

RESPONSE AND BEHAVIOUR IN ANIMALS.

DEFINITION OF TERMS

Behavior: It is an outwardly expressed course of action produced in organisms in response to stimuli from a given situation. The action in some way shows the relationship between the organism and its environment and has adaptive significance to the species. **OR** - Is the sum total of responses of an organism to changes in its environment. **OR**- Is a particular pattern of activity by which an organism makes a response to stimulus which is stereotype.

Stimuli: changes in internal or external environment of an organism.

Response: change in activity of organism / or its reaction to stimulus.

Ethology: is the scientific study of animal behavior, particularly when that behaviour occurs in the context of an animal's natural environment.

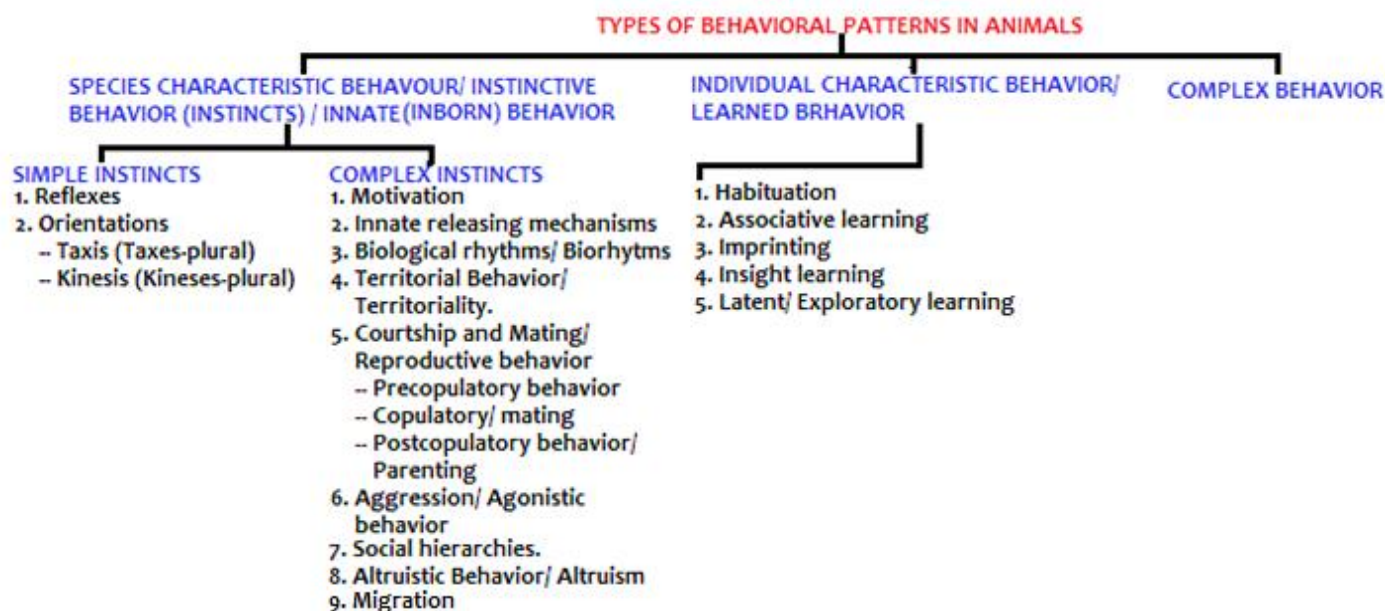
Adaptive significance of behavior

To perpetuate the organism in terms of survival and reproduction.

TYPES OF BEHAVIOUR

There are two types of behaviour;

- ✓ **Species characteristic behaviour**- This is the behaviour showed by all members of the species.
- ✓ **Individual characteristic behaviour**- This is the behaviour which varies from one individual to another. It includes stereotyped behaviour (innate learning) e.g. courtship and copulation. It also includes behaviour carried by an animal in its life time.



INNATE/ INSTINCTIVE/ INBORN/ SPECIFIC CHARACTERISTIC BEHAVIOR.

Natural, inborn behaviour that is genetically programmed hence inherited.

It includes; orientation (kinesis and taxis), simple reflexes and instincts

Characteristics of innate behavior.

1) It is inherited not acquired. 2) It is similar among members of a species though slight differences occur between males and females. 3) It is sequential, the completion of one activity results in start of another. 4) It is unintelligent, the individual does not know the purpose of the behavior.

Note: 1. since innate behavior is encoded in DNA, it is subject to genetic change through mutation, recombination, and natural selection. 2. Just like physical traits, innate behaviors are phylogenetic adaptations that have an evolutionary history.

Advantages of innate behaviour.

- Innate responses are generally rapid – organisms can react quickly to their environments (predators etc.) e.g. the earth worm quickly / rapidly withdraws into its burrow, away from the danger.
- Innate behavior suits species that have short lifespans – they don't have time to learn behaviors
- Suits species with no parental care/solitary lifestyles as they can't learn behaviors from other members of the species
- It does not make enormous demands from the higher centers of the nervous system hence it places economy on nerve pathways.

CATEGORIES OF INNATE BEHAVIOUR.

SIMPLE INSTINCTS

1. REFLEX

This is an involuntary stereotyped response of part of an organism to a given stimulus.

It is a simple, automatic response of a body to a stimulus that involves no conscious control e.g. Pull hand away from hot surface, baby feeding, horse tail swatting at flies.

They are determined by the inheritance of specific patterns of neurons forming cranial and spinal reflexes.

Neurons are concerned with flexion or stretch.

Flexion responses code for withdraw whilst stretch responses code for balance and posture.

There may be an overlap of innate and learned behavior when the brain modifies reflexes according to circumstances. These are called conditioned reflexes e. g. blinking the eye in response to sudden movement.

2. ORIENTATION BEHAVIORS

These are coordinated movements (walking, flying, swimming, etc.) that occur in response to an external stimulus. These behaviors have adaptive value for survival by helping the insect locate (or avoid) the source of a stimulus.

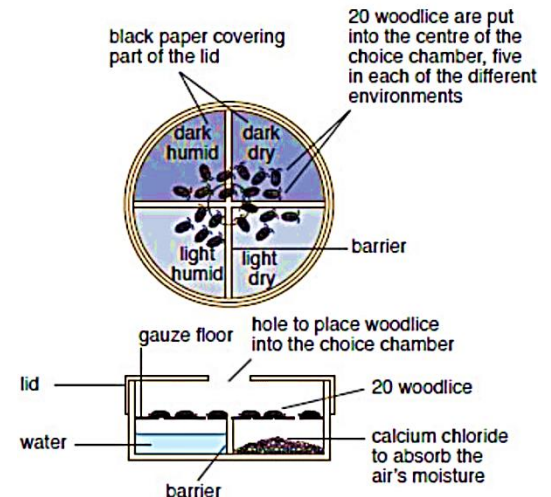
A. KINESIS: This is a non-directional orientation behavior where the rate of movement is directly proportional to the intensity of a stimulus.

Example: Woodlice move around rapidly and randomly when exposed to light, and dry conditions until they find better conditions then they stop moving or move slowly.

B. TAXIS: This is a directional movement of a whole organism in response to an external directional stimulus. If the movement is towards the stimulus, it is positive, if it is away from the stimulus it is negative. Some orientations involve maintain a dorsal light reaction in which the dorsal side is usually uppermost e.g. in fish such as Plaice.

Example: Fly maggots move away from light sources (negative **photo taxis**)

Direction of stimulus is detected by moving the head which bears the major sensory organs. This enables symmetrically placed receptors on the head to detect stimulus. It is called **klinotaxis response**.



COMPLEX INSTINCTS

1. MOTIVATION.

Motivation: a sum total of factors which change/modify the extent and the nature of any behavioral response.

NB: The **same stimulus** does not always evoke the **same response** in the **same organism**. The distance is always circumstantial always and may be controlled by either internal or external factors.

