NATIONAL OPEN UNIVERSITY OF NIGERIA

SCHOOL OF SCIENCE AND TECHNOLOGY

COURSE CODE: BIO 314:

COURSE TITLE: ANIMAL BEHAVIOUR

BIO 314: ANIMAL BEHAVIOUR

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NATIONAL OPEN UNIVERSITY OF NIGERIA

BIO 314 COURSE GUIDE

Introduction

Animal Behaviour (314) is a second semester course. It is a two credit units compustory course which all students offering Bachelor of Science (BSc) in Biology must take.

This course deals with the theories and principles of adaptive behaviour and evolution of animals. The course contents are history of ethology. Reflex and complex behaviour. Orientation and taxes. Fixed action patterns, releasers, motivation and driver. Displays, displacement activities and conflict behaviour. Learning communication and social behaviour. The social behaviour of primates. Hierarchical organization. The physiology of behaviour. Habitat selection, homing and navigation. Courtship and parenthood. Biological clocks.

What you will learn in this course

In this course, you have the course units and a course guide. The course guide will tell you briefly what the course is all about. It is a general overview of the course materials you will be using and how to use those materials. It also helps you to allocate the appropriate time to each unit so that you can successfully complete the course within the stipulated time limit.

The course guide also helps you to know how to go about your Tutor-Marked-Assignment which will form part of your overall assessment at the end of the course. Also, there will be tutorial classes that are related to this course, where you can interact with your facilitators and other student. Please I encourage you to attend these tutorial classes.

This course exposes you to Animal Behaviour, a very important and interesting field in Biology.

Course Aims

(1) This course aims to enable you to understand the theories and principles of adaptive behaviour and evolution of animals.
(2) Behavioural Patterns
(3) Mechanism of Adaptation

Course Objectives

To achieve the aim set above, there are objectives. Each unit has a set of objectives presented at the beginning of the unit. These objectives will give you what to concentrate focus on while studying the unit and during your study to check your progress.

The Comprehensive Objectives of the Course are given below. By the end of the course/after going through this course, you should be able to:

1. Explain emotion in animals under ethology and examples.
2. Explain different views on emotion in animals with examples.
3. State the Jeffrey Moussaieff Masson view with examples.

3.0 Distinguish between intraspecies and interspecies communication.

4. Explain forms of communication with common examples.
5. Explain other aspects of communication like evoluation of communication, human communication and cognitive communication and how to assess cognitive functions.
6. State the component of nervous system.
7. What is phototaxes? List and explain eight types of taxes.

8 What do you understand by negative phototaxis and postive phototaxis. Give related examples of each.

9 Explain the following taxes according to their response to stimulus: Klinotaxes, tropotaxes and telotaxes.

10 Define biological clocks.

11 Differentiate between exogenous and endogenous rhythm

Working through the Course

To successfully complete this course. You are require to read each study unit, read the textbooks materials provided by the National Open University.

Reading the reference materials can also be of great assistance.

Each unit has self –assessment exercise which you are advised to do at certain periods during the course you will be required to submit your assignment for the purpose of assessment.

There will be a final examination at the end of the course. The course should take you about17 weeks to complete.

This course guide provides you with all the components of the course how to go about studying and how you should allocate your time to each unit so as to finish on time and successfully.

The Course Materials

The main components of the course are:

1 The Study Guide

2 Study Units

3 Reference/ Further Readings

4 Practical Sections- by getting animals such as rats and mice etc and study their behavior pattern

5 Assignments

6 Presentation Schedule

Study Units

The study units in this course are given below:

Module 1: History of Ethology

Unit 1: Ethology

Unit 2: Emotion in Animals

Unit 3: Animal Communication

Module 2: Reflex and Complex Behavior

Unit 1: Nervous System

Unit 2: Pheripheral Nervous System

Module 3: Orientation and Taxes

Unit 1: Orientation in Animal Behaviour

Unit 2: Taxes

Module 4: Fixed Action Pattern, Motivation and Drives

Unit 1: Fixed Action Pattern

Unit 2: Motivation and Drives

Module: 5 Display, Displacement Behaviour and Conflict Behaviour

Unit 1: Display and Displacement Behaviour in Animals

Unit 2: Conflit Behaviour

MODULE 6: LEARNING, COMMUNICATION AND SOCIAL BEHAVIOR

Unit 1: Categories of learning namely: habituation, classical conditioning, instrumental conditioning, latent learning and insight learning.

Unit 2: Communication in animals

Unit 3: Social behavior and living in groups; advantages and disadvantages

Unit 4: Examples of various documented behaviors in animals

MODULE 7: SOCIAL BEHAVIOR OF PRIMATES

Unit 1**:** Basic Concepts in the Study of Social Behavior of Primates and **Social Structure**

Unit 2:Non-human primate social group composition

Unit 3: Various forms of social behavior found among primates

MODULE 8: HIERARCHICAL ORGANIZATION

Unit1: Definition, Visualization and Common models of hierarchical organization

Unit 2: Studies of hierarchical organizations, Criticism and alternatives; Simple illustration of hierarchical and Dominance Hierarchies

MODULE 9: PHYSIOLOGY OF BEHAVIOR

Unit 1: Proximate and ultimate causes and four approaches to animal behavior

Unit 2: Development of behavior

MODULE 10: HABITAT SELECTION, HOMING AND NAVIGATION

Unit 1: Habitat Selection

Unit 2: Homing and Navigation

Unit 3: Behavioral and Mechanisms of Homing and Migration/Navigation in Birds

MODULE 11: COURTSHIP AND PARENTHOOD

Unit 1: Animals Displaying Homosexual Behavior

Unit 2: Sexual Selection for Cultural Displays

Unit 3: Animals Displaying Homosexual Behavior

Module 12 BIOLOGICAL CLOCKS

Unit 1: Biological Clock

Unit 2: Sleep

In Module One, unit one deals with the historical aspects of ethology, the second unit focuses on the emotions in animals, how it arises in the mammalian brain and other animals. Unit three focuses on the forms of communication in animals, in general how animal respond to emotions through communication.

Module Two is concerned with the reflex and complex behavior in animals; unit one and two focuses on the function of nervous and peripheral nervous system in reflex and complex behavior in animal.

Module Three, unit one and two deals with orientation and taxis, the behavioral stimulus to response and sexual orientation were focused on.

Module Four is concerned with fixed action pattern and motivation and drivers. Unit one, deal with a fixed action pattern (FAP) focus on instinctive behavioral sequence of animal. Unit two deal with motivation and emotion aspect of animal behavior, and theory of motivation by different scientist.

Module Five is concerned with the display, displacement and conflict behavior. Unit one and two deal with physiological and emotional response of animals to conflict.

In Module six, unit one gave an expository discussion on the categories of learning, unit two elaborate on different types of communication in animals and unit three focuses on social behavior of animal species.

In Module seven, unit one, two and three deals with various forms of social group found among primate and their social structure.

Module Eight and Nine focus on with hierarchical organization of animals and Physiology of Behavior in animals respectively.

Module Ten, Eleven and Twelve focus on Habitat Selection, Homing and Navigation,Courtship and Parenthood and Biological Clocks repectively.

Each unit will take a week or two.Lectures will include an introduction, objectives reading materials, self assessmentquestion, conclusion, summary, tutor marked assignment (TMAs), references and other reading resources.

There are activities related to the lecture in each unit which will help your progress and comprehension of the unit. You are required to work on these exercises which together with the TMAs will enable you to achieve the objective of each unit.

Presentation Schedule

There is a time-table prepared for the early and timely completion and submissions of your TMAs as well as attending the tutorial classes. You are required to submit all your assignments by the stipulated date and time. Avoid falling behind the schedule time.

Assessment

There are three aspects to the assessment of this course.

1) The first one is the self-assessment exercises.
2) The second is the tutor-marked assignments
3) The written examination or the examination to be taken at the end of the course.

Practical classess attendance will also be taken.

Do the exercises or activities in the unit applying the information and knowledge you acquired during the course. The tutor-marked assignments must be submitted to your facilitator for formal assessment in accordance with the deadlines stated in the presentation schedule and the assignment file.

The work submitted to your tutor for assessment will account for 30% of your total work.

At the end of this course you have to sit for a final or end of course examination of about a three hour duration which will account for 70% of your total course mark.

Review

Review of the performances of test with students which tends to improve their performances in the exam.

Tutor Marked Assignment

This is the continuous assessment component of this course and it accounts for 30% of the total score. You will be given four (4) TMAs by your facilitator to answer. Three of which must be answered before you are allowed to sit for the end of the course examination.

These answered assignments must be return to your facilitator.

You are expected to complete the assignments by using the information and material in your reading references and study units.

Reading and researching into the references will give you a wider via point and give you a deeper understanding of the subject.

1. Make sure that each assignment reaches (individual submission) your facilitator on or before the deadline given in the presentation schedule and assignment file. If for any reason you are not able to complete your assignment, make sure you contact your facilitator before the assignment is due to discuss the possibility of an extension. Request for extension will not be granted after the due date unless there is an exceptional circumstance.
2. Make sure you revise the whole course content before sitting for examination. The self-assessment activities and TMAs will be useful for this purposes and if you have any comments please do before the examination. The end of course examination covers information from all parts of the course.

Course Marking Scheme

Assignment	**Marks**
Assignment 1-4	Four assignments, best three marks of the four count at 10% each - 30% of course marks.
End of course examination	70% of overall course marks

Total	100% of course materials

Facilitators/ Tutors and Tutorials

Sixteen (16) hours are provided for tutorials for this course. You will be notified f the dates, times and location for these tutorial classes.

As soon as you are allocated a tutorial group, the name and phone number of your facilitator will be given to you.

These are the duties of your facilitator:

- He or she will mark and comment on your assignment
- He will monitor your progress and provide any necessary assistance you need.
- He or she will mark your TMAs and return to you as soon as possible.

(You are expected to mail your tutored assignment to your facilitators at least two days before the schedule date).

Do not delay to contact your facilitator by telephone or e-mail for necessary assistance if

- You do not understand any part of the study in the course material.
- You have difficulty with the self assessment activities.
- You have a problem or question with an assignment or with the grading of the assignment.

It is important and necessary you attended the tutorial classes because this is the only chance to have face to face contact with your facilitator and to ask questions which will be answered instantly. It is also a period where you can point out any problem encountered in the course of your study.

Summary

Animal Behaviour (314) is a course that introduces you to the Concepts and principles of how animals act in achieving their life requirements; major emphases are on adaptive functions of behaviour; classification of behavioural mechanisms; comparative study of learning; socialisation; social interaction and other components of human behaviour; origin of life.

An examination of the modern theory of evolution; particularly the relationship of evolutionary processes to concepts in ethlology; genetics and population biology; processes and mechanisms of evolution; including variation within populations; natural selection; molecular evolution; speciation and adaptation; systematics; species interactions and processes of evolution in man.

On the completion of this course, you will have an understanding of basic knowledge of Animal Behaviour. Also you will understand the historical background of ethology.You will have understood the concept of Orientation and Taxes, Fixed Action Pattern, Motivation and Drives display, Displacement and Conflict Behaviour. Finally you will be able to explain Learning, Communication and Social Behavior, Social Behavior of Primates, Physiology of Behavior, courtship and Parenthood, Biological Clocks.

In addition you will be able to answer the following questions:

1. Explain displacement behavior in animals.
2. Explain the displacement signs in dog and cat
3. Explain the concepts used in the study of primate behavior
4. Are there similarities between the behavior of nonhuman primates and humans
5. Differentiate between circadian and circannual rhythm

The list of questions you are expected to answer is not limited to the above list.

I believe you will agree with me that Animal Behaviour is a very interesting field of biology.

I wish you success in this course.

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MODULE 1 HISTORY OF ETHOLOGY

Unit 1 Ethology

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1.0 INTRODUCTION

Ethology (from Greek: ἦθος, *ethos*, "character"; and -λογία, *-logia*, "the study of") is the scientific study of animal behavior, and a sub-topic of zoology. Although many naturalists have studied aspects of animal behavior throughout history, the modern discipline of ethology is generally considered to have begun during the 1930s with the work of Dutch biologist Nikolaas Tinbergen and Austrian biologists Konrad Lorenz and Karl von Frisch, joint winners of the 1973 Nobel Prize in Physiology or Medicine.[1] Ethology is a combination of laboratory and field science, with a strong relation to certain other disciplines — e.g., neuroanatomy, ecology, evolution. Ethologists are typically interested in a behavioral process rather than in a particular animal group and often study one type of behavior (e.g. aggression) in a number of unrelated animals. The desire to understand animals has made ethology a rapidly growing topic, and since the turn of the 21st century, many prior understandings related to diverse fields such as animal communication, personal symbolic name use, animal emotions, animal culture, learning, and even sexual conduct long thought to be well understood, have been modified, as have new fields such as neuroethology.

2.0 OBJECTIVES

At the end of this unit, students should be able to:

1. Define ethology.
2. State the theory of evolution by natural selection with related examples.
3. Differentiate between imprinting and imitation in learning.
4. State Tinbergen's four questions for ethology.

3.0 MAIN CONTENT

3.1 Differences and similarities with comparative psychology

Comparative psychology also studies animal behaviour, but, as opposed to ethology, is construed as a sub-topic of psychology rather than as one of biology.

Historically, where comparative psychology researches animal behaviour in the context of what is known about human psychology, ethology researches animal behaviour in the context of what is known about animal anatomy, physiology, neurobiology, and phylogenetic history. This distinction is not representative of the current state of the field. Furthermore, early comparative psychologists concentrated on the study of learning and tended to research behaviour in artificial situations, whereas early ethologists concentrated on behaviour in natural situations, tending to describe it as instinctive. The two approaches are complementary rather than competitive, but they do result in different perspectives and, sometimes, in conflicts of opinion about matters of substance. In addition, for most of the twentieth century, comparative psychology developed most strongly in North America, while ethology was stronger in Europe. A practical difference is that early comparative psychologists concentrated on gaining extensive knowledge of the behaviour of very few species, while ethologists were more interested in gaining knowledge of behaviour in a wide range of species in order to be able to make principled comparisons across taxonomic groups. Ethologists have made much more use of a truly comparative method than comparative psychologists have. Despite the historical divergence, most ethologists (as opposed to behavioural ecologists), at least in North America, teach in psychology departments. It is a strong belief among scientists that the mechanisms on which behavioural processes are based are the same that cause the evolution of the living species: there is therefore a strong association between these two fields.

