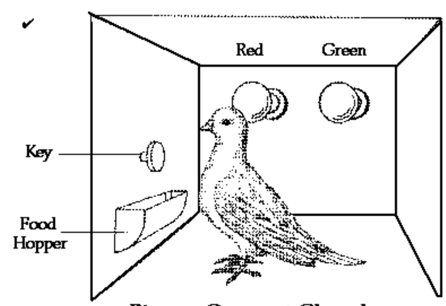
E.g. The window looking into the other monkey's enclosure is shut when the first monkey bites the trainer.

3. Operant Behavior

The term "**Operant**" refers to how an organism operates on the environment, and hence, operant conditioning comes from how we respond to what is presented to us in our environment. Operant behavior can be defined as a spontaneous action without any obvious stimulus. Operant is a set of acts that constitutes some action of an organism. Operant behavior is a term first used by B.F. Skinner who was one of the best-known psychologists in the behaviorism school. He argued that, with the selection of appropriate rewards, this system could be used to teach anything.



B. F. Skinner



Pigeon Operant Chamber

A. **Operant conditioning:**

A learning associated to the operant behavior is termed as operant conditioning. This is operant conditioning, "the behavior is followed by a consequence, and the nature of the consequence modifies the organism's tendency to repeat the behavior in the future." *In other words a behavior* *followed by a reinforcing stimulus results in an increased probability of that behavior occurring in the future.* To study the operant behavior Skinner devised the free-operant procedure in which the animal was allowed to take part freely in various activities and at the same time, the experimenter attempted to manipulate the consequences. In the experiment, pigeons and rats were mostly chosen. These animals were trained to perform a task to obtain a reward. E.g. a pigeon was required to peck an illuminated disc, called a key, or a rat was required to press a bar.

B. Shaping:

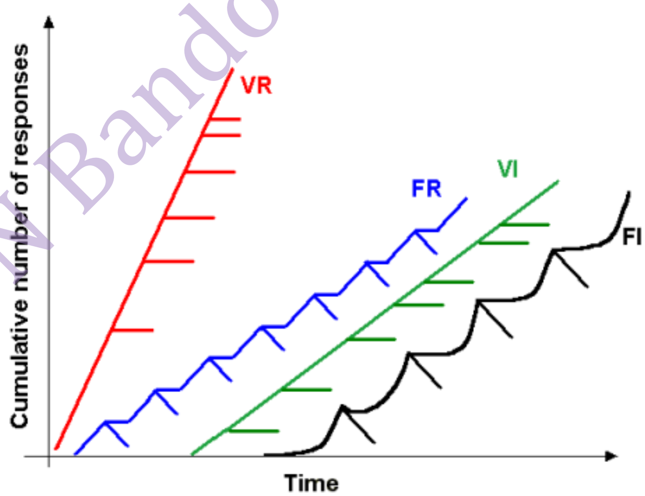
A question Skinner had to deal with was how we get to more complex sorts of behaviors. Skinner called 'shaping' to the process of learning more complex behaviors. Shaping is a phenomenon in which an animal learns difficult and complex behaviors, by introducing desirable modifications in their behavior. In operant conditioning shaping can be achieved by giving rewards at different schedules.

Rewards were given after different **schedules**. Such as **Variable ratio (VR) or fixed ratio (FR) schedule** and **fixed interval (FI) or variable interval schedule (VI)**.

In **fixed ratio schedule** the pigeon is not rewarded for every peck but it is rewarded after a definite number of pecks e.g. 4 pecks; 8 pecks…so on.

In **variable ratio schedule** the reward was given after variable number pecks such as 2 pecks; 9 pecks; 5 pecks…so-on.

In fixed and variable interval instead of number of pecks the **time of waiting period** (interval) is considered.



So in **fixed interval schedule**, even if pigeon pecks several times but food is not rewarded unless a particular waiting period is over, e.g. 2 minutes; 6 minutes…so on.

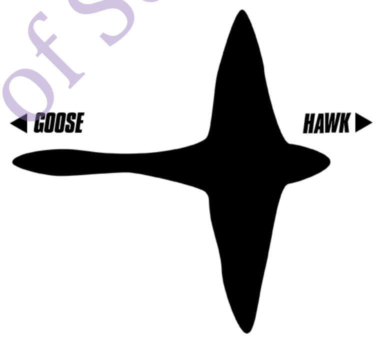
In **variable interval schedule** time period is not fixed.