Example of

1. Presenting the same food to a starved animal will produce a different response from that shown by an animal that has been fed. Thus, varying strengths of responses may be produced at different degrees of hunger in between the two extremes (starvation and satisfied). However, if the feeding response would place a hungry animal in danger if being captured by a predator, the feeding response would be withheld until the danger has passed.

2. Female mammals are receptive are only receptive to mating attempts by males at certain times of the year, which coincide with the oestrus cycle. For example, timing of oestrus in primates is signaled by a swelling and change of colour of the genital part of the female, such behavior reduces attempts of a male to attempt mating when female is not receptive.

NB: The signals used to bring about a change/ modification in behavior are called **sign/key stimuli** and, depending upon their origin or function, are classified as **motivational, releasing or terminating stimuli**.

Motivational stimuli: Provide the goal or drive to prepare the organism for activity. These stimuli determine the animal's state of responsiveness. For example, (1) As depleted food reserve in the body during hibernation prepares the body for awakening and food seeking. (2) Increasing day length induces territorial behavior and courtship behavior. Note: Motivational stimulus may therefore be internal or external.

Releasing stimuli or releasers: These are simple stimuli or sequence of stimuli produced by a member of a species which evokes a behavioral response in another member of the same species. These stimuli elicit/ evokes particular responses when the animal encounters them e.g. (1) sight of food evokes the desire to eat when hungry; (2) secretion of pheromones evokes mating by males to receptive females; (3) large abdomen (male) in stickleback fish elicits a flight response in another male; (4) red spotted beaks in adult herring gulls (birds) evoke pecking action by the herring gull chicks in seeking for food; (5) displacement of eggs from the nest evokes rolling of eggs into nests in ground nesting etc.

Function of releasers

- They serve as a signal to initiate appropriate behaviour.
- Coordinate interaction between individuals.
- It ensures that the same kind of behaviour takes place in different animals of the same species minimizing conflicts.
- Play role in avoiding fights.

Terminating stimuli: terminate/end/ complete a behavioral responses; e.g. (1) a full stomach terminates feeding; (2) external visual stimuli of a successfully completed nest will terminate nest building in birds; (3) internal satisfaction accompanying ejaculation in the male will terminate copulation.

ANIMAL WELFARE: is a measure of how well an animal copes with its environment; If the animal fails to cope or its coping efforts have detrimental effects on the productivity, then the welfare of the that animal is poor. Welfare can also be considered as absence of suffering.

2. INNATE RELEASING MECHANISMS (IRM)

Innate releasing mechanism is a complex, perfect and unadjustable/fixed neural network, in response to a **sign/key stimulus or releaser**. Once released, a **fixed action pattern** runs to completion even in absence of the guiding stimuli.

FIXED ACTION PATTERN (FAP): Is an instinctive (inborn/innate), complex behavioral sequence that is highly stereotyped and species-characteristic. Fixed action patterns are produced by innate releasing mechanisms.

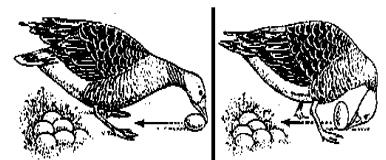
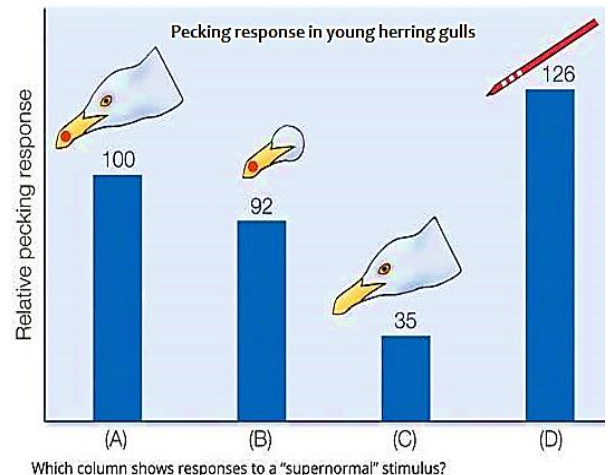
They are controlled and occur at the peripheral receptors or within the central nervous system. **For example:** - Chemoreceptors on the male moth antennae are only sensitive to the sex attracting chemicals (**pheromones**) produced by the female of that species and not to those of other species. **Note:** The animal performs such a behavior without a period of learning.

Characteristics of a fixed action pattern. They are six and include;

1. **Stereotyped:** occur in rigid, predictable, and highly-structured sequences.
2. **Complex:** are not simple reflexes, rather are complex patterns of behavior
3. **Species-characteristic:** occur in all members of a certain sex and / or given age when they have obtained certain level of arousal.
4. **Released:** occur in response to certain sign stimulus or releaser.
5. **Triggered:** once released, fixed action patterns continue to completion, even when there are changes in the surrounding environment.
6. **Independent of experience:** not learned.

Examples of fixed action patterns.

- Males of a given species are only sensitive to pheromones from females of that species and not from a different species.
- A male stickleback fish attacks any male fish who enters his territory/ mating nest built during breeding season; while the female stickleback fish is sensitive to red color of belly of male, hence sexually receptive and triggers behavior in male resulting in fertilisation of her eggs. (NB: The male stickleback only turns its head red in preparation for breeding).
- **Herring gull chicks use a moving red spot on bill as sign stimulus to recognize their mother, and they continuously increase the pecking rate when a yellow stick with red streaks is provided.**
- Nestlings open their beaks wide on every immediate return of the parent in anticipation of food.
- Foster parents respond by working harder to provide food when the nestling provide higher levels of sign stimulus with noisier, more energetic behavior, communicating urgent need for food.
- Toads capture any flying/ moving small sized object (prey), and can starve even though it is surrounded by dead insects, since it is only sensitive to moving animals/ objects as prey.
- Yawning in primates, once triggered and released, one yawns until it is fully complete.
- **Graylag goose rolls the egg back to the nest using side-to-side head motions. If the goose loses the egg during retrieval process, it stops head motion, but continues the pulling motion of retrieval.**



CHECK PROGRESS:

➤ What is the evolutionary significance of fixed action patterns?

Fixed action patterns increase both **fitness**; and **speed** in response; since it does not require learning; hence confer a selection advantage; to organisms such as **egg retrieval behavior of graylag goose**; enables rolling back eggs to the nest if displaced; ensuring survival of her eggs until hatching; and her chicks until they can live independently;

➤ What is the evolutionary disadvantage of fixed action patterns?

Fixed action patterns are **predictable**; leading to **over exploitation**; for example in **brood parasitism** where one species hands off task of raising their young to other bird species; by laying eggs in nest of another species; which will then parent its young ones;

EXCEPTIONS OF FIXED ACTION PATTERNS. These are responses in case of interruption of a fixed action pattern.

1. VACUUM ACTIVITY/BEHAVIOR: is a fixed action pattern delayed to be released, but later released in the absence of a sign stimulus or releaser and ends up performing a right response in a wrong situation without apparent need or stimuli.

Examples.

- In courtship behavior of ring doves, when male ring dove is isolated from their own species, will resort to courting a pigeon or a human's hand, or expressing courtship activity alone in another their box when left alone for a long period of time.
- A bird snaps at imaginary insects in the air even when there are no insects.
- A cock deprived of hen(s) will display to an inanimate object such as a bucket.
- Domestic squirrels raised in a metal cage will go through entire sequence of nut-burring activities as if it were in the bush.
- Showing irritation towards someone who is not the cause of irritation but acts as a substitute.

2. DISPLACEMENT ACTIVITY/ BEHAVIOR: is fixed action pattern performed which is irrelevant to an excess of one or more sign stimuli present. It occurs when an animal experiences high motivation for two or more conflicting/ incompatible behaviors, resulting into a displacement behavior usually irrelevant/ unrelated/ out of context to the competing sign stimuli.

Examples.

- Two male sticklebacks dig/ dive to the bottom/vertical position, picking something up when the two clash at point where their two boundaries meet.
- One of a pair of birds involved in a territorial dispute/ fight may begin nest-building activities, such as pulling up grass, when presented with a choice between fighting and fleeing.
- A human may scratch his or her head when they do not know which of two options to choose.
- A bird may pick up nesting material from the ground and throw it away on being disturbed from the nest.
- Walking up and down when stressed.