3.2 *Scala naturae* and Lamarck's theories

Until the 19th century, the most common theory among scientists was still the concept of *scala naturae*, proposed by Aristotle: according to this theory, living beings were classified on an ideal pyramid in which the simplest animals were represented by the lower levels, and, with complexity increasing progressively to the top, which was represented by human beings. There was also a group of 'biologists' who refuted the Aristotelian theory for a more anthropocentric one, according to which all living beings were created by Buddha to serve mankind, and would behave accordingly. A well-radicated opinion in the common sense of the time in the Western world was that animal species were eternal and immutable, created with a specific purpose, as this seemed the only possible explanation for the incredible variety of the living beings and their surprising adaptation to their habitat. The first biologist elaborating a complex theory of evolution was Jean-Baptiste Lamarck (1744–1829). His theory substantially comprised two statements: the first is that animal organs and behaviour can change according to the way they are being used, and second that those characteristics are capable of being transmitted from one generation to the next (well-known is the example of the giraffe whose neck becomes longer while trying to reach the upper leaves of a tree). The second statement is that each and every living organism, human beings included, tends to reach a greater level of perfection. At the time of his journey for the Galapagos Islands, Charles Darwin was well aware of Lamarck's theories and was influenced by them.

3.3 Theory of evolution by natural selection and the beginnings of ethology

Because ethology is considered a topic of biology, ethologists have been concerned particularly with the evolution of behaviour and the understanding of behaviour in terms of the theory of natural selection. In one sense, the first modern ethologist was Charles Darwin, whose book, *The Expression of the Emotions in Man and Animals*, influenced many ethologists. He pursued his interest in behaviour by encouraging his protégé George Romanes, who investigated animal learning and intelligence using an anthropomorphic method, anecdotal cognitivism, that did not gain scientific support.

Other early ethologists, such as Oskar Heinroth and Julian Huxley, instead concentrated on behaviours that can be called instinctive, or natural, in that they occur in all members of a species under specified circumstances. Their beginning for studying the behaviour of a new species was to construct an **ethogram** (a description of the main types of natural behaviour with their frequencies of occurrence). This provided an objective, cumulative base of data about behaviour, which subsequent researchers could check and supplement.

3.4 Instinct

The Merriam-Webster dictionary defines instinct as a largely inheritable and unalterable tendency of an organism to make a complex and specific response to environmental stimuli without involving reason. For ethologists, instinct means a series of predictable behaviors for fixed action patterns. Such schemes are only acted when a precise stimulating signal is present. When such signals act as communication among members of the same species, they are known as releasers. Notable examples of releasers are, in many bird species, the beak movements by the newborns, which stimulates the mother's regurgitating process to feed her offspring. Another well known case is the classic experiments by Tinbergen on the Graylag Goose. Like similar waterfowl, it will roll a displaced egg near its nest back to the others with its beak. The sight of the displaced egg triggers this mechanism. If the egg is taken away, the animal continues with the behaviour, pulling its head back as if an imaginary egg is still being maneuvered by the underside of its beak. However, it will also attempt to move other egg shaped objects, such as a giant plaster egg, door knob, or even a volleyball back into the nest. Such objects, when they exaggerate the releasers found in natural objects, can elicit a stronger version of the behavior than the natural object, so that the goose will ignore its own displaced egg in favor of the giant dummy egg. These exaggerated releasers for instincts were termed supernormal stimuli by Tinbergen. Tinbergen found he could produce supernormal stimuli for most instincts in animals, such as cardboard butterflies which male butterflies preferred to mate with if their stripes were darker than a real female or dummy fish which a territorial male stickleback fish would fight more violently than a real invading male if the dummy had a brighter colored underside. Harvard psychologist Deirdre Barrett has done research pointing out how easily humans also respond to supernormal stimuli for sexual, nurturing, feeding, and social instincts.[4] However, a behaviour only made of fixed action patterns would be particularly rigid and inefficient, reducing the probabilities of survival and reproduction, so the learning process has great importance, as the ability to change the individual's responses based on its experience. It can be said[*by whom?*] that the more the brain is complex and the life of the individual long, the more its behaviour will be "intelligent" (in the sense of guided by experience rather than stereotyped FAPs).

3.5 Learning

Learning occurs in many ways, one of the most elementary being habituation. This process consists in ignoring persistent or useless stimuli. An example of learning by habituation is the one observed in squirrels: when one of them feels threatened, the others hear its signal and go to the nearest refuge. However, if the signal comes from an individual who has caused many false alarms, its signal will be ignored. Another common way of learning is by association, where a stimulus is, based on the experience, linked to another one which may not have anything to do with the first one. The first studies of associative learning were made by Russian physiologist Ivan Pavlov, his Phenomenon also related to the time and the attractive bell sound that do SAYs ‘to learn makes it away of the food’. An example of associative behaviour is observed when a common goldfish goes close to the water surface whenever a human is going to feed it, or the excitement of a dog whenever it sees a collar as a prelude for a walk. The associative learning process is related to the necessity of developing discriminatory capacities, that is, the faculty of making meaningful choices. Being able to discriminate the members of your own species is of fundamental importance for reproductive success. Such discrimination can be based on a number of factors in many species including birds, however, this important type of learning only takes place in a very limited period of time. This kind of learning is called imprinting.

3.5.1a Imprinting

A second important finding of Lorenz concerned the early learning of young nidifugous birds, a process he called imprinting. Lorenz observed that the young of birds such as geese and chickens followed their mothers spontaneously from almost the first day after they were hatched, and he discovered that this response could be imitated by an arbitrary stimulus if the eggs were incubated artificially and the stimulus was presented during a **critical period** (a less temporally constrained period is called a **sensitive period**) that continued for a few days after hatching.

3.5.1b Imitation

Finally, imitation is often an important type of learning. A well-documented example of imitative learning is that of macaques in Hachijojima island, Japan. These primates used to live in the inland forest until the 1960s, when a group of researchers started giving them some potatoes on the beach: soon they started venturing onto the beach, picking the potatoes from the sand, and cleaning and eating them. About one year later, an individual was observed bringing a potato to the sea, putting it into the water with one hand, and cleaning it with the other. Her behaviour was soon imitated by the individuals living in contact with her; when they gave birth, they taught this practice to their young.

3.6 Mating and supremacy

Individual reproduction is the most important phase in the proliferation of individuals or genes within a species: for this reason, we can often observe complex mating rituals, which can be very complex even if they are often regarded as fixed action patterns **(FAPs)**. The Stickleback's complex mating ritual was studied by Niko Tinbergen and is regarded as a notable example of a FAP. Often in social life, animals fight for the right of reproducing themselves as well as social supremacy.

A common example of fight for social and sexual supremacy is the so-called pecking order among poultry. A pecking order is established every time a group of poultry co-lives for a certain amount of time. In each of these groups, a chicken is dominating among the others and can peck before anyone else without being pecked. A second chicken can peck all the others but the first, and so on. The chicken in the higher levels can be easily distinguished for their well-cured aspect, as opposed to the ones in the lower levels. During the period in which the pecking order is establishing, frequent and violent fights can happen, but once it is established it is only broken when other individuals are entering the group, in which case the pecking order has to be established from scratch.

3.7 Living in groups/Social behavior

Several animal species, including humans, tend to live in groups. Group size is a major aspect of their social environment. Social life is probably a complex and effective survival strategy. It may be regarded as a sort of symbiosis among individuals of the same species: a society is composed of a group of individuals belonging to the same species living within well-defined rules on food management, role assignments and reciprocal dependence. The situation is actually much more complex than it seems. When biologists interested in evolution theory first started examining social behaviour, some apparently unanswerable questions occurred. How could, for instance, the birth of sterile castes, like in bees, be explained through an evolving mechanism which emphasizes the reproductive success of as many individuals as possible? Why, among animals living in small groups like squirrels, would an individual risk its own life to save the rest of the group? These behaviours may be examples of altruism. Of course, not all behaviours are altruistic, as indicated by the table below. Notably, revengeful behaviour was at one point claimed to have been observed exclusively in *Homo sapiens*. However other species have been reported to be vengeful, including reports of vengeful camels and vengeful chimpanzees.

3.8 Tinbergen's four questions for ethologists

Lorenz's collaborator, Niko Tinbergen, argued that ethology always needed to include four kinds of explanation in any instance of behaviour:

- Function — How does the behaviour affect the animal's chances of survival and reproduction? Why does the animal respond that way instead of some other way?
- Causation — What are the stimuli that elicit the response, and how has it been modified by recent learning?
- Development — How does the behaviour change with age, and what early experiences are necessary for the behaviour to be displayed?

- Evolutionary history — How does the behaviour compare with similar behaviour in related species, and how might it have begun through the process of phylogeny?

3.9 Growth of field in ethology

Ethology is now a well recognised scientific discipline, and has a number of journals covering developments in the subject, such as the Ethology Journal. In 1972, the International Society for Human Ethology was founded to promote exchange of knowledge and opinions concerning human behavior gained by applying ethological principles and methods and published in their journal, The Human Ethology Bulletin. During 2008, in a paper published in the journal Behaviour, ethologist Peter Verbeek introduced the term "Peace Ethology" as a sub-discipline of Human Ethology that is concerned with issues of human conflict, conflict resolution, reconciliation, war, peacemaking, and peacekeeping behavior.

4.0 Conclusion

In this unit students have learnt the meaning of ethology, Scalae naturae and Lamarck's theories, theories of evolution by natural selection, the beginning of evolution, learning in ethology and mating.

5.0 Summary

In 1972, the International Society for Human Ethology was founded to promote exchange of knowledge and opinions concerning human behavior gained by applying ethological principles and methods and published in their journal, The Human Ethology Bulletin. During 2008, in a paper published in the journal Behaviour, ethologist Peter Verbeek introduced the term "Peace Ethology" as a sub-discipline of Human Ethology that is concerned with issues of human conflict, conflict resolution, reconciliation, war, peacemaking, and peacekeeping behavior and a lot of behavioural adaptation.

6.0 Tutor-Marked Assignments

1. What is ethology.
2. State the theory of evolution by natural selection
3. Differenciate between impring and imitation in learning, give scenerio
4. State Tinbergen's four questions for ethology.

7.0 References

• Karen Shanor and Jagmeet Kanwal: *Bats Sing, Mice Giggle: Revealing the Secret Lives of Animals*, Icon (2009). 'Accessible to the lay reader and acceptable to the scientific community' (The Daily Telegraph), 10 October 2009.

•Klein, Z. (2000). "The ethological approach to the study of human behavior". *Neuroendocrinology Letters* (21): 477–481. http://www.nel.edu/21_6/NEL21062000X001_Klein_.pdf.

•**B**arrett et al. (2002) Human Evolutionary Psychology. Princeton University Press.

•Verbeek, Peter. (2008) "Peace Ethology." Behaviour 145, 1497-1524

•Nobel Prize page for 1973 Medicine Award to Tinbergen, Lorenz, and von Frisch for contributions in ethology

•Barrett et al. (2002) Human Evolutionary Psychology. Princeton University Press.

Unit 2 Emotion in Animals

CONTENT

1.0 Introduction

There is no scientific consensus on emotion in animals, that is, what emotions certain species of animals, including humans, feel. The debate concerns primarily mammals and birds, although emotions have also been postulated for other vertebrates and even for some invertebrates. Animal lovers, scientists, philosophers, and others who interact with animals, have suggested answers but the core question has proven difficult to answer since animals cannot speak of their experience. Society recognizes animals can feel pain as is demonstrated by the criminalization of animal cruelty. Animal expressions of apparent pleasure are ambiguous as to whether this is emotion, or simply innate responses, perhaps for approval or other hard-wired cues. The ambiguity is a source of controversy as there is no certainty which views, if any, reflect reality. That said, extreme behaviourists would say that human "feeling" is also merely a hard-wired response to external stimuli. In recent years, research has become available which expands prior understandings of animal language, cognition and tool use, and even sexuality. Emotions arise in the mammalian brain, or the limbic system, which human beings share in common with other mammals as well as many other species.

2.0 Objectives

At the end of unit, students should be able to:

8. Explain emotion in animals under ethology.
9. Explain different views on emotion in animals.
10. State the Jeffrey Moussaieff Masson view.
11. Explain emotion in the following animals: Cannies , Felines, Primates etc

3.0 Main Content

3.1 Evidences

While humans have had differing views of animal emotion, the scientific examination of animal emotion has led to little information beyond a recognition that animals have the capacity for pain and fear, and such responses as are needed for survival. Historically, prior to the rise of sciences such as ethology, interpretation of animal behaviour tended to favour a kind of minimalism known as behaviourism, in this context the refusal to ascribe to an animal a capability beyond the least demanding that would explain a behaviour; anything more than this was seen as unwarranted anthropomorphism. Put crudely, the behaviourist argument is, why should humans postulate consciousness and all its near-human implications in animals to explain some behaviour, if mere stimulus-response is a sufficient explanation to produce the same effects?

3.1.1 Different views on emotion in animals

1. The cautious wording of Beth Dixon's 2001 paper on animal emotion exemplifies this viewpoint:

Recent work in the area of ethics and animals suggests that it is philosophically legitimate to ascribe emotions to non-human animals. Furthermore, it is sometimes argued that emotionality is a morally relevant psychological state shared by humans and non humans. What is missing from the philosophical literature that makes reference to emotions in non-human animals is an attempt to clarify and defend some particular account of the nature of emotion, and the role that emotions play in a characterization of human nature. I argue in this paper that some analyses of emotion are more credible than others. Because this is so, the thesis that humans and nonhumans share emotions may well be a more difficult case to make than has been recognized thus far.

While the study of emotion is a respectable field, those who work in it are usually academic psychologists who confine their studies to human emotions. The standard reference work, The Oxford Companion to Animal Behavior, advises animal behaviourists that "One is well advised to study the behaviour, rather than attempting to get at any underlying emotion."

2.1 Jeffrey Moussaieff Masson expresses a similar view:

While the study of emotion is a respectable field, those who work in it are usually academic psychologists who confine their studies to human emotions. The standard reference work, The Oxford Companion to Animal Behavior, advises animal behaviourists that "One is well advised to study the behaviour, rather than attempting to get at any underlying emotion."

There is considerable uncertainty and difficulty related to the interpretation and ambiguity of emotion: an animal may make certain movements and sounds, and show certain brain and chemical signals when its body is damaged in a particular way. But does this mean an animal feels—is aware of—pain as we are, or does it merely mean it is programmed to act a certain way with certain stimuli? Similar questions can be asked of any activity an animal (including a human) might undertake, in principle. Many scientists regard all emotion and cognition (in humans and animals) as having a purely mechanistic basis.

3.2 Examples of emotion in animal

3.2.1 Primates

Primates and in particular great apes are candidates for highly developed capabilities for empathy and theories of mind. Great apes have highly complex social systems. Young apes and their mothers have very strong bonds of attachment. Often when a baby chimpanzee or gorilla dies, the mother will carry the body around for several days. Jane Goodall has described chimpanzees as exhibiting mournful behavior. See notably the example of the gorilla Koko, who expressed sadness over the death of her pet cat, All Ball.