III. Biological Aspects of Learning

4. Learning to avoid enemies

When an animal is experiences any situation of danger it tries to behave such a way so as to minimize its exposure to the situation called as avoidance reaction. Thus avoidance reaction is nothing but a kind of defensive behavior. This defensive behavior of animal is because of certain fear provoking stimuli which may be sign stimuli. Sign stimuli are responded by the animal in an instinctive manner, i.e. without any earlier experience of such stimuli. Hence it is also called as innate avoidance behavior.

A classical example is of the **silhouette**. When hawk-like silhouette is shown to young birds (chick), they exhibit innate avoidance behavior. Whereas silhouette of a flying goose, does not normally affect the chick. Different kind of innate avoidance behavior is observed in different animals. It may be warning signals, freezing posture, protean display etc.



1. **Warning signals**: warning signals are used either to warn or discourage an attack by enemy. Numerous species have several tricks to startle the enemy by sudden displays, such as suddenly exposing eye-spots on the wings as in case of hawk-moth or producing noise such as claps, hissing or vocalization.

2. **Freezing posture**: many animals remain motionless to avoid being spotted by their enemy. E.g. Opossum (*Didelphis virginiana*) remains motionless on its back if attacked by predator such as dog. Similarly the spotted white-tailed deer fawn remains freezing and pretends to be dead when attacked by predator.

3. **Protean display**: Certain animals display startling body postures to frighten the enemy. Such as change in body shape, posture and size or spreading of wings and legs. E.g. Cat exhibit rising hump of the back and raise the tail when attacked by a dog.

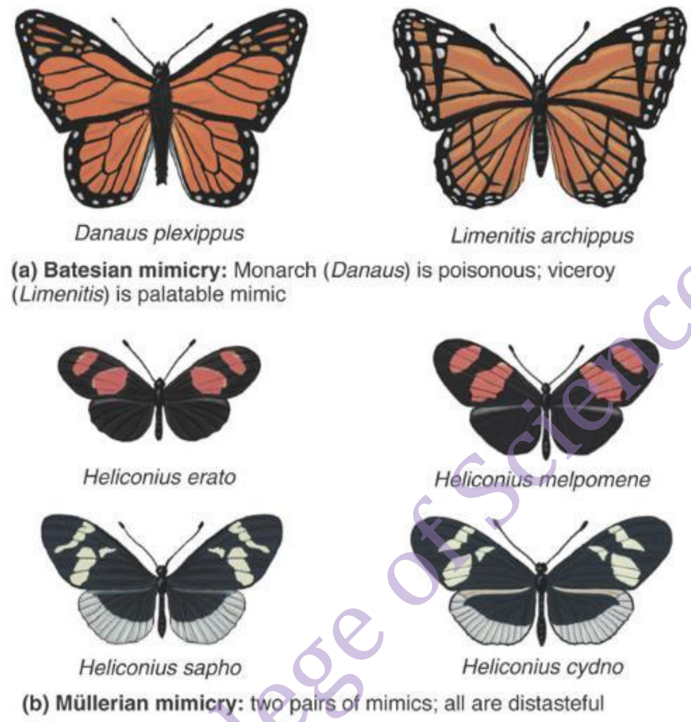
Mimicry:

Behavior of animals to avoid enemies is known as avoidance reactions. It is a kind of defensive behavior. Avoiding is achieved through the way by which animal try to face minimum effects of the consequences. One of the example of avoiding the enemy or escape of prey is achieved by mimicry. Mimicry can be described as the resemblance of one animal the mimic, to the other animal called the model, so that two are confused by a third animal called as enemy or predator. Sometimes the mimicry is also seen in the predator to confuse their prey. There are different kinds of the mimicry, such as Mullerian mimicry, Batesian mimicry, Mertensian mimicry and automimicry.

1. **Batesian mimicry**: Batesian mimicry is named after English naturalist Henry Walter Bates. When the noxious species coloration is resembled by a harmless edible species to avoid predator is called as Batesian mimicry. Batesian mimicry is common in insects. E.g. Viceroy Butterfly is edible and monarch butterfly is toxic if eaten by bird. Viceroy butterfly is a mimic and monarch butterfly is a model. Monarch butterfly caterpillar feeds on milkweed containing cardiac glycosides which is a toxin. Cardiac glycosides are accumulated by caterpillar is eventually carried to the wings of adult monarch butterfly. If this monarch butterfly is eaten by any predatory bird it causes nausea and omitting. Thus once any bird has an experience of eating monarch butterfly will not eat the mimic viceroy butterfly.