Significance of displacement and vacuum activity.

- Relieves/reduces stress/frustration; prevents an animal from engaging from open conflicts in which it would get injured or waste energy;

NB: displacement activities are done unconsciously

3. BIOLOGICAL RHYTHMS/ BIORHYTHMS

These are **cyclical biological and behavioral patterns/ events that reoccur in time in a repeated order and with a repeated interval between occurrences.** They can occur often, like sleeping every night, or can occur once, like an insect developing from a larva.

Biological rhythms can be:

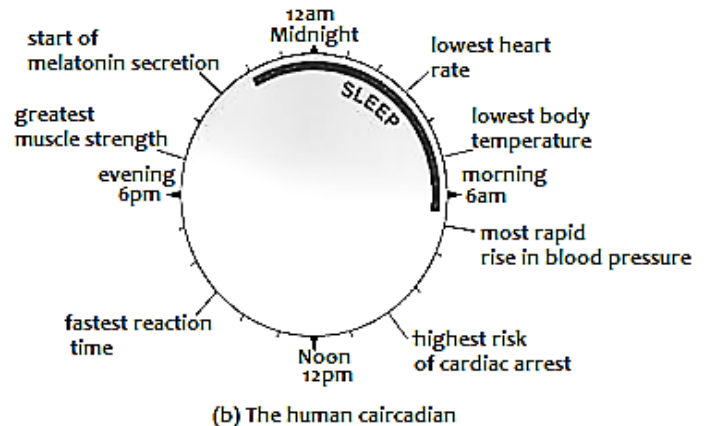
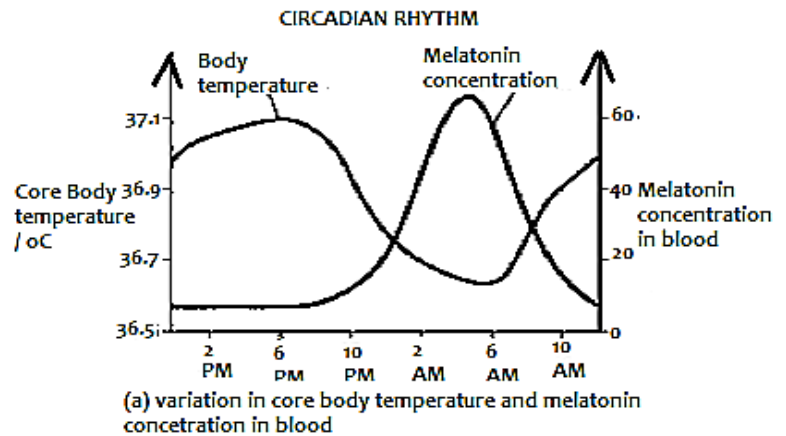
- **Internal (endogenous) rhythms** - controlled by the internal biological clock e.g. body temperature cycle.
- **External (exogenous) rhythms** - controlled by synchronizing internal cycles with external stimuli e.g. sleep/wakefulness and day/night. Many terrestrial insects appear to be controlled by exogenous rhythms which are related to periods of darkness and light. E.g. drosophila emerge from pupa at dawn whereas cockroaches are most active at the onset of darkness and rest at dawn.

Forms of biological rhythms.

Circadian rhythms: endogenously generated rhythms with a period close to 24 hours. For example, (1) Cockroaches are most active at the onset of darkness and just before dawn; (2) Honey bees are most active during day but return to their nest/hives on onset of darkness. **NOTE:** (a) night migratory animals, such as birds, turtles, fish, and some insects which migrate over long distances use the sun and stars to a compass to locate direction. (b) Foragers such as honeybees, ants and sandhoppers use the sun as compass to locate food and their homes. (c) Human internal physiological circadian rhythm is out of step the day-and-night rhythm due to several factors such as health, how far one travelled, night duties.

Diurnal rhythms: a circadian rhythm that is synchronized with the day/night cycle.

Ultradian rhythms: biological rhythms (e.g. feeding cycles) with a period much shorter (i.e. frequency much higher) than that of a circadian rhythm/ 24 hours. For example, (1) lug worm carries out feeding movements very after 6-7 minutes;



Circannual rhythms/ Infradian rhythms: biological rhythms with a period of about one year. Occur on seasonal or annual basis. E.g. (1) the human menstrual cycle, (2) Hibernation in bears, frogs, toads, salamanders bury themselves in mud during the winter, (3) seasonal migration patterns of birds, breeding patterns in some mammals.

TYPICAL WORKED EXAMPLES OF BIOLOGICAL RHYTHMS:

1. Adiponectin is an endogenous and circadian metabolic hormone produced in the adipose tissues that stimulates laying down fats in premigratory birds. The figure below shows variation in the amounts of Adiponectin produced in the adipose tissues during a 24 hour period.

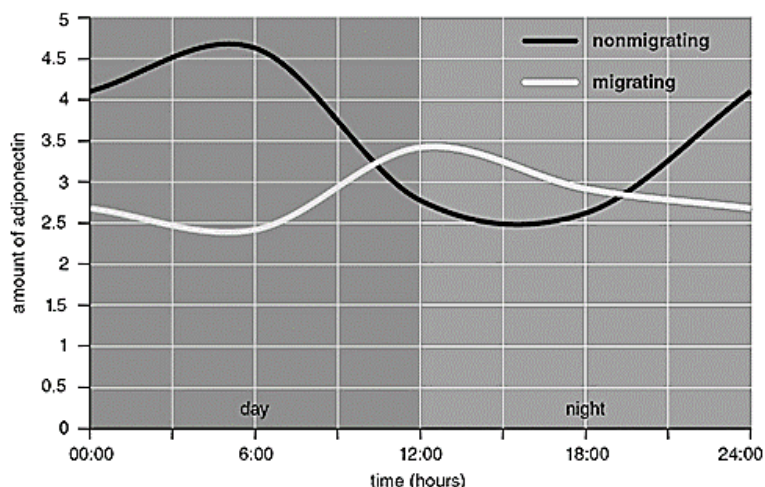
(a) Describe the changes in the amount of Adiponectin during the 24 hour clock.

In migrating.

From 00:00 hours (midnight) to 6:00 hours, amount of adiponectin decreased gradually, to a minimum;
From 6:00 hours to 12:00 hours (midday), amount of adiponectin increased gradually to a peak;
From 12:00 hours to 18:00 hours, amount of adiponectin decreases gradually; then slightly to midnight back to norm.

In nonmigrating birds.

From 00:00 hours (midnight) to 6:00 hours, amount of adiponectin increased rapidly, to a peak;
From 6:00 hours to 10:00 hours (afternoon), amount of adiponectin decreased rapidly to a minimum;
From 15:00 hours to 18:00 hours, amount of adiponectin increases gradually;
From 18:00 hours to 24:00 hours, amount of adiponectin increases rapidly; to norm.



(b) Explain the changes adiponectin levels and time of the day for;

(i) Non migrating birds.

At night, nonmigrating birds are not active; adiponectin levels increase in adipose tissues; more fats laid down and stored in subcutaneous stores; to insulate the body against heat loss; during day, nonmigrating birds are active; adiponectin levels decrease rapidly to allow accumulation of glucose; to be used by respiring tissues during day;

(ii) Migrating birds.

From midnight, the level of adiponectin is low during night hours, and high during day; because at night migrating birds are active in migration, hence need to utilize fats in metabolism; to provide energy to fight muscles. During day, adipose tissues secrete more adiponectin; to lay down more fats from glucose; this lowers glucose concentration in blood to be used during day when less active; and increase fat content to be respired during migration.

(c) Relatively lower maximum amount adiponectin is produced during in the migrating birds. Explain.

Migrating birds are active both at night and during day time, maximum amount of adiponectin produced during day is relatively lower, to allow part of glucose remain circulated in blood for respiration during day; and allow part of glucose be converted to fats; for night fatty acid metabolism; during migration.

(d) Explain the following observations.

(i) R.Q in adipose cells of premigratory birds is above 1.