3.2.2 Fish

A 2007 study by the University of Guelph Scientists in Canada suggests that fish may have their own separate personalities. The study examined a group of trout that were visually identical. The study concluded that different fish within the same group exhibited different personality traits. Some fish were more willing to take risks in unknown waters than others when taken from their environment and introduced to a dark tube. Some fish were more social than others while some fish preferred being alone. Fish were also shown to have different preferences as far as eating habits.

3.2.3 Felines

The emotions of cats have also been studied scientifically. It has been shown that cats can learn to manipulate their owners through vocalizations that are similar to the cries of human babies. Some cats learn to add a purr to the cry, which makes it less harmonious[clarification needed] to humans and therefore harder to ignore. Individual cats learn to make these cries through operant conditioning; when a particular cry elicits a positive response from a human, the cat is more likely to use that cry in the future.

3.2.4 Canines

Research suggests that canines can experience negative emotions in a similar manner to people, including the equivalent of certain chronic and acute psychological conditions. The classic experiment for this was Martin Seligman's foundational experiments and theory of learned helplessness at the University of Pennsylvania in 1965, as an extension of his interest in depression:

A further series of experiments showed that (similar to humans) under conditions of long term intense psychological stress, around 1/3 of dogs do not develop learned helplessness or long term depression.[citation needed] Instead these animals somehow managed to find a way to handle the unpleasant situation in spite of their past experience. The corresponding characteristic in humans has been found to correlate highly with an explanatory style and optimistic attitude and lower levels of emotion dog that had earlier been repeatedly conditioned to associate a sound with electric shocks did not try to escape the electric shocks after the warning was presented, even though all the dog would have had to do is jump over a low divider within ten seconds, more than enough time to respond. The dog didn't even try to avoid the "aversive stimulus"; it had previously "learned" that nothing it did mattered. A follow-up experiment involved three dogs affixed in harnesses, including one that received shocks of identical intensity and duration to the others, but the lever which would otherwise have allowed the dog a degree of control was left disconnected and didn't do anything. The first two dogs quickly recovered from the experience, but the third dog suffered chronic symptoms of clinical depression as a result of this perceived helplessness.

nal rigidity regarding expectations, that views the situation as other than personal, pervasive, or permanent. Such studies highlighted similar distinctions between people who adapt and those who break down, under long term psychological pressure, which were conducted in the 1950s in the realm of brainwashing.

10.0 CONCLUSION

In this unit, Students have learnt emotion in animals, different view on emotion and emotion in animals like, fish canines etc.

5.0 Summary

Emotions arise in the mammalian brain, or the limbic system, which human beings share in common with other mammals as well as many other species.

6.0 Tutor-Marked Assignment

1. Explain emotion in animals under ethology.

2. Explain different views on emotion in animals.

3. State the Jeffrey Moussaieff Masson view.

4.0 Explain emotion in the following animals: Cannies , Felines, Primates and any other related animals that has not been described earlier.

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Unit 3 Animal Communication

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1.0 INTRODUCTION

Animal communication is any behavior on the part of one animal that has an effect on the current or future behaviour of another animal. The study of animal communication, sometimes called Zoosemiotics (defined as the study of sign communication or semiosis in animals; distinguishable from anthroposemiotics, the study of human communication) has played an important part in the methodology of ethology, sociobiology, and the study of animal cognition. Animal communication, and indeed the understanding of the animal world in general, is a rapidly growing field, and even in the 21st century so far, many prior understandings related to diverse fields such as personal symbolic name use, animal emotions, animal culture and learning, and even sexual conduct, long thought to be well understood, have been revolutionized.

2.0 Objectives

At the end of this unit, students should be able to:

1. Distinguish between intraspecies and interspecies communication.
2. Explain forms of communication .
3. Explain other aspects of communication like evoluation of communication, human communication and cognitive communication.

3.0 Main Content

3.1 Validation

3.1.1 Forms of communication

The best known form of communication involves the display of distinctive body parts, or distinctive bodily movements; often these occur in combination, so a distinctive movement acts to reveal or emphasize a distinctive body part. For example, the presentation of a parent Herring Gull's bill to its chick signals feeding time. Like many gulls, the Herring Gull has a brightly coloured bill, yellow with a red spot on the lower mandible near the tip. When it returns to the nest with food, the parent stands over its chick and taps the bill on the ground in front of it; this elicits a begging response from a hungry chick (pecking at the red spot), which stimulates the parent to regurgitate food in front of it. The complete signal therefore involves a distinctive morphological feature (body part), the red-spotted bill, and a distinctive movement (tapping towards the ground) which makes the red spot highly visible to the chick. Congruently, some cephalopods, such as the octopus, have specialized skin cells that can change the apparent colour, opacity, and reflectiveness of their skin. In addition to being used for camouflage, rapid changes in skin colour are used while hunting and in courtship rituals.

Many animals communicate through vocalizations. Communication through vocalization is essential for many tasks including mating rituals, warning calls, conveying location of food sources, and social learning. Male mating calls are used to signal the female and to beat competitors in species such as hammer-headed bats, red deers, humpback whales and elephant seals. In whale species Whale song has been found to have different dialects based on location. Other instances of communication include the warning cries of the Campbell monkey, the territorial calls of gibbons, the use of frequency in Greater Spear-nosed bats to to distinguish between groups.

Less obvious (except in a few cases) is olfactory communication. Many mammals, in particular, have glands that generate distinctive and long-lasting smells, and have corresponding behaviours that leave these smells in places where they have been. Often the scented substance is introduced into urine or feces. Sometimes it is distributed through sweat, though this does not leave a semi-permanent mark as scents deposited on the ground do. Some animals have glands on their bodies whose sole function appears to be to deposit scent marks: for example Mongolian gerbils have a scent gland on their stomachs, and a characteristic ventral rubbing action that deposits scent from it. Golden hamsters and cats have scent glands on their flanks, and deposit scent by rubbing their sides against objects; cats also have scent glands on their foreheads. Bees carry with them a pouch of material from the hive which they release as they reenter, the smell of which indicates that they are a part of the hive and grants their safe entry. Ants use pheromones to create scent trails to food as well as for alarm calls, mate attraction and to distinguish between colonies. Additionally, they have pheromones that are used to confuse an enemy and manipulate them into fighting with themselves.

A rarer form of animal communication is electrocommunication. It is seen primarily in aquatic life, though some mammals, notably the platypus and echidnas are capable of electroreception and thus theoretically of electrocommunication.

Functions of communication

agonistic interaction: everything to do with contests and aggression between individuals. Many species have distinctive threat displays that are made during competition over food, mates or territory; much bird song functions in this way. Often there is a matched submission display, which the threatened individual will make if it is acknowledging the social dominance of the threatener; this has the effect of terminating the aggressive episode and allowing the dominant animal unrestricted access to the resource in dispute. Some species also have affiliative displays which are made to indicate that a dominant animal accepts the presence of another.

courtship rituals: signals made by members of one sex to attract or maintain the attention of potential mate, or to cement a pair bond. These frequently involve the display of body parts, body postures (gazelles assume characteristic poses as a signal to initiate mating), or the emission of scents or calls, that are unique to the species, thus allowing the individuals to avoid mating with members of another species which would be infertile. Animals that form lasting pair bonds often have symmetrical displays that they make to each other: famous examples are the mutual presentation of reeds by Great Crested Grebes, studied by Julian Huxley, the triumph displays shown by many species of geese and penguins on their nest sites and the spectacular courtship displays by birds of paradise and manakins.

food-related signals: many animals make "food calls" that attract a mate, or offspring, or members of a social group generally to a food source. When parents are feeding offspring, the offspring often have begging responses (particularly when there are many offspring in a clutch or litter - this is well known in altricial songbirds, for example). Perhaps the most elaborate food-related signal is the dance language of honeybeesstudied by Karl von Frisch.

alarm calls: signals made in the presence of a threat from a predator, allowing all members of a social group (and often members of other species) to run for cover, become immobile, or gather into a group to reduce the risk of attack.

ownership/territorial: signals used to claim or defend a territory, food, or a mate.

metacommunications: signals that modify the meaning of subsequent signals. The best known example is the play face in dogs, which signals that a subsequent aggressive signal is part of a play fight rather than a serious aggressive episode.

3.3. Species communication

The sender and receiver of a communication may be of the same species or of different species. The majority of animal communication is intraspecific (between two or more individuals of the same species). However, there are some important instances of interspecific communication. Also, the possibility of interspecific communication, and the form it takes, is an important test of some theoretical models of animal communication.

3.3.1 Intraspecies Communication.

The majority of animal communication occurs within a single species, and this is the context in which it has been most intensively studied.

Most of the forms and functions of communication described above are relevant to intra-species communication.

3.3. 2 Interspecies communication

Many examples of communication take place between members of different species. Animals communicate to other animals with various signs: visual, sound, echolocation, body language, and smell.

3.3.3 Human communication

Various ways in which humans interpret the behavior of domestic animals, or give commands to them, fit the definition of interspecies communication. Depending on the context, they might be considered to be predator to prey communication, or to reflect forms of commensalism. The recent experiments on animal language are perhaps the most sophisticated attempt yet to establish human/animal communication, though their relation to natural animal communication is uncertain. Lacking in the study of human-animal communication is a focus on expressive communication from animal to human specifically. Other than a few natural expressions animals (especially dogs) use to communicate to humans, scientists in general do not pursue expanding the expressive/productive communication of domesticated animals. Horses are taught to not communicate (for safety). Dogs and horses are generally not encouraged to communicate expressively, but are encouraged to develop receptive language (understanding). One scientist, Sean Senechal has pursued (since the late 1990's) developing, studying, and using the learned visible, expressive language in dogs and horses. By teaching these animals a gestural (human made) ASL-like language animals have been found to learn and use the new signs on their own to get what they need. Senechal's book Dogs Can Sign, Too documents this process.

3.3.4 Predator to prey

Some predators communicate to prey in ways that change their behaviour and make them easier to catch, in effect deceiving them. A well-known example is the angler fish, which has a fleshy growth protruding from its forehead and dangling in front of its jaws; smaller fish try to take the lure, and in so doing are perfectly placed for the angler fish to eat them.

3.3.5 Symbiotic species

Interspecies communication also occurs in various kinds of mutualism and symbiosis. For example, in the cleaner fish/grouper system, groupers signal their availability for cleaning by adopting a particular posture at a cleaning station.

3.4 Other aspect of communication

3.4.1 Cognitive aspects

Ethologists and sociobiologists have characteristically analysed animal communication in terms of more or less automatic responses to stimuli, without raising the question of whether the animals concerned understand the meaning of the signals they emit and receive. That is a key question in animal cognition. There are some signalling systems that seem to demand a more advanced understanding. A much discussed example is the use of alarm calls by vervet monkeys. Robert Seyfarth and Dorothy Cheney showed that these animals emit different alarm calls in the presence of different predators (leopards, eagles, and snakes), and the monkeys that hear the calls respond appropriately - but that this ability develops over time, and also takes into account the experience of the individual emitting the call. Metacommunication, discussed above, also seems to require a more sophisticated cognitive process.

3.4.2 **Evolution of communication**

Significant contributions to the first of these problems were made by Konrad Lorenz and other early ethologists. By comparing related species within groups, they showed that movements and body parts that in the primitive forms had no communicative function could be "captured" in a context where communication would be functional for one or both partners, and could evolve into a more elaborate, specialised form. For example, Desmond Morris showed in a study of grass finches[citation needed] that a beak-wiping response occurred in a range of species, serving a preening function, but that in some species this had been elaborated into a courtship signal.

The second problem has been more controversial. The early ethologists assumed that communication occurred for the good of the species as a whole, but this would require a process of group selection which is believed to be mathematically impossible in the evolution of sexually reproducing animals. Altruism towards an unrelated group is not widely accepted in the scientific community, but rather can be seen as a sort of reciprocal altruism, expecting the same behavior from others, a benefit of living in a group. Sociobiologists argued that behaviours that benefited a whole group of animals might emerge as a result of selection pressures acting solely on the individual. A gene-centered view of evolution proposes that behaviors that enabled a gene to become wider established within a population would become positively selected for, even if their effect on individuals or the species as a whole was detrimental.

In the case of communication, an important discussion by John Krebs and Richard Dawkins established hypotheses for the evolution of such apparently altruistic or mutualistic communications as alarm calls and courtship signals to emerge under individual selection. This led to the realisation that communication might not always be "honest" (indeed, there are some obvious examples where it is not, as in mimicry). The possibility of evolutionarily stable dishonest communication has been the subject of much controversy, with Amotz Zahavi in particular arguing that it cannot exist in the long term. Sociobiologists have also been concerned with the evolution of apparently excessive signalling structures such as the peacock's tail; it is widely thought that these can only emerge as a result of sexual selection, which can create a positive feedback process that leads to the rapid exaggeration of a characteristic that confers an advantage in a competitive mate-selection situation.

One theory to explain the evolution of traits like a peacock's tail is 'runaway selection'. This requires two traits-a trait that exists, like the bright tail, and a prexisting bias in the female to select for that trait. Females prefer the more elaborate tails, and thus those males are able to mate successfully. Exploiting the psychology of the female, a positive feedback loop is enacted and the tail becomes bigger and brighter. Eventually, the evolution will level off because the survival costs to the male do not allow for the trait to be elaborated any further. Two theories exist to explain runaway selection. The first is the good genes hypothesis. This theory states that an elaborate display is an honest signal of fitness and truly is a better mate. The second is the handicap hypothesis. This explains that the peacock's tail is a handicap, requiring energy to keep and makes it more visible to predators. Regardless, the individual is able to survive, even though its genes are not as good per se.

Animal communication and human behavior

Another controversial issue is the extent to which humans have behaviours that resemble animal communication, or whether all such communication has disappeared as a result of our linguistic capacity. Some of our bodily features - eyebrows, beards and moustaches, deep adult male voices, perhaps female breasts - strongly resemble adaptations to producing signals. Ethologists such as Irenäus Eibl-Eibesfeldt have argued that facial gestures such as smiling, grimacing, and the eyebrow flash on greeting are universal human communicative signals that can be related to corresponding signals in other primates. Given the recency with which spoken language has emerged, it is very likely that human body language does include some more or less involuntary responses that have a similar origin to the communication we see in other animals.

Humans also often seek to mimic animals' communicative signals in order to interact with the animals. For example, cats have a mild affiliative response involving closing their eyes; humans often close their eyes towards a pet cat to establish a tolerant relationship. Stroking, petting and rubbing pet animals are all actions that probably work through their natural patterns of interspecific communication.