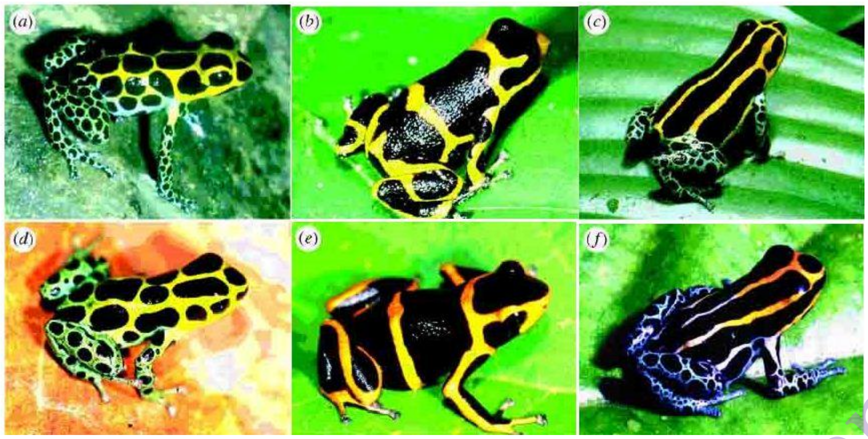
Mimicry II

a) Batesian mimicry between toxic monarch (model) and harmless viceroy (mimic), left and right, respectively. b) An example of Müllerian mimicry, where both ecologically sympatric pairs are distasteful, and both have warning coloration.



2. **Mullerian mimicry**: It was proposed by German naturalist Fritz Muller. Where two or more species have very similar warning signals and both share anti-predation attributes (such as non-edible). When number of noxious animals share the same warning coloration is known as Mullerian mimicry. Thus it is also known as **mutualistic or convergent mimicry**. Mainly insects exhibit Mullerian mimicry. Milk weed bugs show various combinations of the red and black colors but share the similar appearance and warning coloration. Others like wasps and bees also exhibit Mullerian mimicry.





Mullerian mimicry can be found in the poison dart frogs of South America and Madagascar. Poison frogs of the *Dendrobate* genus are known to secrete poison onto their skin as a means of protection. Most of them are marvelously colored with bright yellow, green, and blue, and some have elaborate striped patterns. All of this coloration serves as a warning sign for any predators. Once a predator tries to consume or attack one of the frogs, they will be more likely to leave all of the brightly colored frogs alone.

Another example is all of these butterflies of the genus *Heliconius* (*H. erato* and *H. melpomene*) use Mullerian mimicry. Their bad taste is derived from the food that their caterpillar form eats before they undergo metamorphosis and become butterflies. Since both of these species have the same bad taste, most predators will need to only try one to learn to avoid the other.

3. **Mertensian (Emsleyan) mimicry**: It is named after M.G. Emsley and German herpetologist Robert Mertens. This type of mimicry is found in snakes and insects. Some snakes resemble other dangerous species. They also display subtle movements of dangerous snakes such as hiss, shaking tail, flattening neck etc. some flies resemble dangerous bees. The deadly prey species mimic the

less deadly species and thus are avoided by their predators because of their common appearance. Sometimes harmless species also mimic less deadly species and thus get the protection.

Mullerian mimicry in coral snakes and similar form: (left) the venomous Eastern coral snake *Micrurus fulvius*; (right) the harmless king snake *Lampropeltis polyzone*; and (bottom) the moderately venomous rear-fanged false coral snake (*Oxyrhopus*). In above case moderately venomous false coral snake is a **model** and the deadly coral snake and harmless king snakes are **mimics**.

4. **Automimicry:** *Automimicry* or *intraspecific mimicry* occurs within a single species, one case being where one part of an organism's body resembles another part. Examples include snakes in which the tail resembles the head and show behavior such as moving backwards to confuse predators and insects and fishes with eyespots on their hind ends to resemble the head. The phrase is also used when the mimic imitates other morphs within the same species. When males mimic females or *vice versa* this may be referred to as sexual mimicry.

Two headed skink

Fish with eyespot on tail

Caterpillar snake head at posterior

5. Learning to avoid sickness

According to Scott and Verney (1947), the animals learn to associate the stimulus characteristics of the food with subsequent beneficial feeling of recovery from sickness. It means the animal recognize the food types whether they are beneficial to cure from sickness. Number of experiments has been conducted on rats to understand this phenomenon. It has been seen that a sodium deficient rat easily learn which food contains salt because it can recognize salt after eating the food. And then rat selects that particular food containing more amount of sodium.