Premigratory birds convert carbohydrates to fats/ fattening in preparation of migration; fattening produces high volumes of carbon dioxide in the process; thus increasing the R.Q above 1.

(ii) RQ in the respiring muscles of migrating birds is below 1.

Fats are transported from the adipose tissues to respiring muscles cells; highly oxidised to provide energy; during migration; however fat metabolism consumes more oxygen compared to the carbon dioxide evolved; lowering the R.Q below 1.

(e) Why is fattening necessary in premigratory birds at the end of summer?

Fattening increases the body-fat percentage, metabolism of fats provides great energy per unit mass; during migration;

2. The figure shows the number of bees that leave the hive to forage in a specific field at different times of the day. The changes in the environmental temperatures was also recorded and the results presented graphically as in the figure below. Study the figure below and answer the questions that follow.

(a) Explain the relationship between times of the day and number of bees visiting the flowers in the field. (14marks)

At 8:30am (early morning g); few bees visit the flowers; because flowers are in a partly-open state, due to extremely low light intensity at this time; few bees fly out to the nest;

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As environmental temperature decreases gradually between 9:30am and 10:30am (late morning), number of bees visiting flowers further increased rapidly, to a peak; light intensity at this time stimulates further opening of more flowers to be foraged by bees; favorable temperature favour activity of bees;

Between 10:30am and 12:30am (mid-day), number of bees visiting the flowers decreases as environmental temperature increased gradually to maximum day temperature; because activity of bees is not favoured at this high temperature, coupled with decreased humidity at this temperature;

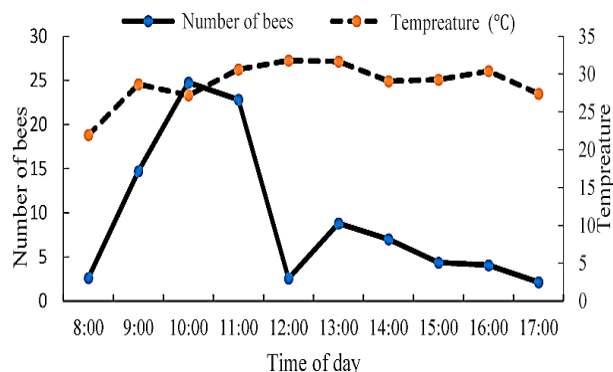
Between 12:30am and 1:30pm (noon); as temperature remains constant, number of bees visiting the flowers increases rapidly to a low peak; because few bees withstand to forage at high temperatures of the day;

Between 1:30pm and 3:30pm, number of bees visiting the flowers decreases gradually as temperature increases slightly; because more flowers start to close in late afternoon;

Between 3:30pm and 4:30pm, number of bees visiting flowers remained few and almost constant as temperature increased gradually; because more flowers are closed; thus more bees return to the nest;

Between 4:30pm and 5:30pm, number of bees visiting the flowers gradually as environmental temperature decreases gradually; because in late evening, light intensity decreases; most flowers are closed; most bees return to their nest/hives;

NB: stomatal opening and closure is another example of biological rhythm, though in plants.



4. TERRITORIAL BEHAVIOR/ TERRITORIALITY

A territory is an area of the habitat occupied by an individual or group of individuals and defended from others of the same species. Most territories are usually defended for breeding purposes and form one of the more elaborate forms of reproductive behaviour.

The phenomenon is observed in all classes of vertebrates except amphibia and is rare in invertebrates. Animals keeping territories do not usually defend them by fighting or by other forms of aggressive behaviour but by rather passive means such as, (1) Urinating around it (2) Defecating around the territory (3) Odour/ pheromones (4) Threat displays (5) Sound.

But if all fails, actual fighting occurs. The level of aggression shown by an animal increases towards the centre of the territory. The size of the territory occupied by organisms varies. Large carnivores have territories of miles while herrings and penguins have territories of a few square metre

The main reasons for territoriality, Control food supply | Retreat; shelter; nest, | Access to mates; | space for sexual display; courtship.

Advantages of territorial significance.

- Males able to hold on to resources show their evolutionary fitness and are attractive to females.
- Exclusive access to food, particularly at times of shortage.
- Exclusive area for breeding and raising young.
- Space for sexual display and courtship.
- Spacing of animals avoids competition.
- Reduces aggression / conflicts.
- Improves local knowledge of predators and resources.
- Exclusive place to retreat and shelter.
- Dispersion of nests reduces predation.
- Higher survival rates.

Disadvantages of territorial significance.

- Cost of defending territory including risk of physical contact, and displays of strength.
- Need to be vigilant for intruders.
- Defending territory is time that could be feeding or mating.
- Vocal or visual communication of territory ownership makes the individual vulnerable to predation.
- Difficult for smaller animals to hold territory; i.e. more likely to be attacked than larger animals
- Difficult to move if resources exhausted.
- Importance of territory size. If too large, then hard to maintain resources for effort of defending.
- Higher risk of predation if territory within predator's territory.
- Easy for predators to find.
- Ever present threat of take-over as surplus of animals without territory.
- Extra vigilance required at certain times of the year (e.g. breeding season).

CHECK PROGRESS:

The graph below shows the effect territory size on both cost of defense and Benefit gained from territoriality of sunbirds.

(a) Comment on the shape of the graph for,

At smaller territory size, below optimum; cost benefit gained increases rapidly; and is higher than the cost of defense;

Beyond/ above the optimum size, cost of defense increases rapidly; to the highest and exceeds the benefit gained; with increase in territory size;

Beyond/ above the optimum territory, benefit gained increases gradually, and remains constant and below/ lower than cost of defense with further increase in territory size.

(b) Account for the above observations.

Below the optimum size; a smaller sized territory is **economically defendable**; thus requires less time to survey, less energy spent energy in defense activities such as surveying and making defense signals; and pauses limited risks to injuries for the sunbirds due to actual fights; more time is spent on foraging; breeding rather than defense; this lowers the cost of defense and increases the benefit gained from defense.

Above the optimum territory size; energy and time spent on defense increases; this gradually increases the benefit gained, and rapidly increases the cost of defense, and exceeds benefits gained.

Benefit gained remains low and constant with further increase in territory size; because less time available for foraging; more time spent on territory defense;

(c) An exceedingly high cost defense is observed during the breeding period. Explain.

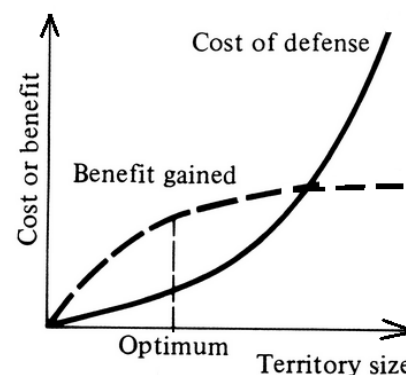
During breeding period, there is increased defense for food; mates; and nesting sites; is necessary for successful reproduction.

(d) How do birds defend territories?

Birds use both visual and auditory signal; signals may be long range; intermediate; and short range. Long range signals are typically auditory (songs or calls); in open habitats may use flight displays. Intermediate range signals may be visual or vocal. Short range signals may involve chasing and actual fight.

(e) State any two ways by which birds may physically mark their territories.

(1) Marking by fecal droppings; (2) marking using feathers



5. COURTSHIP AND MATING (REPRODUCTIVE BEHAVIOR)

COURTSHIP BEHAVIOR/ PRECOPULATORY BEHAVIOR: is a set of display behavior in which an animal attempts to attract a mate and exhibit their desire to copulate. It is a complex behavior designed to stimulate organisms into sexual activity.