3.5 Animal communication and linguistics

For linguistics, the interest of animal communication systems lies in their similarities to and differences from human language:

Human languages are characterized for having a double articulation (in the characterization of French linguist André Martinet). It means that complex linguistic expressions can be broken down in meaningful elements (such as morphemes and words), which in turn are composed of smallest phonetic elements that affect meaning, called phonemes. Animal signals, however, do not exhibit this dual structure.

In general, animal utterances are responses to external stimuli, and do not refer to matters removed in time and space. Matters of relevance at a distance, such as distant food sources, tend to be indicated to other individuals by body language instead, for example wolf activity before a hunt, or the information conveyed in honeybee dance language. It is therefore unclear to what extent utterances are automatic responses and to what extent deliberate intent plays a part.

Human language is largely learned culturally, while animal communication systems are known largely by instinct.

Human languages combine elements to produce new messages (a property known as creativity). One factor in this is that much human language growth is based upon conceptual ideas and hypothetical structures, both being far greater capabilities in humans than animals. This appears far less common in animal communication systems, although current research into animal culture is still an ongoing process with many new discoveries.

In contrast to human language, animal communication systems are usually not able to express conceptual generalizations. (Cetaceans and some primates may be notable exceptions).

4.0 Conclusion

In this unit , students have learnt animal communication, differences between intraspecies and interspecies communication, human communication, evolution of communication ect.

5.0 Summary

The study of animal communication, sometimes called Zoosemiotics (defined as the study of sign communication or semiosis in animals

6.0 Tutor-Marked Assignment

1.0 Distinguish between intraspecies and interspecies communication.

2. Explain forms of communication with specific examples.

3. Explain other aspects of communication like evoluation of communication, human communication and cognitive communication.

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MODULE 2 REFLEX AND COMPLEX BEHAVIOR

Unit 1 Nervous System

CONTENT

5.0 Summary

6.0 Tutor-Marked Assignment

7.0 References

1.0 Introduction

The nervous system is an organ system containing a network of specialized cells called neurons that coordinate the actions of an animal and transmit signals between different parts of its body. In most animals the nervous system consists of two parts, central and peripheral. The central nervous system of vertebrates (such as humans) contains the brain, spinal cord, and retina. The peripheral nervous system consists of sensory neurons, clusters of neurons called ganglia, and nerves connecting them to each other and to the central nervous system. These regions are all interconnected by means of complex neural pathways. The enteric nervous system, a subsystem of the peripheral nervous system, has the capacity, even when severed from the rest of the nervous system through its primary connection by the vagus nerve, to function independently in controlling the gastrointestinal system. Neurons send signals to other cells as electrochemical waves travelling along thin fibers called axons, which cause chemicals called neurotransmitters to be released at junctions called synapses. A cell that receives a synaptic signal may be excited, inhibited, or otherwise modulated. Sensory neurons are activated by physical stimuli impinging on them, and send signals that inform the central nervous system of the state of the body and the external environment. Motor neurons, situated either in the central nervous system or in peripheral ganglia, connect the nervous system to muscles or other effector organs. Central neurons, which in vertebrates greatly outnumber the other types, make all of their input and output connections with other neurons. The interactions of all these types of neurons form neural circuits that generate an organism's perception of the world and determine its behavior. Along with neurons, the nervous system contains other specialized cells called glial cells (or simply glia), which provide structural and metabolic support.

Nervous systems are found in most multicellular animals, but vary greatly in complexity. Sponges have no nervous system, although they have homologs of many genes that play crucial roles in nervous system function, and are capable of several whole-body responses, including a primitive form of locomotion. Placozoans and mesozoans—other simple animals that are not classified as part of the subkingdom Eumetazoa—also have no nervous system. In Radiata (radially symmetric animals such as jellyfish) the nervous system consists of a simple nerve net. Bilateria, which include the great majority of vertebrates and invertebrates, all have a nervous system containing a brain, one central cord (or two running in parallel), and peripheral nerves. The size of the bilaterian nervous system ranges from a few hundred cells in the simplest worms, to on the order of 100 billion cells in humans. Neuroscience is the study of the nervous system.

2.0 Objectives

At the end of this unit, students should be able to:

1. Component of neruos system.
2. State the function of nervous system.
3. Explain comparative anatomy and evolution of different animals like sponges, bilateria ,arthropods etc

3.0 Main Content

3.1 Structure

The nervous system derives its name from nerves, which are cylindrical bundles of fibers that emanate from the brain and central cord, and branch repeatedly to innervate every part of the body. Nerves are large enough to have been recognized by the ancient Egyptians, Greeks, and Romans, but their internal structure was not understood until it became possible to examine them using a microscope. A microscopic examination shows that nerves consist primarily of the axons of neurons, along with a variety of membraes that wrap around them and segregate them into fascicles. The neurons that give rise to nerves do not lie entirely within the nerves themselves—their cell bodies reside within the brain, central cord, or peripheral ganglia.

All animals more advanced than sponges have nervous systems. However, even sponges, unicellular animals, and non-animals such as slime molds have cell-to-cell signalling mechanisms that are precursors to those of neurons. In radially symmetric animals such as the jellyfish and hydra, the nervous system consists of a diffuse network of isolated cells. In bilaterian animals, which make up the great majority of existing species, the nervous system has a common structure that originated early in the Cambrian period, over 500 million years ago.

3.1.1 Cells

The nervous system is primarily made up of two categories of cells: neurons and glial cells.

3.1.2 Neurons

The nervous system is defined by the presence of a special type of cell—the neuron (sometimes called "neurone" or "nerve cell"). Neurons can be distinguished from other cells in a number of ways, but their most fundamental property is that they communicate with other cells via synapses, which are membrane-to-membrane junctions containing molecular machinery that allows rapid transmission of signals, either electrical or chemical. Many types of neuron possess an axon, a protoplasmic protrusion that can extend to distant parts of the body and make thousands of synaptic contacts. Axons frequently travel through the body in bundles called nerves. Even in the nervous system of a single species such as humans, hundreds of different types of neurons exist, with a wide variety of morphologies and functions. These include sensory neurons that transmute physical stimuli such as light and sound into neural signals, and motor neurons that transmute neural signals into activation of muscles or glands; however in many species the great majority of neurons receive all of their input from other neurons and send their output to other neurons.

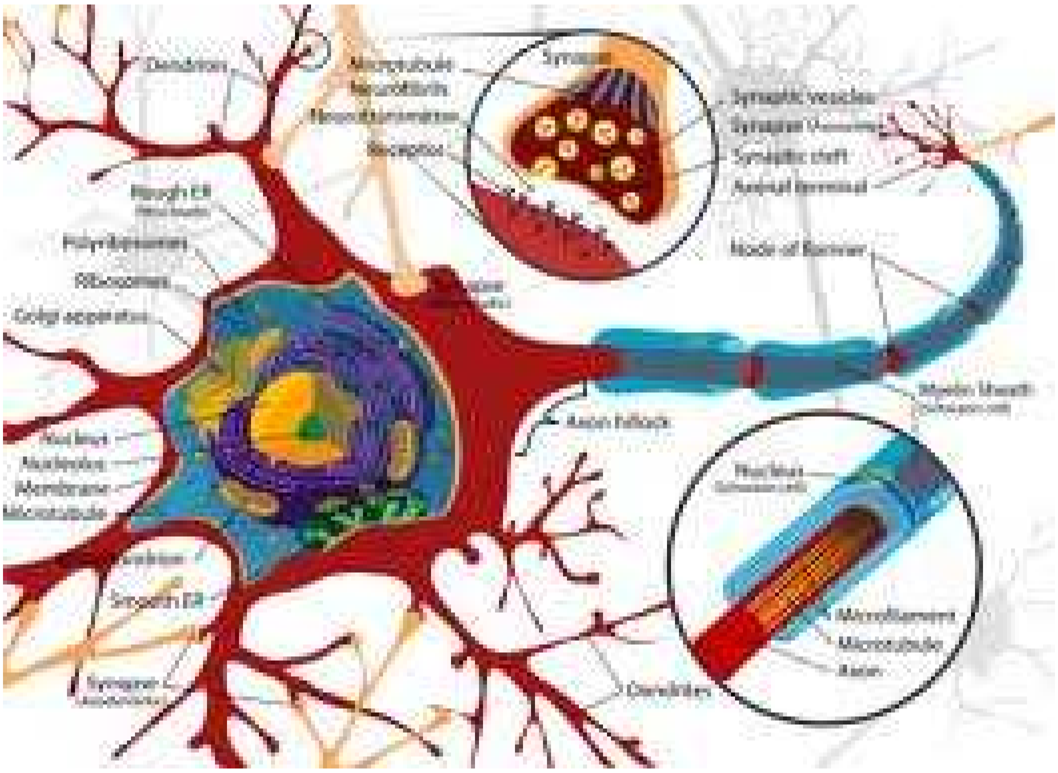

Figure 1: The Neurons

3.1.3 Glial cells

Glial cells are non-neuronal cells that provide support and nutrition, maintain homeostasis, form myelin, and participate in signal transmission in the nervous system. In the human brain, it is estimated that the total number of glia roughly equals the number of neurons, although the proportions vary in different brain areas. Among the most important functions of glial cells are to support neurons and hold them in place; to supply nutrients to neurons; to insulate neurons electrically; to destroy pathogens and remove dead neurons; and to provide guidance cues directing the axons of neurons to their targets. A very important type of glial cell (oligodendrocytes in the central nervous system, and Schwann cells in the peripheral nervous system) generates layers of a fatty substance called myelin that wraps around axons and provides electrical insulation which allows them to transmit action potentials much more rapidly and efficiently.

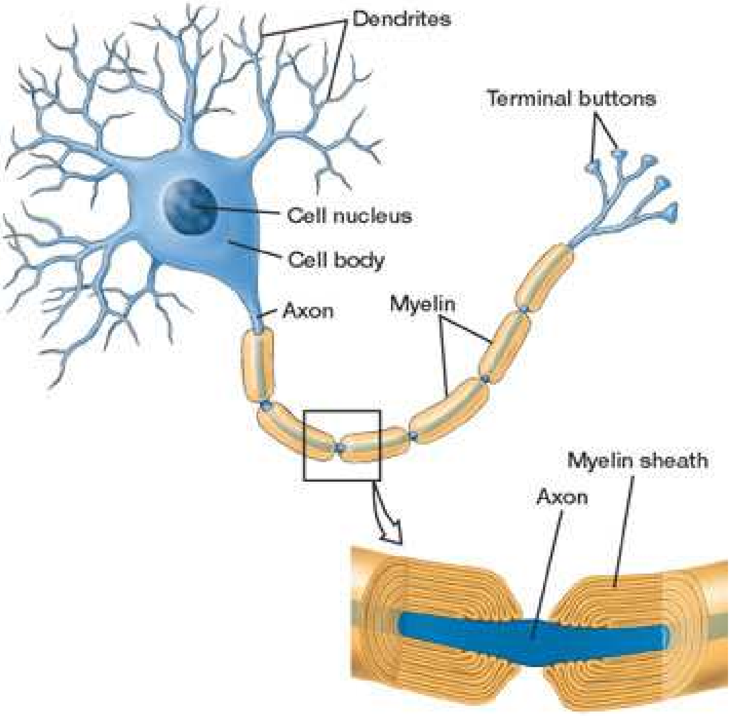

Figure 2: The Glial cells

3.2 Functions

At the most basic level, the function of the nervous system is to send signals from one cell to others, or from one part of the body to others. There are multiple ways that a cell can send signals to other cells. One is by releasing chemicals called hormones into the internal circulation, so that they can diffuse to distant sites. In contrast to this "broadcast" mode of signaling, the nervous system provides "point-to-point" signals—neurons project their axons to specific target areas and make synaptic connections with specific target cells. Thus, neural signaling is capable of a much higher level of specificity than hormonal signaling. It is also much faster: the fastest nerve signals travel at speeds that exceed 100 meters per second.

At a more integrative level, the primary function of the nervous system is to control the body. It does this by extracting information from the environment using sensory receptors, sending signals that encode this information into the central nervous system, processing the information to determine an appropriate response, and sending output signals to muscles or glands to activate the response. The evolution of a complex nervous system has made it possible for various animal species to have advanced perception abilities such as vision, complex social interactions, rapid coordination of organ systems, and integrated processing of concurrent signals. In humans, the sophistication of the nervous system makes it possible to have language, abstract representation of concepts, transmission of culture, and many other features of human society that would not exist without the human brain.

3.2.1 Neurons and synapses

Most neurons send signals via their axons, although some types are capable of dendrite-to-dendrite communication. (In fact, the types of neurons called amacrine cells have no axons, and communicate only via their dendrites.) Neural signals propagate along an axon in the form of electrochemical waves called action potentials, which produce cell-to-cell signals at points where axon terminals make synaptic contact with other cells.

Synapses may be electrical or chemical. Electrical synapses make direct electrical connections between neurons, but chemical synapses are much more common, and much more diverse in function. At a chemical synapse, the cell that sends signals is called presynaptic, and the cell that receives signals is called postsynaptic. Both the presynaptic and postsynaptic areas are full of molecular machinery that carries out the signalling process. The presynaptic area contains large numbers of tiny spherical vessels called synaptic vesicles, packed with neurotransmitter chemicals. When the presynaptic terminal is electrically stimulated, an array of molecules embedded in the membrane are activated, and cause the contents of the vesicles to be released into the narrow space between the presynaptic and postsynaptic membranes, called the synaptic cleft. The neurotransmitter then binds to receptors embedded in the postsynaptic membrane, causing them to enter an activated state. Depending on the type of receptor, the resulting effect on the postsynaptic cell may be excitatory, inhibitory, or modulatory in more complex ways. For example, release of the neurotransmitter acetylcholine at a synaptic contact between a motor neuron and a muscle cell induces rapid contraction of the muscle cell. The entire synaptic transmission process takes only a fraction of a millisecond, although the effects on the postsynaptic cell may last much longer (even indefinitely, in cases where the synaptic signal leads to the formation of a memory trace).

There are literally hundreds of different types of synapses. In fact, there are over a hundred known neurotransmitters, and many of them have multiple types of receptor. Many synapses use more than one neurotransmitter—a common arrangement is for a synapse to use one fast-acting small-molecule neurotransmitter such as glutamate or GABA, along with one or more peptide neurotransmitters that play slower-acting modulatory roles. Molecular neuroscientists generally divide receptors into two broad groups: chemically gated ion channels and second messenger systems. When a chemically gated ion channel is activated, it forms a passage that allow specific types of ion to flow across the membrane. Depending on the type of ion, the effect on the target cell may be excitatory or inhibitory. When a second messenger system is activated, it starts a cascade of molecular interactions inside the target cell, which may ultimately produce a wide variety of complex effects, such as increasing or decreasing the sensitivity of the cell to stimuli, or even altering gene transcription.