Rozin (1976) believes that the rats categorize food into four classes, namely, **novel, familiar-safe, familiar dangerous and familiar beneficial foods**. A rat suffering from dietary deficiency was supplied with familiar safe food, a familiar averse food and new food; it was then observed that the rat preferred the familiar safe food. The situation is more complicated since rats have natural aversion to novel foods.

Rodgers and Rozin (1966) observed that the rats with thiamine deficiency show an immediate preference for new foods, even if the new food is deficient in thiamine and the old food is supplemented with thiamine. It is the reason that why the rat population from an area is very difficult to eradicate by way of using a poison as rats tend to avoid unfamiliar foods. If rat survives after consuming small amount of poisoned food , it will never touch the same type of food again.

6. Insight Learning

Thrope (1963) defined insight learning as 'the sudden production of the new adaptive response not arrived at by trial behavior.' The term insight has been actually used by scientists when it is observed that animals solving problems very

rapidly or for normal trial and error. Insight learning differs from trial and error learning since it involves the sudden production of a new response. Wolfgang Kohler (1913-17) conducted experiments on chimpanzees of using tools for obtaining food rewards.

In one experiment, the chimp was required to use stick to get the fruit placed outside the cage. The chimp was given two bamboo poles but both not long enough to reach the food. However it was possible to reach the fruit by fitting the poles together.

After many unsuccessful attempts to reach fruit with only one pole, the chimp gave up and started playing with the poles. While playing, accidentally the chimp joined the poles together by pushing the narrow pole inside the hollow of the other. The chimp then jumped up and immediately ran to the bars of the cage and managed to get the fruit with the long jointed pole.

7. Representation

Representation is to study or inculcate the problem into details and use this knowledge to plan the problem-solving procedure. In other words it is involvement of **mental image** of the goal to be achieved.

Procedural representation

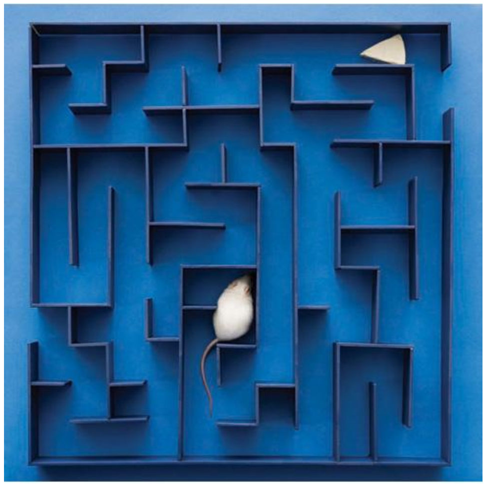
Representation of knowledge by means of procedure that can perform skills **step by step** without reasoning about it (no logics). **Procedural Representation** describes knowledge as set of instructions to solve a problem. In this type of representation animal does not have mental image of the goal to be achieved. It enables animals to acquire motor skills and gradually improve them. It is a set of instructions related to some procedure.

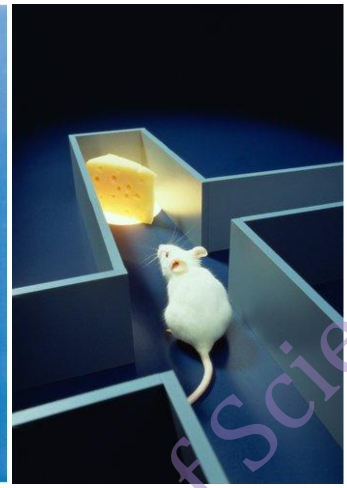
Explicit representation

Fully and clearly expressed; leaving nothing implied. Fully and clearly defined or formulated representation. In Explicit representation the mental image of the goal to be achieved is clear. Explicit representation is similar to declarative representation but **lacks language**.

Declarative representation

Declarative representation involves detailed problem solving knowledge which **involves language to declare it**. A form of knowledge representation in terms of formulas, data structures, or rules of a **restricted form**. The primary advantage of declarative knowledge is the ability to use knowledge in logical ways.





Procedural representation: In case if the rat has no knowledge of the food kept in the maze then it has to follow the instructions every step to complete the procedure of getting food; such phenomenon is called as procedural representation.

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