Examples:

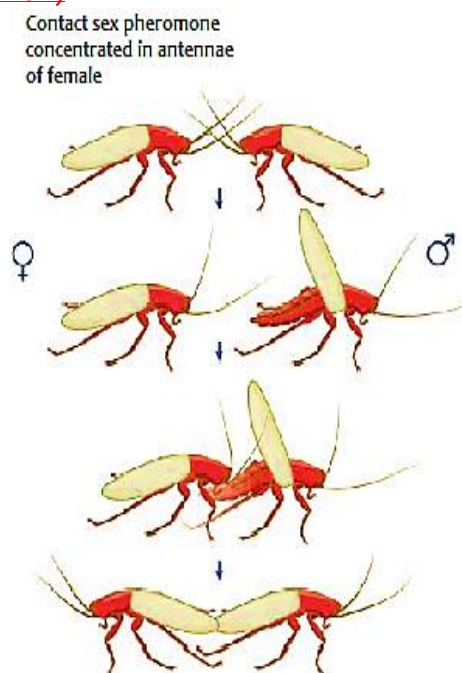
Singing in male birds; Peacocks display flamboyant plumage colors and prominent tail feathers; preening (sit with their bodies touching one another to show that they are not intending to harm their partner); Dancing in birds; Building nests in birds

Significance of courtship behavior

- It involves formation of a pair bond – relationship between male and female of same species which means they recognize each other as individuals and avoid aggression.
- It advertises sexually receptive individuals
- Brings both mating partners to reproductive readiness simultaneously
- It ensures that members of the same species find each other and mate e.g. at dusk, different species of fireflies flash distinct light patterns. However, female fireflies of one species respond only to those males exhibiting the species-correct flashing pattern.
- Maintain distinct species
- Reduction of escape tendencies of the female.
- Synchronization of gonad development so that gametes mature at the same time.
- Reinforcing altruistic, territorial and agonistic behavior.

NB: During courtship and mating, organisms secrete and release small amounts of chemical substances called **pheromones**, leading to specific physiological or behavioral responses in other members of the same species.

PARENTAL CARE/ POST COPULATORY BEHAVIOR: These are activities a parent animal performs to ensure survival and development of its offspring. It is well developed in birds and mammals. In most animals where parental care occurs, stimulation of parental care is usually by the young ones themselves.



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The highest and most profound form of parental care has been achieved in man. The activities associated with parental care are of evolutionary significance since they ensure survival of the species. The higher the animal on the evolutionary scale, the smaller the number of offspring at birth and the greater the parental care.

Advantages of parental behaviour

- Young ones are given adequate protection by the adult. This increases their chances of survival into adult life.
- Less energy is usually lost in looking for food for the young ones as they are fed on milk from their mothers.
- Young ones learn to avoid harmful situations and survival tactics from the adults. These increase their probability of survival into the adult life.

NB: In some animals such as ants, pheromones are important in marking paths and direction to food sources from the nest.

6. AGGRESSION (AGONISTIC BEHAVIOR/ AGONISM).

Includes (Aggression, Threat/ defense, Avoidance/ submission)

Aggression (agonistic behavior) is a group of behavioral activities including threat postures, rituals and occasionally physical attacks on other organisms, other than those associated with predation. They are usually directed towards members of the same sex and species and have various functions.

- Displacement of other animals of same species from an area usually a territory or a source of food.
- Defence of a mate or offspring among organisms of same group.
- Welcome ritual to sort and group new entrant rank in a social hierarchy.
- Promotion of ranks among groups of animals.

The threats issued by two organisms in an agonistic conflict situation are settled invariably by one of the organisms, generally the weaker backing down, and withdrawing from the situation by exhibiting a posture of submission or appeasement e.g. a weaker dog lying down on its back.

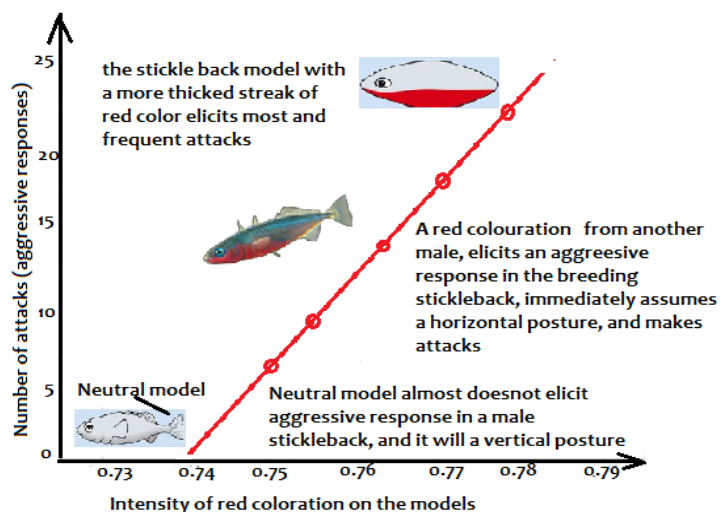
During actual physical contact, animals refrain from using their most effective weapons on another member of the same species. For example, giraffes will fight each other using their short horns on their heads, but in defence against other animals, they use their very powerful feet.

Agonistic behavior in breeding stickleback fish towards another male with a red belly.

Assumes a horizontal postures with fins and spines outstretched, showing full threat posture and has potential to ward off other sticklebacks, showing a red belly and approaching their breeding territory.

Assumes a vertical position, with reduced threat posture towards other sticklebacks; without a red belly.

NB: (1) Sticklebacks with red belly elicit aggressive responses, triggered off by releasers/ sign stimuli (red colour). The greater the intensity of the red color, the more aggressive response/ attacks made. (2) Sticklebacks or accurate models do not elicit aggression from male sticklebacks.



7. ALTRUISTIC BEHAVIOR/ ALTRUISM. "Living for others"

Altruistic behavior: a form of social behaviour whereby one organism puts itself either at a risk or personal disadvantage for the good of other members of the species.

Examples.

(1) Sterile female worker bees don't produce offspring, yet spend their lives looking after the brothers and sisters. (2) For God and My Country in humans. (3) Mutual grooming and food sharing in Apes. (4) Alarm calls by ground squirrels warning the others of approaching predators, but draw attention to themselves.

The extent of the altruistic behaviour appears to be related to close relatives (**kin**) such as offsprings and **siblings** (brothers, sisters and cousins) with whom they share certain alleles.

Significance of altruism

- Ensures survival and protection of weak and young ones.
- There is increased chance of survival of young ones.
- It increases allele frequency of a particular organism.
- Leads to increased population size.

Adaptive/ evolutionary significance of Altruism.

To increase the frequency of alleles common to both donor and recipient(s) of the altruistic behavior. Thus, the behavior is called kin selected; because it confers genetic advantage in kin by promoting survival and reproduction within the species.

8. DOMINANCE/SOCIAL HIERARCHIES

A dominance hierarchy: a form of social ranking within a group in which some individuals are more subordinate than others. The ability to form a dominance hierarchy is innate, but the position each animal assumes may be learned. The term **pecking order** comes from a dominance hierarchy that is formed by chickens. The top-ranking chicken can peck any other chicken. The chicken lowest in the hierarchy is pecked at by all the other chickens in the group.

Features of dominance hierarchies

Individuals carry out specific roles in the society there are pecking orders; there is a chain of command in the colony

Position in the hierarchy is determined by the level of agonistic behavior, size, strength and aggressiveness.

Highly determined by ability of an individual to learn and recognize those in higher ranks of the hierarchy

Levels of testosterone or estrogens determines order in the hierarchy.

Importance of dominance hierarchy

- 1) Reduces aggression associated with feeding, mate selection and breeding site selection. established order and stability
- 2) Influences resources among population.
- 3) Avoiding injury of animals due to fighting in order to establish a hierarchy.
- 4) Subordinate remains to obtain food, avoid predators, and chance to mate.
- 5) Increasing genetic vigor by ensuring that the strongest and genetically fittest have a reproductive advantage

SOCIAL BEHAVIOR/ SOCIAL ORGANISATION/ SOCIETIES IN BEES

Social behavior: involves adaptive interactions between two or more animals of the same species. Evidenced in animals that organize themselves into highly structured social groups, societies. In bees, roles are unchangeable among members of a group due to genetic differences conferring differences in body structure- **polymorphism** giving rise to queens, drones and workers. Organization is based on a **caste system**. Perform **dances** as visual orientations for communication. Grooming and licking activities are in form **trophallaxes** transmitting chemical odors and pheromones.