According to a rule called Dale's principle, which has only a few known exceptions, a neuron releases the same neurotransmitters at all of its synapses. This does not mean, though, that a neuron exerts the same effect on all of its targets, because the effect of a synapse depends not on the neurotransmitter, but on the receptors that it activates. Because different targets can (and frequently do) use different types of receptors, it is possible for a neuron to have excitatory effects on one set of target cells, inhibitory effects on others, and complex modulatory effects on others still. Nevertheless, it happens that the two most widely used neurotransmitters, glutamate and GABA, each have largely consistent effects. Glutamate has several widely occurring types of receptors, but all of them are excitatory or modulatory. Similarly, GABA has several widely occurring receptor types, but all of them are inhibitory. Because of this consistency, glutamatergic cells are frequently referred to as "excitatory neurons", and GABAergic cells as "inhibitory neurons". Strictly speaking this is an abuse of terminology—it is the receptors that are excitatory and inhibitory, not the neurons—but it is commonly seen even in scholarly publications.

One very important subset of synapses are capable of forming memory traces by means of long-lasting activity-dependent changes in synaptic strength. The best-known form of neural memory is a process called long-term potentiation (abbreviated LTP), which operates at synapses that use the neurotransmitter glutamate acting on a special type of receptor known as the NMDA receptor. The NMDA receptor has an "associative" property: if the two cells involved in the synapse are both activated at approximately the same time, a channel opens that permits calcium to flow into the target cell. The calcium entry initiates a second messenger cascade that ultimately leads to an increase in the number of glutamate receptors in the target cell, thereby increasing the effective strength of the synapse. This change in strength can last for weeks or longer. Since the discovery of LTP in 1973, many other types of synaptic memory traces have been found, involving increases or decreases in synaptic strength that are induced by varying conditions, and last for variable periods of time.[40] Reward learning, for example, depends on a variant form of LTP that is conditioned on an extra input coming from a reward-signalling pathway that uses dopamine as neurotransmitter. All these forms of synaptic modifiability, taken collectively, give rise to neural plasticity, that is, to a capability for the nervous system to adapt itself to variations in the environment.

3.2.2 Neural circuits and system

The basic neuronal function of sending signals to other cells includes a capability for neurons to exchange signals with each other. Networks formed by interconnected groups of neurons are capable of a wide variety of functions, including feature detection, pattern generation, and timing. In fact, it is difficult to assign limits to the types of information processing that can be carried out by neural networks: Warren McCulloch and Walter Pitts showed in 1943 that even networks formed from a greatly simplified mathematical abstraction of a neuron are capable of universal computation. Given that individual neurons can generate complex temporal patterns of activity all by themselves, the range of capabilities possible for even small groups of interconnected neurons are beyond current understanding.

Historically, for many years the predominant view of the function of the nervous system was as a stimulus-response associator. In this conception, neural processing begins with stimuli that activate sensory neurons, producing signals that propagate through chains of connections in the spinal cord and brain, giving rise eventually to activation of motor neurons and thereby to muscle contraction, i.e., to overt responses. Descartes believed that all of the behaviors of animals, and most of the behaviors of humans, could be explained in terms of stimulus-response circuits, although he also believed that higher cognitive functions such as language were not capable of being explained mechanistically. Charles Sherrington, in his influential 1906 book The Integrative Action of the Nervous System, developed the concept of stimulus-response mechanisms in much more detail, and Behaviorism, the school of thought that dominated Psychology through the middle of the 20th century, attempted to explain every aspect of human behavior in stimulus-response terms.

However, experimental studies of electrophysiology, beginning in the early 20th century and reaching high productivity by the 1940s, showed that the nervous system contains many mechanisms for generating patterns of activity intrinsically, without requiring an external stimulus. Neurons were found to be capable of producing regular sequences of action potentials, or sequences of bursts, even in complete isolation. When intrinsically active neurons are connected to each other in complex circuits, the possibilities for generating intricate temporal patterns become far more extensive. A modern conception views the function of the nervous system partly in rms of stimulus-response chains, and partly in terms of intrinsically generated activity patterns—both types of activity interact with each other to generate the full repertoire of behavior.

3.2.3 Reflexes and other stimulus-response circuits

The simplest type of neural circuit is a reflex arc, which begins with a sensory input and ends with a motor output, passing through a sequence of neurons in between. For example, consider the "withdrawal reflex" causing the hand to jerk back after a hot stove is touched. The circuit begins with sensory receptors in the skin that are activated by harmful levels of heat: a special type of molecular structure embedded in the membrane causes heat to generate an electrical field across the membrane. If the electrical potential change is large enough, it evokes an action potential, which is transmitted along the axon of the receptor cell, into the spinal cord. There the axon makes excitatory synaptic contacts with other cells, some of which project to the same region of the spinal cord, others projecting into the brain. One target is a set of spinal interneurons that project to motor neurons controlling the arm muscles. The interneurons excite the motor neurons, and if the excitation is strong enough, some of the motor neurons generate action potentials, which travel down their axons to the point where they make excitatory synaptic contacts with muscle cells. The excitatory signals induce contraction of the muscle cells, which causes the joint angles in the arm to change, pulling the arm away. In reality, this straightfoward schema is subject to numerous complications. Although for the simplest reflexes there are short neural paths from sensory neuron to motor neuron, there are also other nearby neurons that participate in the circuit and modulate the response. Furthermore, there are projections from the brain to the spinal cord that are capable of enhancing or inhibiting the reflex.

Although the simplest reflexes may be mediated by circuits lying entirely within the spinal cord, more complex responses rely on signal processing in the brain. Consider, for example, what happens when an object in the periphery of the visual field moves, and a person looks toward it. The initial sensory response, in the retina of the eye, and the final motor response, in the oculomotor nuclei of the brain stem, are not all that different from those in a simple reflex, but the intermediate stages are completely different. Instead of a one or two step chain of processing, the visual signals pass through perhaps a dozen stages of integration, involving the thalamus, cerebral cortex, basal ganglia, superior colliculus, cerebellum, and several brainstem nuclei. These areas perform signal-processing functions that include feature detection, perceptual analysis, memory recall, decision-making, and motor planning.

Feature detection is the ability to extract biologically relevant information from combinations of sensory signals. In the visual system, for example, sensory receptors in the retina of the eye are only individually capable of detecting "points of light" in the outside world. Second-level visual neurons receive input from groups of primary receptors, higher-level neurons receive input from groups of second-level neurons, and so on, forming a hierarchy of processing stages. At each stage, important information is extracted from the signal ensemble and unimportant information is discarded. By the end of the process, input signals representing "points of light" have been transformed into a neural representation of objects in the surrounding world and their properties. The most sophisticated sensory processing occurs inside the brain, but complex feature extraction also takes place in the spinal cord and in peripheral sensory organs such as the retina.

3 .2 .4 Intrinsic pattern generation

Although stimulus-response mechanisms are the easiest to understand, the nervous system is also capable of controlling the body in ways that do not require an external stimulus, by means of internally generated rhythms of activity. Because of the variety of voltage-sensitive ion channels that can be embedded in the membrane of a neuron, many types of neurons are capable, even in isolation, of generating rhythmic sequences of action potentials, or rhythmic alternations between high-rate bursting and quiescence. When neurons that are intrinsically rhythmic are connected to each other by excitatory or inhibitory synapses, the resulting networks are capable of a wide variety of dynamical behaviors, including attractor dynamics, periodicity, and even chaos. A network of neurons that uses its internal structure to generate temporally structured output, without requiring a corresponding temporally structured stimulus, is called a central pattern generator.

Internal pattern generation operates on a wide range of time scales, from milliseconds to hours or longer. One of the most important types of temporal pattern is circadian rhythmicity—that is, rhythmicity with a period of approximately 24 hours. All animals that have been studied show circadian fluctuations in neural activity, which control circadian alternations in behavior such as the sleep-wake cycle. Experimental studies dating from the 1990s have shown that circadian rhythms are generated by a "genetic clock" consisting of a special set of genes whose expression level rises and falls over the course of the day. Animals as diverse as insects and vertebrates share a similar genetic clock system. The circadian clock is influenced by light but continues to operate even when light levels are held constant and no other external time-of-day cues are available. The clock genes are expressed in many parts of the nervous system as well as many peripheral organs, but in mammals all of these "tissue clocks" are kept in synchrony by signals that emanate from a master timekeeper in a tiny part of the brain called the suprachiasmatic nucleus.

3.3 Anatomy in vertebrates

The nervous system of vertebrate animals (including humans) is divided into the central nervous system (CNS) and peripheral nervous system (PNS); aneurone nervous system.

The central nervous system (CNS) is the largest part, and includes the brain and spinal cord. The spinal cavity contains the spinal cord, while the head contains the brain. The CNS is enclosed and protected by meninges, a three-layered system of membranes, including a tough, leathery outer layer called the dura mater. The brain is also protected by the skull, and the spinal cord by the vertebrae.

The peripheral nervous system (PNS) is a collective term for the nervous system structures that do not lie within the CNS. The large majority of the axon bundles called nerves are considered to belong to the PNS, even when the cell bodies of the neurons to which they belong reside within the brain or spinal cord. The PNS is divided into somatic and visceral parts. The somatic part consists of the nerves that innervate the skin, joints, and muscles. The cell bodies of somatic sensory neurons lie in dorsal root ganglia of the spinal cord. The visceral part, also known as the autonomic nervous system, contains neurons that innervate the internal organs, blood vessels, and glands. The autonomic nervous system itself consists of two parts: the sympathetic nervous system and the parasympathetic nervous system. Some authors also include sensory neurons whose cell bodies lie in the periphery (for senses such as hearing) as part of the PNS; others, however, omit them.

The vertebrate nervous system can also be divided into areas called grey matter ("gray matter" in American spelling) and white matter. Grey matter (which is only grey in preserved tissue, and is better described as pink or light brown in living tissue) contains a high proportion of cell bodies of neurons. White matter is composed mainly of myelinated axons, and takes its color from the myelin. White matter includes all of the peripheral nerves, and much of the interior of the brain and spinal cord. Grey matter is found in clusters of neurons in the brain and spinal cord, and in cortical layers that line their surfaces. There is an anatomical convention that a cluster of neurons in the brain or spinal cord is called a nucleus, whereas a cluster of neurons in the periphery is called a ganglion. There are, however, a few exceptions to this rule, notably including the part of the forebrain called the basal ganglia.

3.4 Comparative anatomy and evolution

3.4 .1 Neural precursors in sponges

Sponges have no cells connected to each other by synaptic junctions, that is, no neurons, and therefore no nervous system. They do, however, have homologs of many genes that play key roles in synaptic function. Recent studies have shown that sponge cells express a group of proteins that cluster together to form a structure resembling a postsynaptic density (the signal-receiving part of a synapse). However, the function of this structure is currently unclear. Although sponge cells do not show synaptic transmission, they do communicate with each other via calcium waves and other impulses, which mediate some simple actions such as whole-body contraction.

3.4.1.1 Radiate

Jellyfish, comb jellies, and related animals have diffuse nerve nets rather than a central nervous system. In most jellyfish the nerve net is spread more or less evenly across the body; in comb jellies it is concentrated near the mouth. The nerve nets consist of sensory neurons that pick up chemical, tactile, and visual signals, motor neurons that can activate contractions of the body wall, and intermediate neurons that detect patterns of activity in the sensory neurons and send signals to groups of motor neurons as a result. In some cases groups of intermediate neurons are clustered into discrete ganglia.

3.4.3 Bilateria

The vast majority of existing animals are bilaterians, meaning animals with left and right sides that are approximate mirror images of each other. All bilateria are thought to have descended from a common wormlike ancestor that appeared in the Cambrian period, 550–600 million years ago. The fundamental bilaterian body form is a tube with a hollow gut cavity running from mouth to anus, and a nerve cord with an enlargement (a "ganglion") for each body segment, with an especially large ganglion at the front, called the "brain". Even mammals, including humans, show the segmented bilaterian body plan at the level of the nervous system. The spinal cord contains a series of segmental ganglia, each giving rise to motor and sensory nerves that innervate a portion of the body surface and underlying musculature. On the limbs, the layout of the innervation pattern is complex, but on the trunk it gives rise to a series of narrow bands. The top three segments belong to the brain, giving rise to the forebrain, midbrain, and hindbrain.

Bilaterians can be divided, based on events that occur very early in embryonic development, into two groups (superphyla) called protostomes and deuterostomes. Deuterostomes include vertebrates as well as echinoderms, hemichordates (mainly acorn worms), and Xenoturbellidans. Protostomes, the more diverse group, include arthropods, molluscs, and numerous types of worms. There is a basic difference between the two groups in the placement of the nervous system within the body: protostomes possess a nerve cord on the ventral (usually bottom) side of the body, whereas in deuterostomes the nerve cord is on the dorsal (usually top) side. In fact, numerous aspects of the body are inverted between the two groups, including the expression patterns of several genes that show dorsal-to-ventral gradients. Most anatomists now consider that the bodies of protostomes and deuterostomes are "flipped over" with respect to each other, a hypothesis that was first proposed by Geoffroy Saint-Hilaire for insects in comparison to vertebrates. Thus insects, for example, have nerve cords that run along the ventral midline of the body, while all vertebrates have spinal cords that run along the dorsal midline.

3.4.4 Worms

Worms are the simplest bilaterian animals, and reveal the basic structure of the bilaterian nervous system in the most straightforward way. As an example, earthworms have dual nerve cords running along the length of the body and merging at the tail and the mouth. These nerve cords are connected by transverse nerves like the rungs of a ladder. These transverse nerves help coordinate the two sides of the animal. Two ganglia at the head end function similar to a simple brain.

Photoreceptors on the animal's eyespots provide sensory information on light and dark.

The nervous system of one very small worm, the roundworm Caenorhabditis elegans, has been mapped out down to the synaptic level. Every neuron and its cellular lineage has been recorded and most, if not all, of the neural connections are known. In this species, the nervous system is sexually dimorphic; the nervous systems of the two sexes, males and hermaphrodites, have different numbers of neurons and groups of neurons that perform sex-specific functions. In C. elegans, males have exactly 383 neurons, while hermaphrodites have exactly 302 neurons.

3.4.5 Arthropods

Arthropods, such as insects and crustaceans, have a nervous system made up of a series of ganglia, connected by a ventral nerve cord made up of two parallel connectives running along the length of the belly. Typically, each body segment has one ganglion on each side, though some ganglia are fused to form the brain and other large ganglia. The head segment contains the brain, also known as the supraesophageal ganglion. In the insect nervous system, the brain is anatomically divided into the protocerebrum, deutocerebrum, and tritocerebrum. Immediately behind the brain is the subesophageal ganglion, which is composed of three pairs of fused ganglia. It controls the mouthparts, the salivary glands and certain muscles. Many arthropods have well-developed sensory organs, including compound eyes for vision and antennae for olfaction and pheromone sensation. The sensory information from these organs is processed by the brain.

3.4.6 "Identified" neurons

A neuron is called identified if it has properties that distinguish it from every other neuron in the same animal—properties such as location, neurotransmitter, gene expression pattern, and connectivity—and if every individual organism belonging to the same species has one and only one neuron with the same set of properties. In vertebrate nervous systems very few neurons are "identified" in this sense—in humans, there are believed to be none—but in simpler nervous systems, some or all neurons may be thus unique. In the roundworm C. elegans, whose nervous system is the most thoroughly described of any animal's, every neuron in the body is uniquely identifiable, with the same location and the same connections in every individual worm. One notable consequence of this fact is that the form of the C. elegans nervous system is completely specified by the genome, with no experience-dependent plasticity.

The brains of many molluscs and insects also contain substantial numbers of identified neurons. In vertebrates, the best known identified neurons are the gigantic Mauthner cells of fish. Every fish has two Mauthner cells, located in the bottom part of the brainstem, one on the left side and one on the right. Each Mauthner cell has an axon that crosses over, innervating neurons at the same brain level and then travelling down through the spinal cord, making numerous connections as it goes. The synapses generated by a Mauthner cell are so powerful that a single action potential gives rise to a major behavioral response: within milliseconds the fish curves its body into a C-shape, then straightens, thereby propelling itself rapidly forward. Functionally this is a fast escape response, triggered most easily by a strong sound wave or pressure wave impinging on the lateral line organ of the fish. Mauther cells are not the only identified neurons in fish—there are about 20 more types, including pairs of "Mauthner cell analogs" in each spinal segmental nucleus. Although a Mauthner cell is capable of bringing about an escape response all by itself, in the context of ordinary behavior other types of cells usually contribute to shaping the amplitude and direction of the response. Mauthner cells have been described as command neurons. A command neuron is a special type of identified neuron, defined as a neuron that is capable of driving a specific behavior all by itself. uch neurons appear most commonly in the fast escape systems of various species—the squid giant axon and squid giant synapse, used for pioneering experiments in neurophysiology because of their enormous size, both participate in the fast escape circuit of the squid. The concept of a command neuron has, however, become controversial, because of studies showing that some neurons that initially appeared to fit the description were really only capable of evoking a response in a limited set of circumstances.

4.0 Conclusion

I n this topic students must have learnt the components of nervous system and their function.

5.0 Summary

At the most basic level, the function of the nervous system is to send signals from one cell to others, or from one part of the body to others.

5.0 Tutor-Marked Assignment.

1 What is nervous system?

2 Explain nervous system structure using cells, neurons and glial cells (a mature form) in a diagram.

3 Explain the anatomy and evolution of sponge and arthropods.

- What is the function of the neurons and synapses and neural circuit system

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Unit 2 Peripheral Nervous System

CONTENT

1.0 Introduction

The **peripheral nervous system**, or PNS, consists of the nerves and ganglia outside of the brain and spinal cord.[1] The main function of the PNS is to connect the central nervous system (CNS) to the limbs and organs. Unlike the CNS, the PNS is not protected by the bone of spine and skull, or by the blood–brain barrier, leaving it exposed to toxins and mechanical injuries. The peripheral nervous system is divided into the somatic nervous system and the autonomic nervous system; some textbooks also include sensory systems.

2.0 Objectives

At the end of this study student should be able to:

1 Explain pheriperal nervous system.

2 Classify PNS according to function and direction.

3 Explain specific nerves and plexus.

3.0 Main Content

3.1 General classification

3.1.1 By Functions

The peripheral nervous system is functionally as well as structurally divided into the somatic nervous system and autonomic nervous system. The somatic nervous system is responsible for coordinating the body movements, and also for receiving external stimuli. It is the system that regulates activities that are under conscious control. The autonomic nervous system is then split into the sympathetic division, parasympathetic division, and enteric division. The *sympathetic nervous system* responds to impending danger, and is responsible for the increase of one's heartbeat and blood pressure, among other physiological changes, along with the sense of excitement one feels due to the increase of adrenaline in the system. ("fight or flight" responses). The *parasympathetic nervous system*, on the other hand, is evident when a person is resting and feels relaxed, and is responsible for such things as the constriction of the pupil, the slowing of the heart, the dilation of the blood vessels, and the stimulation of the digestive and genitourinary systems. ("rest and digest" responses). The role of the *enteric nervous system* is to manage every aspect of digestion, from the esophagus to the stomach, small intestine and colon.

3.1.2 By direction

There are two types of neurons, carrying nerve impulses in different directions. These two groups of neurons are:

- The sensory neurons are afferent neurons which relay nerve impulses toward the central nervous system.
- The motor neurons are efferent neurons which relay nerve impulses away from the central nervous system.

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3.2 Specific nerves and plexi

Ten out of the twelve cranial nerves originate from the brainstem, and mainly control the functions of the anatomic structures of the head with some exceptions. The nuclei of cranial nerves I and II lie in the forebrain and thalamus, respectively, and are thus not considered to be true cranial nerves. CN X (10) receives visceral sensory information from the thorax and abdomen, and CN XI (11) is responsible for innervating the sternocleidomastoid and trapezius muscles, neither of which is exclusively in the head. Spinal nerves take their origins from the spinal cord. They control the functions of the rest of the body. In humans, there are 31 pairs of spinal nerves: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral and 1 coccygeal. In the cervical region, the spinal nerve roots come out *above* the corresponding vertebrae (i.e. nerve root between the skull and 1st cervical vertebrae is called spinal nerve C1). From the thoracic region to the coccygeal region, the spinal nerve roots come out *below* the corresponding vertebrae. It is important to note that this method creates a problem when naming the spinal nerve root between C7 and T1 (so it is called spinal nerve root C8). In the lumbar and sacral region, the spinal nerve roots for travel within the dural sac and they travel below the level of L2 as the cauda equina.

3.2 .1 Cervical spinal nerves (C1–C4)

The first 4 cervical spinal nerves, C1 through C4, split and recombine to produce a variety of nerves that subserve the neck and back of head.

Spinal nerve C1 is called the suboccipital nerve which provides motor innervation to muscles at the base of the skull. C2 and C3 form many of the nerves of the neck, providing both sensory and motor control. These include the greater occipital nerve which provides sensation to the back of the head, the lesser occipital nerve which provides sensation to the area behind the ears, the greater auricular nerve and the lesser auricular nerve. See occipital neuralgia. The phrenic nerve arises from nerve roots C3, C4 and C5. It innervates the diaphragm, enabling breathing. If the spinal cord is transected above C3, then spontaneous breathing is not possible. See myelopathy

3.2.2 Brachial plexus

The last four cervical spinal nerves, C5 through C8, and the first thoracic spinal nerve, T1,combine to form the brachial plexus, or plexus brachialis, a tangled array of nerves, splitting, combining and recombining, to form the nerves that subserve the arm and upper back. Although the brachial plexus may appear tangled, it is highly organized and predictable, with little variation between people. See brachial plexus injuries.

3.2.3 Neurotransmitter

The main neurotransmitters of the peripheral nervous system are acetylcholine and noradrenaline. However, there are several other neurotransmitters as well, jointly labeled Non-noradrenergic, non-cholinergic (NANC) transmitters. Examples of such transmitters include non-peptides: ATP, GABA, dopamine, NO, and peptides: neuropeptide Y, VIP, GnRH, Substance P and CGRP.

4.0 Conclusion

Students have learnt the function of pheripheral nervous system and specific nerves.

5.0 Summary

The peripheral nervous system is functionally as well as structurally divided into the somatic nervous system and autonomic nervous system. The somatic nervous system is responsible for coordinating the body movements, and also for receiving external stimuli. It is the system that regulates activities that are under conscious control.

6.0 Tutor-Marked Assignment

1. Classify peripheral nervous system (PNS) by the following:

   1 Function

   2 Direction

2. What is neurotransmitter?

3. Explain the following and how they function: authomatic nervous system and somatic nervous sysytem.

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MODULE 3 ORIENTATION AND TAXES

Unit 1 Orientation in Animal Behavior

CONTENT

1.0 Introduction

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3.0 Main Content

3.1 Sexual orientation distinguished from sexual identity and behavior

3.1.1 Sexualities include

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3.1.5. Efforts to change sexuality

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3.2.2 Means of assessment

3.2.3 Biology

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3.2.3.2 Hormones

3.2.3.3The auditory system

4.0 Conclusion

5.0 Summary

6.0 Tutor –Marked Assignment

7.0 References

1.0 Introduction

Sexual Orientation

Though people may use other labels or none at all, sexual orientation is usually discussed in terms of three categories: heterosexuality, homosexuality, and bisexuality (asexuality is increasingly recognized as a fourth). The three exist along a continuum that ranges from exclusively heterosexual to exclusively homosexual, including various forms of bisexuality in between. This continuum does not suit everyone, however, as some people identify as asexual. This linear scale is a simplification of the much more nuanced nature of sexual orientation and sexual identity; many sexologists believe it to be oversimplified.

Though people may use other labels or none at all, sexual orientation is usually discussed in terms of three categories: heterosexuality, homosexuality, and bisexuality (asexuality is increasingly recognized as a fourth).[1] The three exist along a continuum that ranges from exclusively heterosexual to exclusively homosexual, including various forms of bisexuality in between. This continuum does not suit everyone, however, as some people identify as asexual.[8] This linear scale is a simplification of the much more nuanced nature of sexual orientation and sexual identity; many sexologists believe it to be oversimplified. Classifying sexual desires or people on the basis of sexual orientation is a modern Western concept.

Doubts have been raised about the validity of this concept in non-Western and indigenous societies, as well as in the pre-modern West. While sexual orientation is reported in this article primarily within biology and psychology, including sexology, for reports within anthropology and history, including social constructionism, see the section on other explanations.

2.0 Objectives

At the end of this study, students should be able to explain factor that distinguished sexual orientation from sexual behaviour.

3.0 Main Contents

3.1 Sexual orientation distinguished from sexual identity and behavior

Most definitions of sexual orientation include a psychological component, such as the direction of an individual's erotic desire, and/or a behavioral component, which focuses on the sex of the individual's sexual partner/s. Some people prefer simply to follow an individual's self-definition or identity. The American Psychological Association states that "[s]exual orientation is an enduring emotional, romantic, sexual, or affectional attraction toward others. It is easily distinguished from other components of sexuality including biological sex, gender identity (the psychological sense of being male or female), and the social gender role (adherence to cultural norms for feminine and masculine behavior). Sexual orientation exists along a continuum that ranges from exclusive heterosexuality to exclusive homosexuality and includes various forms of bisexuality. Bisexual persons can experience sexual, emotional, and affectional attraction to both their own sex and the opposite sex. Persons with a homosexual orientation are sometimes referred to as gay (both men and women) or as lesbian (women only). Sexual orientation is different from sexual behavior because it refers to feelings and self-concept. Individuals may or may not express their sexual orientation in their behaviors.

Sexual identity and sexual behavior are closely related to sexual orientation, but they are distinguished, with identity referring to an individual's conception of themselves, behavior referring to actual sexual acts performed by the individual, and orientation referring to "fantasies, attachments and longings. Individuals may or may not express their sexual orientation in their behaviors. People who have a homosexual sexual orientation that does not align with their sexual identity are sometimes referred to as 'closeted'.. The term may, however, reflect a certain cultural context and particular stage of transition in societies which are gradually dealing with integrating sexual minorities. In studies related to sexual orientation, when dealing with the degree to which a person's sexual attractions, behaviors and identity match, scientists usually use the terms *concordance* or *discordance*.[Thus, a woman who is attracted to other women, but calls herself heterosexual and only has sexual relations with men, can be said to experience discordance between her sexual orientation (homosexual or lesbian) and her sexual identity and behaviors (heterosexual).

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3.1.1 Sexualities include

Sexual orientation traditionally was defined as including heterosexuality, bisexuality, and homosexuality. Asexuality is now considered a sexual orientation by some researchers and has been defined as the absence of a traditional sexual orientation; an asexual has little to no sexual attraction to males or females.

3.1.2 Gender, transgender, cisgender, and conformance

The earliest writers on sexual orientation usually understood it to be intrinsically linked to the subject's own sex. For example, it was thought that a typical female-bodied person who is attracted to female-bodied persons would have masculine attributes, and vice versa. [This understanding was shared by most of the significant theorists of sexual orientation from the mid nineteenth to early twentieth century, such as Karl Heinrich Ulrichs, Richard von Krafft-Ebing, Magnus Hirschfeld, Havelock Ellis, Carl Jung, and Sigmund Freud, as well as many gender-variant homosexual people themselves. However, this understanding of homosexuality as sexual inversion was disputed at the time, and, through the second half of the twentieth century, gender identity came to be increasingly seen as a phenomenon distinct from sexual orientation. Transgender and cisgender people may be attracted to men, women, or both, although the prevalence of different sexual orientations is quite different in these two populations (see sexual orientation of transwomen). An individual homosexual, heterosexual or bisexual person may be masculine, feminine, or androgynous, and in addition, many members and supporters of lesbian and gay communities now see the "gender-conforming heterosexual" and the "gender-nonconforming homosexual" as negative stereotypes. However, studies by J. Michael Bailey and KJ Zucker have found that a majority of gay men and lesbians report being gender-nonconforming during their childhood years.

3.1.3 Relationships outside of orientation

Gay and lesbian people can have sexual relationships with someone of the opposite sex for a variety of reasons including the desire for family with children and concerns of discrimination and religious ostracism. some GLBT people hide their respective orientations from their spouses, others develop positive gay and lesbian identities while maintaining successful marriages. Coming out of the closet to oneself, a spouse of the opposite sex, and children can present challenges that are not faced by gay and lesbian people who are not married to people of the opposite sex or do not have children.

3.1.4 Born bisexual, then monosexualizing

Innate bisexuality, or predisposition to bisexuality, is an idea introduced by Sigmund Freud, based on work by his associate Wilhelm Fliess. According to this theory, all humans are born bisexual but through psychological development, which includes both external and internal factors, become monosexual while the bisexuality remains in a latent state.