❖ **Honeybee Dance Language**

Honey bee dancing is performed by a worker bee that has returned to the honey comb with pollen or nectar, informing other workers about both the distance and direction where the food is.

1. Round dance: Communicates only distance from the food source (less than 50 meters from the hive).

How round dance is performed?

A bee runs around in narrow circles, suddenly reversing direction to her original course. After the round dance has ended, a bee distributes food to the bees following it (recruits). May repeat the dance at same location, or move to another location to repeat the dance. NB: round dance therefore communicates distance (close to the hive), **but no direction**.

2. Sickle dance: Communicates only distance from the food source (between 50 and 150 meters from the hive). This dance represents a transitional dance between the round dance and a waggle dance.

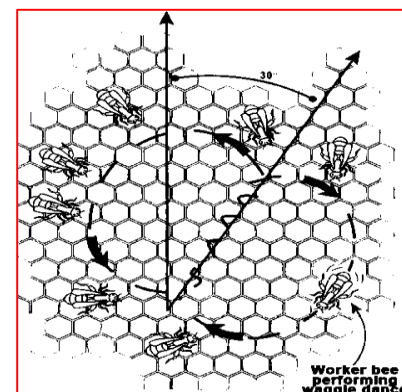
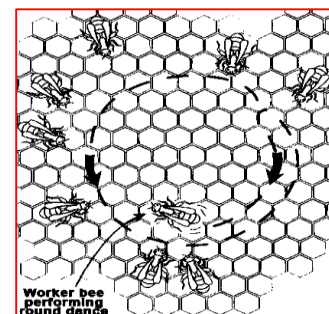
3. Waggle dance (wag-tail dance): Communicates both distance and direction. Is performed by bees foraging at food sources that are more than 150 meters from the hive.



How waggle dance is performed?

A bee that performs a waggle dance runs straight ahead (for a short distance, returns in a semicircle to the starting point, runs again through the straight course, then makes a semicircle in the opposite direction to complete a full figure-eight circuit.

While running the straight-line course of the dance, the bee's body, especially the abdomen, wags vigorously from side to side. The vibration of the body gives it a **tail – wagging motion**.

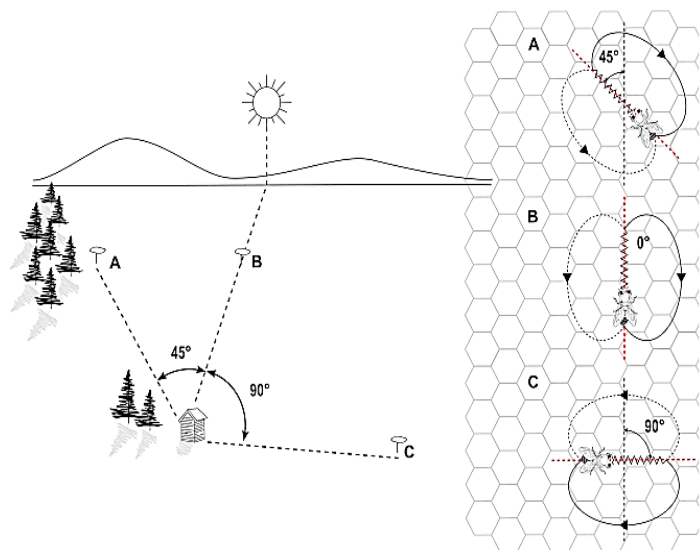


The duration of the waggle run = distance from the food source.

(1 second = 1050m \cong 1 Km).

The orientation of the dancing bee during the straight portion of her waggle dance indicates the **location/direction** of the food source relative to the sun. The angle between the vertical and the run = angle between sun and food source from the hives. **This is achieved by the bee transposing the solar angle into gravitational angle.**

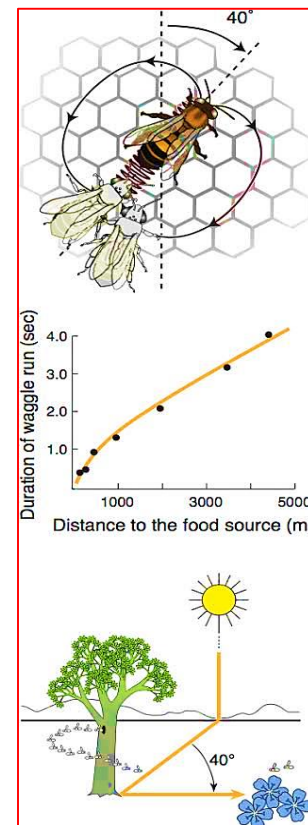
RELATIONSHIP BETWEEN WAGGLE RUN AND ANGLE OF RUN WITH RESPECT TO GRAVITY.



(1) If the food source (B) is located directly away ("straight line") from the sun, the straight run on the comb would be directed vertically down or vertically up (that is 0° or 180° exactly on the vertical respectively).

(2) If food source (A) is 45° to the right of the sun, then waggle run would be 45° to the right of vertical.

(3) If food source (C) is 90° to the left of the sun, then waggle run would be 90° to the right of vertical.



Check Progress: The data below shows the duration of each dance run made by a forager bee. Durations for each run were recorded in seconds. The final run indicated the total distance of the food source from the hive. Use the data to answer the questions below.

Duration of the bee run/ seconds	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
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- How many runs did the forager make? (01mark)
- Determine the distance in meters that corresponds to duration of the runs. (4½marks)
- Plot a graph of duration of the run against distance to food source. (08marks)
- Describe the relationship between duration of the bee run and the distance to food source from the hive. (02marks)
- Name the type of be run from the graph plotted. Give a reason for your answer. (02marks)
- If the forager's run was 115° to the left of the vertical on the comb. Using illustration, draw accurately the movement of the forager on the comb and in the movement of the recruits in the field to the food source. (06marks)
- Clearly describe the position of the food source. (04marks)
- How is social behavior important in bees? (05marks)

Advantages of animals living in societies.

- Greater success in catching larger prey, when hunting in groups than when alone.
- Increased reproductive efficiency, as the fittest only are allowed to breed.
- Establishment of hierarchies increases chances of survival, thus minimizing aggression.
- Faster learning in young ones.
- Increased protection against predators.
- Division of labour, thus efficiency in doing multitasks at same time.

Disadvantages of animals living in societies/ social organizations.

- Increased risks of predation on young by cannibalistic neighbors.
- Increased susceptibility to diseases.
- Increased intraspecific competition.

9. MIGRATION.

MIGRATION: It is the movement of a population from one region to another (and could return after sometime). The length of the time of the journey varies from species to species. It may range from a short distance like movement up and down the mountain to long distances across oceans and continents. Results from marking individuals show that many returned to places previously occupied. An animal must possess a compact sense (ability to travel a constant direction) and a navigational sense (sense of its destination).

Causes of migration.

- **Resource availability** changes depending on seasonal fluctuations, which influence migration patterns.
- Different species also might migrate for **reproductive purposes**. Pacific salmon is an example of a species migrating to reproduce. Every year Pacific salmon travel upstream to mate and then return to the ocean.
- **Temperature** is also a driving factor of migration that is dependent on the time of year. Many species, especially birds, migrate to warmer locations during the winter to escape poor environmental conditions.
- In circadian migration clocks of both circadian (daily) and Circannual (annual) patterns are utilized to determine the birds' orientation in both time and space as they migrate from one destination to the next. This type of migration serves as being advantageous in birds that during the winter remain close to the equator and also to monitor the auditory and spatial changes.

Examples of migration:

- 1) Some species of Gallinaceous and raptorial birds migrate from valley to mountain peaks.
- 2) Salmon return to native streams to breed after several years at sea.
- 3) Deer and Caribou, African ungulates - mammals engaged in overland migrations.
- 4) Some sharks, whales (northern oceans for calving, southern areas for breeding) and other marine mammals - engaged in long distance oceanic migrations

CUES THAT ANIMALS USE TO NAVIGATE

- (i) **Endogenous/ Internal cues** – hormonal.
- (ii) **Exogenous/ External cues** - external cues from the environment.

Examples:

- Sun compass - movement of sun; angle of sun; polarized light (pattern of light based on sun's position and reflection on water).
- Geomagnetic compass - sensitivity to magnetic North and the earth's magnetic field.
 - Star compass or position of moon.
- Other visual cues - patterns of waves; cloud patterns; landmarks.
- Smell or pheromones.
- Sound.
- Electric.
- Young animals may learn when and where to migrate by following their parents.

Advantages of migration.

- 1) Return to specialist site for breeding that does not need all year round food supply, and often no (or few) predators.
- 2) Move to where food/prey available when not breeding, particularly with young (i.e. maximize feeding opportunity).
- 3) Stationary can mean increased predator risk
- 4) Constant temperature conditions: escape bad weather and lower temperatures (and greater risk of death), especially to give birth.
- 5) Able to have specialist breeding site (e.g. no predators) and another site for feeding.
- 6) Flexible strategy - some members of the species can migrate and others not depending on where live.
- 7) Stationary animals risk exhausting food supply using it all year round, particularly if competition from other species.
- 8) Opportunity for different members of the species to meet, and greater breeding variety
- 9) Ideal when specialist food required because the earth's resources are not evenly distributed.
- 10) Birds migrating at night usually safe from predators as few day-time birds of prey adapt to night-time hunting.

Disadvantages of migration.

- 1) Large amount of energy required to travel long distances.
- 2) Problems and risks of navigation.
- 3) Risk of forgetting sites or not being able to find again.
- 4) Leave home territory empty allowing for invaders, and then fights on returning
- 5) Risk at temporary stopovers from lack of local knowledge about predators.
- 6) Vulnerable to weather changes or poor conditions in one year.
- 7) Many decisions required including optimal fuel load and optimal time of departure.
- 8) Other risks like the change from salt to freshwater or vice versa for some fish.
- 9) Evolutionary maladaptive behavior in some cases; e.g. green turtles feed on eastern coast of South America but breed on Ascension Island (south Atlantic).
- 10) Risks of night-time migration if animals normally active in day-time (e.g. bat predation of birds).



LEARNED (INDIVIDUAL SPECIFIC) BEHAVIOR

Learning: adaptive change in behaviour that occurs as a result of experience / practice.

Learned behavior: behavior acquired through previous experience / practice

Advantages of learned behaviour

1) Flexible. 2) Benefits animals with longer life spans and so there is time to learn. 3) Benefits animals with an element of parental care of the young; which involves learning from the parent. 4) Benefits animals that live with other members of the species for at least a time e.g. in herds & packs.

Note: The responses of learnt behaviour are adapted to the environment.

TYPES OF LEARNED BEHAVIOUR.

1. HABITUATION.

Habituation: is the reduced/ decreased response to repeated exposure of an organism to same stimulus.

Examples.

- Birds learn to ignore a scare crow that is positioned in one position of the garden.
- Animals learning not to be alarmed or alarm by presence of non-predatory species.
- Snail stops the withdraw behavior back into its shell when hits a harmless external object during its movement.
- Goat tied alongside the road ignore movements of people and grazes calmly.
- Police learns to operate in crowds and loud noise of traffic police.
- Humans no longer noticing a new smell or sound after a period of exposure.
- Wild animals losing their fear of humans after non-harmful contact.

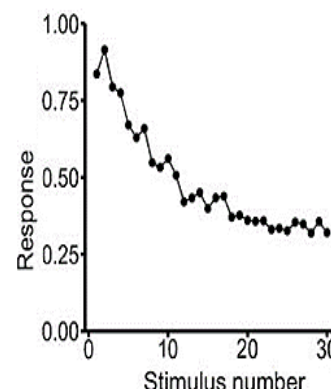
Significance of habituation.

- Helping young animals to understand neutral elements of their environment.
- Economy of neuronal pathways and energy to other beneficial elements of the environment.

NB: If the stimulus to which an animal has become habituated changes, then the nervous system will respond to it. E.g. if a constant low level of sound becomes louder.

The process of habituation.

On arrival of a nerve impulses; fewer calcium ions diffuse into the presynaptic neurone; less neurotransmitter is released; fewer molecules of neurotransmitter bind to receptors on post synaptic membrane; fewer sodium gated channels open; fewer sodium ions enter into the post synaptic neurone; potential difference inside remains negative relative to outside; threshold potential not reached; inhibits formation of action potentials; nerve impulse not fired to reach the effector organ; and thus receptors adapt; and animal doesn't respond to stimulus.



2. ASSOCIATIVE LEARNING.

Associative learning: any learning process in which a new response becomes associated with a particular stimulus.

Two types of associative learning

(a) Classical Conditioning: A process in which an animal learns to associate a previously neutral stimulus with a behavior once triggered by a different stimulus.

E.g. (1) Honey bees learn to associate floral colors and fragrances with the presence of nectar. (2) Pavlov's Dogs salivated on hearing the sound of a bell in expectation of food, yet initially it was the food smell that stimulated salivation.

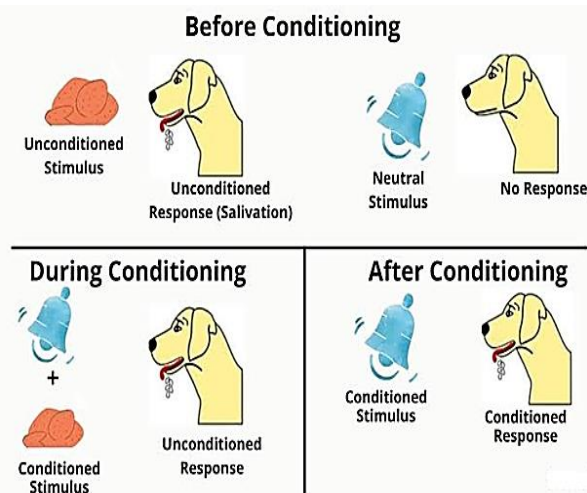
Pavlov on the control of salivation in dogs.

He noted that when presented with the sight and smell of food, the dogs began to salivate in preparation of eating. Pavlov began to ring a bell each time the dog was shown their food. After a while he found dogs salivated when the bell was rung, regardless of whether food was present.

(b) Operant conditioning (Instrumental learning / 'Trial-and-Error' learning): A form of adaptive learning in which an animal learns to carry out a particular action in order to receive a reward or avoid an unpleasant experience. Reinforcement is in related to behavior not reward or punishment.

E.g. (1) In Skinners box, rats learnt to press a lever in order to obtain food. (2) Cockroaches learning to run through a **simple maze** to find food.

Skinner's work on pigeons / rats.

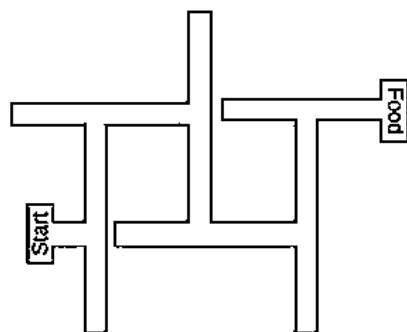


- Trained rats and pigeons to press a lever in order to obtain food.
- Certain motor-output responses generated e.g. running around, resting, pressing lever.
- After training the subject will show the conditioned response (e.g. pressing the lever) if the response-unconditioned stimulus (a food reward) association has been memorized.

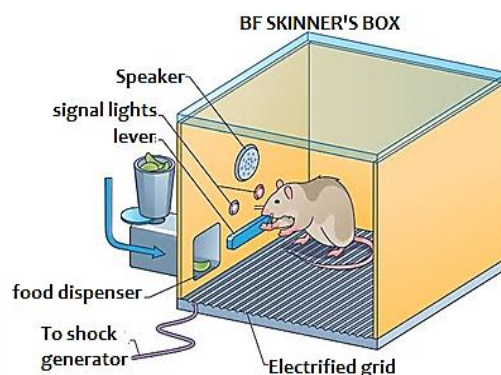
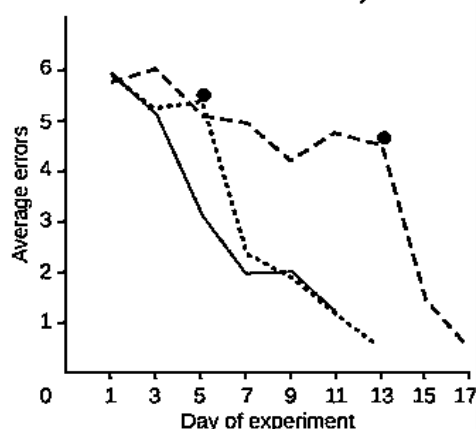
Significance of conditioning.