3.1.5. Efforts to change sexuality

Efforts to change sexual orientation are unlikely to be successful and involve some risk of harm, contrary to the claims of SOCE practitioners and advocates. Even though the research and clinical literature demonstrate that same-sex sexual and romantic attractions, feelings, and behaviors are normal and positive variations of human sexuality, regardless of sexual orientation identity, the task force concluded that the population that undergoes SOCE tends to have strongly conservative religious views that lead them to seek to change their sexual orientation. Thus, the appropriate application of affirmative therapeutic interventions for those who seek SOCE involves therapist acceptance, support, and understanding of clients and the facilitation of clients' active coping, social support, and identity exploration and development, without imposing a specific sexual orientation identity outcome.

3.2 Measuring sexual orientation

Varying definitions and strong social norms about sexuality can make sexual orientation difficult to quantify.

3.2.1 Scales for assessment

From at least the late nineteenth century in Europe, there was speculation that the range of human sexual response looked more like a continuum than two or three discrete categories. Berlin sexologist Magnus Hirschfeld published a scheme in 1896 that measured the strength of an individual's sexual desire on two independent 10-point scales, A (homosexual) and B (heterosexual). A heterosexual individual may be A0, B5; a homosexual individual may be A5, B0; an asexual would be A0, B0; and someone with an intense attraction to both sexes would be A9, B9. The Kinsey scale measures sexual orientation from 0 (exclusively heterosexual) to 6 (exclusively homosexual), with an additional category, X, for those with no sexual attraction to either women or men. Unlike Hirschfeld's scale, the Kinsey scale is one-dimensional. Simon LeVay wrote, "it suggests (although Kinsey did not actually believe this) that every person has the same fixed endowment of sexual energy, which he or she then divides up between same-sex and opposite-sex attraction in a ratio indicative of his or her own sexual orientation.

3.2.2 Mean of assessment

Means typically used include surveys, interviews, cross-cultural studies, physical arousal measurements sexual behavior, sexual fantasy, or a pattern of erotic arousal.[48] The most common is verbal self-reporting or self-labeling, which depend on respondents being accurate about themselves.

3.2.3 Biology

Research has identified several biological factors which may be related to the development of sexual orientation, including genes, prenatal hormones, and brain structure. No single controlling cause has been identified, and research is continuing in this area.

The prevailing view is that sexual orientation is biological in nature, determined by a complex interplay of genetic factors and the early uterine environment. Sexual orientation is therefore not a choice. That is, individuals do not choose to be homosexual or heterosexual. There is no substantive evidence to support the suggestion that early childhood experiences, parenting, sexual abuse, or other adverse life events influence sexual orientation.[3][4][28][50][51]

3.2.3.1 Genetic factor

Genes may be related to the development of sexual orientation. At one time, studies of twins appeared to point to a major genetic component, but problems in experimental design of the available studies have made their interpretation difficult, and one recent study appears to exclude genes as a major factor.

3.2.3.1 Hormones

The hormonal theory of sexuality holds that, just as exposure to certain hormones plays a role in fetal sex differentiation, such exposure also influences the sexual orientation that emerges later in the adult. Fetal hormones may be seen as either the primary influence upon adult sexual orientation or as a co-factor interacting with genes and/or environmental and social conditions.

A 2010 endocrinology study by Garcia-Falgueras and Swaab[5] says that intrauterine exposure to hormones is largely determinative. Sketching the argument briefly here, it says that sexual organs are differentiated and then the brain is sexually differentiated "under the influence, mainly, of sex hormones such as testosterone, estrogen and progesterone on the developing brain cells and under the presence of different genes as well . . . . The changes brought about in this [p. 24:]

stage are permanent. . . . [S]exual differentiation of the brain is not caused by hormones alone, even though they are very important for gender identity and sexual orientation."[54] ". . . . These fetal and neonatal peaks of testosterone, together with the functional steroid receptor activity, are thought to fix the development of structures and circuits in the brain for the rest of a boy's life (producing 'programming' or 'organizing' effects). Later, the rising hormonal levels that occur during puberty 'activate' circuits and behavioral patterns that were built during development, in a masculinized and de-feminized direction for male brains or in a feminized and de-masculinized direction for female brains. Because organ differentiation and brain differentiation occur at different times, in "rare" cases transsexualism can result (transsexualism resulting from having organs of one gender and feelings of the other). The brain structure differences that result from the interaction between hormones, genes and developing brain cells are thought to be the basis of sex differences in a wide spectrum of behaviors, such as . . . sexual orientation (heterosexuality, homosexuality, or bisexuality) . . . . Factors that interfere with the interactions between hormones and the developing brain systems during development in the womb may permanently influence later behavior. In humans, the main mechanism responsible of [*sic*] sexual identity and orientation involves a direct effect of testosterone on the developing brain. Drawing on some transsexualism cases, the authors say, "[f]rom these examples it appears that the direct action of testosterone on the developing brain in boys and the lack of such action on the developing brain in girls are crucial factors in the development of male and female gender identity and sexual orientation . . . .There are no indications that postnatal social factors could be responsible for the occurrence of transsexuality [ ]With regard to sexual orientation, the most likely outcome of childhood gender identity disorder is homosexuality or bisexuality. The apparent impossibility of getting someone to change their sexual orientation . . . is a major argument against the importance of the social environment in the emergence of homosexuality, as well as against the idea that homosexuality is a lifestyle choice. The presence of a genetic component of over 50% in the development of sexual orientation is apparent from family and twin studies.[ ]Women with gay sons appeared to have an extreme skewing of X-inactivation [referring to the "X-chromosome"] . . .[S]ome two million pregnant women . . . were prescribed diethylstilbestrol (DES)[,] . . . . an estrogen-like substance[,] . . . [and] it [was] . . . found . . . to increase the chance of bisexuality or homosexuality in girls. The . . . . fraternal birth order effect . . . is putatively explained by an immunological response by the mother to a product of the Y chromosome of her sons. The chance of such an immune response to male factors would increase with every pregnancy resulting in the birth of a son. Prenatal exposure to nicotine, amphetamine, or thyroid-gland hormones increases the chances of giving birth to lesbian daughters. Stress in pregnancy makes birth of a gay son likelier. Although it has often been postulated that postnatal development is also important for the direction of sexual orientation, there is no solid proof for this]

3.2.3.3 The auditory system

Sexual orientation depends on the ability of one person to identify the sex of another. In humans, this is a learned mental process. In 2008, it was suggested that innate root cues and mechanisms determine the sexual orientation of the adult. These root cues and mechanisms process information that the child receives from the environment. They identify other sexual orientation cues that are embedded in the information flow, and internalize them in information structures. At puberty, sexual orientation emerges. Adults of the same sexual orientation share common root cues and mechanisms. Different root cues and mechanisms result in different orientations. Different life experiences cause personal variations within an orientation.

3.2.4 Sexual arousal

Studying human sexual arousal has proved a fruitful way of understanding how men and women differ as genders and in terms of sexual orientation. A clinical measurement may use penile or vaginal photoplethysmography, where genital engorgement with blood is measured in response to exposure to different erotic material.

Some researchers who study sexual orientation argue that the concept may not apply similarly to men and women. A study of sexual arousal patterns found that women, when viewing erotic films which show female-female, male-male and male-female sexual activity (oral sex or penetration), have patterns of arousal which do not match their declared sexual orientations as well as men's. That is, heterosexual and lesbian women's sexual arousal to erotic films do not differ significantly by the genders of the participants (male or female) or by the type of sexual activity (heterosexual or homosexual). On the contrary, men's sexual arousal patterns tend to be more in line with their stated orientations, with heterosexual men showing more penis arousal to female-female sexual activity and less arousal to female-male and male-male sexual stimuli, and homosexual and bisexual men being more aroused by films depicting male-male intercourse and less aroused by other stimuli.

Another study on men and women's patterns of sexual arousal confirmed at men and women have different patterns of arousal, independent of their sexual orientations. The study found that women's genitals become aroused to both human and nonhuman stimuli from movies showing humans of both genders having sex (heterosexual and homosexual) and from videos showing non-human primates (bonobos) having sex. Men did not show any sexual arousal to non-human visual stimuli, their arousal patterns being in line with their specific sexual interest (women for heterosexual men and men for homosexual men). These studies suggest that men and women are different in terms of sexual arousal patterns and that this is also reflected in how their genitals react to sexual stimuli of both genders or even to non-human stimuli. It must be stated that sexual orientation has many dimensions (attractions, behavior, identity), of which sexual arousal is the only product of sexual attractions which can be measured at present with some degree of physical precision. Thus, the fact that women are aroused by seeing non-human primates having sex does not mean that women's sexual orientation includes this type of sexual interest. Some researchers argue that women's sexual orientation depends less on their patterns of sexual arousal than men's and that other components of sexual orientation (like emotional attachment) must be taken into account when describing women's sexual orientations. In contrast, men's sexual orientations tend to be primarily focused on the physical component of attractions and, thus, their sexual feelings are more exclusively oriented according to sex.

4.0 Conclusion

Student must have learnt the origin of sexual orientation. Measuring factors of sexual orientation and ways of distingushing sexual orientaion from sexual behaviour.

5.0 Summary

Sexual orientation is always discussed under three categories: heterosexuality, homosexuality and bisexuality

6.0 Tutor –Marked Assignment

1. Explain sexual orientation.
2. Explain factors that can be used to differentiate sexual orientation from sexual behavior.
3. What are the factor that can be used to measure sexual orientation in animals.

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Different aspects of sexual orientation may be influenced to a greater or lesser degree [p. 303:] by experiential factors such that sexual experimentation with same-gender partners may be more dependent on a conducive family environment than the development of a gay or lesbian identity." Susan E. Golombok & Fiona L. Tasker, *Do Parents Influence the Sexual Orientation of Their Children?*, in J. Kenneth Davidson, Sr., & Nelwyn B. Moore, *Speaking of Sexuality: Interdisciplinary Readings* (Los Angeles, Calif.: Roxbury Publishing, 2001) (ISBN 1-891487-33-7), pp. 302–303 (adapted from same authors, *Do Parents Influence the Sexual Orientation of Their Children? Findings From a Longitudinal Study of Lesbian Families*, in *Developmental Psychology* (American Psychological Association), vol. 32, 1996, 3–11) (author Susan Golombok prof. psychology, City Univ., London, *id.*, p. xx, & author Fiona Tasker sr. lecturer, Birkbeck Coll., Univ. of London, *id.*, p. xxiii).

Unit 2 Taxes

Contents

1.0 Introduction

Taxis

A **taxis** (plural **taxes**, pronounced /□tæksi□z/) is an innate behavioral response by an organism to a directional stimulus or gradient of stimulus intensity. A taxis differs from a tropism (turning response, often growth towards or away from a stimulus) in that the organism has motility and demonstrates guided movement towards or away from the stimulus source. It is sometimes distinguished from a kinesis, a non-directional change in activity in response to a stimulus.

2.0 Objective

At the end of this topic students should be able to:

Define taxes in animal behaviour and differentiate types of taxes. Explain taxes in animal and plants

3.0 Main Content

3.1 Examples of Taxes in animals

For example, flagellate protozoans of the genus *Euglena* move towards a light source. Here the directional stimulus is light, and the orientation movement is towards the light. This reaction or behaviour is a positive one to light and specifically termed "positive phototaxis", since phototaxis is a response to a light stimulus, and the organism is moving towards the stimulus. If the organism moves away from the stimulus, then the taxis is negative. Many types of taxis have been identified and named using prefixes to specify the stimulus that elicits the response. These include **aerotaxis** (stimulation by oxygen) **anemotaxis** (wind), **barotaxis** (pressure), **chemotaxis** (chemicals), **galvanotaxis** (electrical current), **geotaxis** (gravity), **hydrotaxis** (moisture), **magnetotaxis** (magnetic field), **phototaxis** (light), **rheotaxis** (fluid flow), **thermotaxis** (temperature changes) and **thigmotaxis** (physical contact).

Depending on the type of sensory organs present, taxes can be classified as **klinotaxes**, where an organism continuously samples the environment to determine the direction of a stimulus, **tropotaxes**, where bilateral sense organs are used to determine the stimulus direction, and **telotaxes**, which are similar to tropotaxes but where a single organ suffices to establish the orientation movement.

3.1.1 Aerotaxis

Aerotaxis is the response of an organism to variation in oxygen concentration, and is mainly found in aerobic bacteria.

3.1.2 Chemotaxis

Chemotaxis is a migratory response elicited by chemicals: that is, a response to a chemical concentration gradient. For example, chemotaxis in response to a sugar gradient has been observed in motile bacteria such as E. Coli. Chemotaxis also occurs in the antherozoids of liverworts, ferns, and mosses in response to chemicals secreted by the archegonia, also in higher animals e.g Dogs for sexual attraction.

Unicellular (e.g. protozoa) or multicellular (e.g. worms) organisms are targets of chemotactic substances. A concentration gradient of chemicals developed in a fluid phase guides the vectorial movement of responder cells or organisms. Inducers of locomotion towards increasing steps of concentrations are considered as chemoattractants, while chemorepellents result moving off the chemical.

Chemotaxis is described in prokaryotic and eukaryotic cells, but signalling mechanisms (receptors, intracellular signaling) and effectors are significantly different.

3.1.3 Energy taxis

Energy taxis is the orientation of bacteria towards conditions of optimal metabolic activity by sensing the internal energetic conditions of cell. Therefore in contrast to chemotaxis (taxis towards or away from a specific extracellular compound), energy taxis responds on an intracellular stimulus (e.g. proton motive force, activity of NDPH- 1) and requires metabolic activity.

3.1.4 Phototaxis

Phototaxis is the movement of an organism in response to light: that is, the response to variation in light intensity and direction.

- Negative phototaxis, or movement away from a light source, is demonstrated in some insects, such as cockroaches.
- Positive phototaxis, or movement towards a light source, is advantageous for phototrophic organisms as they can orient themselves most efficiently to receive light for photosynthesis. Many phytoflagellates, e.g. *Euglena*, and the chloroplasts of higher plants positively phototactic, moving towards a light source. Two types of positive phototaxis are observed in prokaryotes.

1. Scotophototaxis is observable as the movement of a bacterium out of the area illuminated by a microscope. Entering darkness signals the cell to reverse direction and reenter the light.
2. A second type of positive phototaxis is true phototaxis, which is a directed movement up a gradient to an increasing amount of light.

3.1.5 **Thermotaxis**

Thermotaxis is a migration along a gradient of temperature. Some slime molds and small nematodes can migrate along amazingly small temperature gradients of less than 0.1C/cm. They apparently use this behavior to move to an optimal level in soil.[8] [9]

3.1.6 Geotaxis

Geotaxis is a response to the attraction due to gravity. The planktonic larvae of the king crab *Lithodes aequispinus* use a combination of positive phototaxis (movement towards the light) and negative geotaxis (upward movement) . Both positive and negative geotaxes are found in a variety of protozoans .