- 1) Emphasizes the importance of learning from the environment.
- 2) Extinguishes or promotes behavior by reward or punishment.
- 3) Makes animal behavior predictable and flexible.

T-maze



- Group I: Rewarded with food at completion of run
- - - Group II: Not rewarded the first six days, but rewarded with food after day six
- Group III: Not rewarded the first three days, but rewarded with food after day three



Learning (reduction in number of errors) is associated with reward of movement through the maze, providing motivation in the animal to reduce number of errors in the maze.

Factors affecting learning in a T-maze include; size of reward or punishment; state of brain development; state of development of sense organs; complexity of the puzzle box;

3. LATENT LEARNING/ EXPLORATORY LEARNING.

Latent Learning (Exploratory learning): Animals explore new surrounding and learn information that has no apparent value at the time, but may be remembered and used later when necessity arises because it may mean the difference between life and death.

Examples.

- 1) Rabbits / rats / mice explore their burrows, which may save them in case of an emergency.
- 2) A sand wasp remembers the pattern of surrounding landmarks to help her find the nest when she returns.
- 3) Worker ants can remember a series of landmarks along a trail and follow them (in reverse order) back home to the nest site.
- 4) A hen uses previous experience to regroup eggs in the nest using wings.

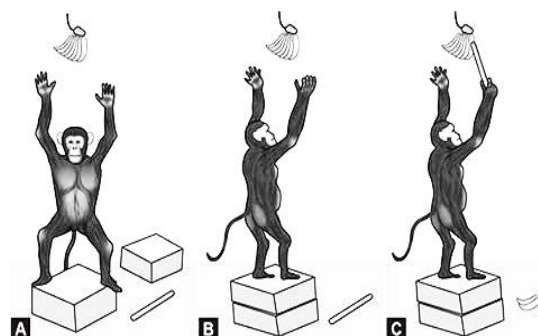
4. INSIGHT LEARNING.

Insight learning: The highest form of learning in which an animal applies thinking and reasoning in order to solve problems or deal with complex situations without immediate trial and error.

It is based on information learned from other behavioral activities. It requires advanced perceptual abilities such as thought and reasoning.

Examples.

- 1) A chimpanzee piles boxes to increase height for reaching hanging sweet bananas which are out of its reach. Experience from playing with the boxes (apparent learning) increased the likelihood of the response.
- 2) A child uses stones to hit at mango fruits which are high on the tree.



5. IMPRINTING.

Imprinting: Within a specific period of time after birth an animal learns to recognize and bond to its parent. Imprinting occurs in the receptive and hypersensitive period of an animal's life called "**critical period**". It is around 36 hours after hatching in goslings and helps survival during infancy

Example: Goslings, ducklings and chicks become attached to the organism they interact with during the sensitive period.

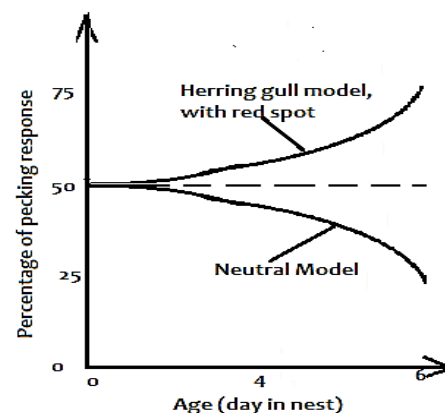
COMPARISON OF INNATE BEHAVIOUR AND LEARNED BEHAVIOUR

INNATE BEHAVIOUR	LEARNED BEHAVIOUR
<ol style="list-style-type: none"> Heritable - encoded in DNA and passed from generation to generation Intrinsic - present in animals raised in isolation from others. Stereotyped - performed in the same way each time by each individual of a species Inflexible - not modified by development or experience Consummate - fully developed or expressed at first performance Unintelligent and automatic; the animal does not appreciate the importance of the behavior 	<ol style="list-style-type: none"> Non-heritable - acquired only through observation or experience Extrinsic - absent in animals raised in isolation from others. Permutable - pattern or sequence may change among individuals of a species flexible - capable of modification to suit changing conditions Progressive - subject to improvement or refinement through practice Intelligent; the animal appreciates the importance of the behavior.

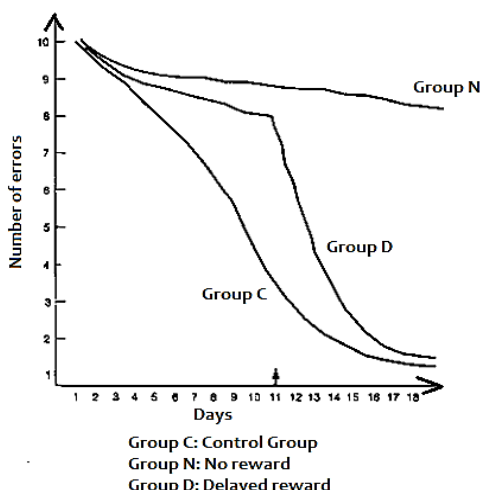
TYPICAL EXAMINATION QUESTIONS.

1. The figure below shows the percentage of pecking response in young herring during their development after hatching on the herring gull model and on a neutral herring model.

- Describe the changes in percentage pecking response in the young herring.
- Account of the above changes.
- What is the relevance of pecking response in the young herring?
- Identify the type of behavior and give three characteristics of this type of behavior.



2. The figure below shows the number of errors made by a three groups of rats, C, D and N in a T-maze box. The treatments to the respective groups are shown in the key below the graph. The control was rewarded each day it completed a successful run through the maze.



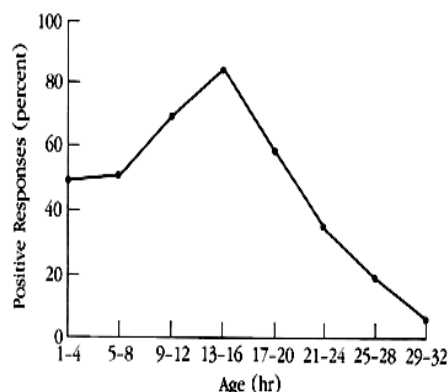
- Describe the variation in number of errors made by the rats with days of experience in the maze.
- Compare number of errors in group C and group N rats.
- Account for the above differences.
- State three factors which affect the rate of accuracy in runs made by the rats in the T-maze box.

3. In an investigation of suitable condition for woodlice. 20 woodlice were put in dark/light/damp/dry box, an observed for 20 minutes. The following results were obtained.

Number of woodlice	Dark	Light
Damp	12	4
Dry	3	1

- From the results obtained, state the most preferred conditions for the woodlice.
- Explain your answer.
- Which type of behavior is observed in the above investigation? Give a reason for your answer.

4. The figure below shows the results in an imprinting investigation of chicks immediately after hatching. The chicks showed ability to follow the model hen, and the percentage of chicks following the model hen at a particular age were represented graphically.



- Describe the changes in the level of imprinting from the graph.
- Account for the changes in the positive response of the chicks throughout the investigation.
- Risks of predation to the chicks are high if hatching occurs in absence of an adult. Explain.

DISCLAIMER.

These questions are built in a similar style to that presented within the previous exam board's sample assessment materials. There can be no guarantee of the extent to which these questions will reflect the actual examination questions students will sit. I hope that schools and students find these questions useful in the exam preparations in this Topic. However, I take no responsibility for the relevance of this document to actual examinations sat.

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