3.1.7 Rheotaxis

Rheotaxis is a response to a current in a fluid. Positive rheotaxis is shown by fish turning to face against the current. In a flowing stream, this behavior leads them to hold their position in a stream rather than being swept downstream. Some fish will exhibit negative rheotaxis where they will avoid currents.

3.1.8 Magnetotaxis

Logically, **magnetotaxis** is the ability to sense a magnetic field and coordinate movement in response. However, the term is commonly applied to bacteria that contain magnets and are physically rotated by the force of the Earth's magnetic field. In this case, the "behavior" has nothing to do with sensation, and the bacteria are more accurately described as "magnetic bacteria".

3.1.9 Galvanotaxis / electrotaxis

Galvanotaxis or electrotaxis is directional movement of motile cells in response to an electric field. It has been suggested that by detecting and orientating themselves toward the electric fields, cells are able to direct their movement towards the damages or wounds to repair the defect. It also is suggested that such a movement may contribute to directional growth of cells and tissues during development and regeneration. This notion is based on 1) the existence of measurable electric fields that naturally occur during wound healing, development and regeneration; and 2) cells in cultures respond to applied electric fields by directional cell migration – electrotaxis / galvanotaxis.

3.1.10 Phonotaxis

Phonotaxis is the movement of an organism in response to sound.

4.0 Conclusion

Many types of taxis have been identified and named using prefixes to specify the stimulus that elicits the response. These include **aerotaxis** (stimulation by oxygen)

anemotaxis (wind), **barotaxis** (pressure), **chemotaxis** (chemicals), **galvanotaxis** (electrical current), **geotaxis** (gravity), **hydrotaxis** (moisture), **magnetotaxis** (magnetic field), **phototaxis** (light), **rheotaxis** (fluid flow), **thermotaxis** (temperature changes) and **thigmotaxis** (physical contact).

5.0 Summary

Depending on the type of sensory organs present, taxes can be classified as **klinotaxes**, where an organism continuously samples the environment to determine the direction of a stimulus, **tropotaxes**, where bilateral sense organs are used to determine the stimulus direction, and **telotaxes**, which are similar to tropotaxes but where a single organ suffices to establish the orientation movement.

6.0 Tutor-Mark Assgnment

What is taxis? List and explain eight types of taxes.What do you understand by negative phototaxis and postive phototaxis. Explain the following taxes according to their response to stimulus:Klinotaxes, tropotaxes and telotaxes.

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MODULE 4 : FIXED ACTION PATTERN , MOTIVATION AND DRIVES

Unit 1: Fixed Action Pattern

CONTENT

1.0 Introduction

In ethology, a **fixed action pattern** (**FAP**) is an instinctive behavioral sequence that is indivisible and runs to completion.[1] Fixed action patterns are invariant and are produced by a neural network known as the **innate releasing mechanism** in response to an external sensory stimulus known as a **sign stimulus** or **releaser** (a signal from one individual to another). A fixed action pattern is one of the few types of behaviors which can be said to be **hard-wired** and instinctive.

2.0 Objectives

At the end of this topic students should be able to explain fixed action pattern and give examples of animals that perform it.

3.0 Main Content

3.1 Examples

Many mating dances, commonly carried out by birds, are examples of fixed action patterns. In these cases, the sign stimulus is typically the presence of the female. Another example of fixed action patterns is aggression towards other males during mating season in the red-bellied stickleback. A series of experiments carried out by Niko Tinbergen showed that the aggressive behavior of the males is a FAP triggered by anything red, the sign stimulus. The threat display of male stickleback is also a fixed action pattern triggered by a stimulus.

Another well known case are the classic experiments by Tinbergen and Lorenz on the Graylag Goose. Like similar waterfowl, it will roll a displaced egg near its nest back to the others with its beak. The sight of the displaced egg triggers this mechanism. If the egg is taken away, the animal continues with the behavior, pulling its head back as if an imaginary egg is still being maneuvered by the underside of its beak.[2] However, it will also attempt to move other egg shaped objects, such as a golf ball, door knob, or even an egg too large to have possibly been laid by the goose itself (a supernormal stimulus).[3]

3.1. 1 Other Examples

- Kelp Gull chicks are stimulated by a red spot on the mother's beak to peck at spot, which induces regurgitation.
- Some moths instantly fold their wings and drop to the ground if they encounters ultrasonic signals such as those produced by bats; see ultrasound avoidance.
- Mayflies drop their eggs when they encounter a certain pattern of light polarization which indicates they are over water.

3.2 Important/Significant

A FAP is significant in animal behavior because it represents the simplest type of behavior, in which a readily defined stimulus nearly always results in an invariable behavioral response. A FAP can truly be said to be "hard-wired." FAPs are also unusual, in that almost behaviors are modulated by the environment; a fixed response can lead to maladaptive results, whereas flexible behaviors are generally more useful. Because of this, most behaviors which are both FAPs and occur in more complex animals are usually essential to the animal's fitness or in which speed is a factor. For instance, the Greylag Goose's egg rolling behavior is so essential to the survival of its chicks that its fitness is increased by this behavior being hard-wired. A chick which cannot consistently feed will die. A moth's response to encountering echolocation needs to be immediate in order to avoid predation. An attacking stickleback is placed at an advantage if it reacts quickly to a threat. However, because these behaviors are hard-wired, they are also predictable. This can lead to their exploitation by humans or other animals.

3.3 Exploitation

Some species have evolved to exploit the fixed action patterns of other species by mimicry of their sign stimulus. Replicating the releasing mechanism required to trigger a FAP is known as **code-breaking**. A well known example of this is brood parasitism, where one species will lay its eggs in the nest of another species, which will then parent its young. A young North American cowbird, for example, provides a supernormal stimulus to its foster parent, which will cause it to forage rapidly in order to satisfy the larger bird's demands.[4] In a natural situation a nestling will provide higher levels of stimulus with noisier, more energetic behavior, communicating its urgent need for food. Parents in this situation should work extra hard to provide food, otherwise their own offspring are likely to die of starvation.

4.0 CONCLUSION

A fixed action pattern is one of the few types of behaviors which can be said to be **hard-wired** and instinctive.

5.0 SUMMARY

FAP are modulated by the environment; a fixed response can lead to maladaptive results, whereas flexible behaviors are generally more useful.

6.0 Tutor-Marked Assignments

1. Explain fixed action pattern and how it works.
2. **Give four examples of animals that experience this action.**
3. **Explain exploitation in FAP**

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UNIT 2 MOTIVATION AND DRIVES

1.0 Introduction

Motivation is the driving force which help causes us to achieve goals. Motivation is said to be intrinsic or extrinsic. The term is generally used for humans but, theoretically, it can also be used to describe the causes for animal behavior as well. This article refers to human motivation. According to various theories, motivation may be rooted in a basic need to minimize physical pain and maximize pleasure, or it may include specific needs such as eating and resting, or a desired object, goal, state of being, ideal, or it may be attributed to less-apparent reasons such as altruism, selfishness, morality, or avoiding mortality. Conceptually, motivation should not be confused with either volition or optimism.[1] Motivation is related to, but distinct from, emotion.

2.0 Objectives

At the end of this topic students should be able to:

1. Explain motivation.
2. Differentiate between intrinsic and extrinsic motivation.
3. Explain theories types of motivation.
4. Motivation and emotion.
5. Motivation in animals like dog and cat

3.0 Main Contents

3.1 THEORIES ON MOTIVATION

3.1.1 Self-Actualization

Abraham Maslow developed a theory of motivation where human needs were spearated into two groups: deficiency needs and growth needs. The four deficiency needs are: physiological, safety, belongingness and love, and esteem. In order to have a need for one, all the other needs before that must be met.

At first, the only growth need Maslow made was self-actualization; later, however, he separated self-actualization into cognitive, aesthetic, self-actualization, and transcendence needs. The cognitive need is described by the need to know and understand more; the aesthetic need is described by the appreciation of symmetry and beauty; the self-actualization need is when one needs to find self-fulfillment; transcendence occurs when one helps others realize their potentials.

The appeal of Maslows theory is the ladder upward toward higher and higher achievments. Realistically, however, Maslows theory begins to fall apart. One example is the pattern found when subjects are asked if they were on a deserted island, and were only granted one thing, what would it be; after much consideration, the answer is often a special someone. According to Maslows pyramid, people would invariably want food or water before anything else; this simply is not the case.

3.1.2 Hulls Drive-Reduction Model

Hulls Model states that a body wants to stay in a homeostatic equilibrium. If a part of the body's system is thrown off balance, the body will work to go back to a level state. Hull's Drive-Reduction Model implies that behaviors are caused by a corresponding lacking in the internal environment.

This can be confusing so here is an example. When you get home from school, you are hungry. Because the body is off balance you ask mom when dinner will be ready and you sneak a snack to ward off the hunger. The body's off balance stimulates the behavior necessary to get food. Likewise, after the huge meal, you dont feel like moving, you sit down and watch TV. Once again, the body is thrown off by too much food and stimulates the behavior to rest and let it digest.

However, Hulls model has been criticized because it fails to explain why humans have the drive to do certain actions, like sports, surfing, juggling, etc.

3.1 3 **Cognitive Consistency Theory**

The cognitive consistency theory is an alternative to Hulls, yet it still has a foundation in homeostatic equilibrium. In this theory, motivation for behavior occurs when different internal thoughts conflict and create tension. The tension creates the motivation for behaviors to ease the tension and thus bringing the subject back to a homeostatic state.

A popular version of this theory has been the cognitive dissonance theory. It basically is very similar to what was stated above. Discrepancies in the environment created the motivation to alleviate the stress. It allows the subject to choose between two options, forcing the subject to weigh the positives and negatives of each choice, and in the end choosing the option that relieves the most stress. Examples can be found all throughout our world, such as weighing the options and choosing the best Internet provider or cell phone service.

3.1.4 **Arousal Theory**

Arousal theory is based on the ideas that different individuals perform better at different levels of arousal and that every individual seeks to find its optimum level. Some people enjoy a quite evening to relax while others might prefer a loud concert to end a tough week. This also explains the behaviors of thrill-seekers. There optimum arousal level is high, so to feel comfortable they get involved in sensational acts.

Another part of the arousal theory is the Yerkes-Dodson law. This states that simple tasks require a high level of arousal to get the motivation to do them, while difficult tasks require low arousal to get the proper motivation. You may have found that doing your boring busy-work homework requires a lot of effort on your part while doing a difficult brain teaser is fun and is easy to concentrate on

3.1 5 **Biological Determinism**

The idea behind Biological Determinism is that behavior is controlled biologically. All animals have a preset way of behaving, instincts, and an animals instincts are geared toward survival. Instincts are triggered by stimuli. The image of a predator stimulates the animals instincts, which tell it to leave the area. The stimulus of food arouses the animal, creating hunger and the desire to eat. The stimulus of the opposite sex encourages sexual behavior, producing offspring and future generations. The stimulus does not always have to be a complete object, but rather it may only be one aspect of an object, such as the color red, that will trigger the behavior.

Usually when an instinct is triggered it will follow a set pattern. The concept is called the fixed action pattern (FAPs). However, the idea that the pattern is not fixed, but rather follows a model or set of guidelines is becoming increasing popular and is called the modal action pattern (MAPs). This allows for minor variation in the animals behavior even though it is following the same pattern.

Vacuum behavior is an unusual phenomenon that occurs after an animals instinct is not stimulated for an extended period of time, so the animal exhibits it anyway. This results in the animal hunting imaginary food or having sex with your friends leg.

3.1.6 Incentive Theory

While other theories of motivation support the belief that the cause of responses is internal, the incentive theory says that in fact the environment brings out behaviors. The basic concept behind the incentive theory is goals. When a goal is present, the person attempts to reach that goal. The goal may be anything from relalxing to feeling stimulated to losing weight. In order to relax, we may watch t.v.; in order to feel stimulated, we may skydive; in order to lose weight, we might go on an exercise preogram.

Incentives may be tangible or intangible. An intangible incentive may involve feeling good about oneself, while a tangible one may involve awards or something to give public recognition. Intangible incentives are also known as intrinsic rewards, while tangible incentives are also known as extrinsic rewards. Sometimes, one type of reward is replaced with the other. This usually happens when an intrinsic reward is replaced with an extrinsic reward. For instance, consider someone who becomes a doctor. At first, the person may have become a doctor because he or she enjoys being able to help people (intrinsic); later on, however, the reason for being a doctor may change to money (extrinsic). Suppose, however, that the hospital must have cutbacks, and they offer the doctor a choice: continue being a doctor and continue helping people but with a substantial pay cut, or become an administrator for somewhat more money than before. The doctor would likely take the raise even though it would mean he or she wouldn't be helping people anymore because the external reward of the increased pay would outweigh the internal reward of the satisfaction gained by helping people. This situation is known as the over justification effect. In general, over justification occurs when the external reward becomes the only reason for continuing a behavior.

Educational psychologists are debating whether schools should use extrinsic rewards to encourage behavior. There is evidence which suggests that its a bad idea because when the reward disappears, so does the children's motivation. The is also evidence, however, which suggests that it's a good idea

3.2 Motivation and Emotion

by Renee and Nicole

Motives, Needs, Drives, and Incentives

- *Motive* - Hypothetical state that activates behavior and propels one towards goals
- *Need* - Physiological and psychological
  - Physiological needs - Oxygen, food, drink, etc.
  - Psychological needs - Achievement, power, self-esteem, etc.
  - Not necessarily based on a state of deprivation and may be acquired through experience
- *Drive* - Arises from needs
  - Physiological drives are the psychological counterparts of physiological needs
- *Incentive* - Something capable of being desirable or satisfying for its own sake

3.2.1 Theoretical Perspectives on Motivation

- *Instinct Theory* - Behaviors are characteristic of a species and do not rely on learning
    - *Instinct* - Inherited disposition; activates certain behaviors to attain certain goals
    - *Ethologist* - Studies behavior patterns characteristic of certain species
    - *Fixed-action Patterns (FAPs)* - Response to stimuli known as releasers
    - *Releaser* - Stimulus that elicits a FAP
    - *James and McDougall* - Theorized that people have various instincts that foster self-survival and social behavior
    - *Freud* - Theorized that instincts of sex and aggression create psychic energy or a feeling of tension
- *Drive-Reduction Theory* - Behaviors are reactions to drives; the main goal of action is to reduce tension
    - *Hull* - Theorized that rewards are pleasant because they reduce drives
    - *Primary drives* - Hunger, thirst, and pain; do not need to be learned
        - Trigger tension and activate behavior
        - We learn responses to partially or completely reduce the drive
    - *Acquired drives* - Acquired or learned through experience
- *Humanistic Theory* - Behavior is motivated in part by the conscious desire for personal growth; people will tolerate pain, hunger, and other sources of tension to achieve personal fulfillment
    - *Self-actualization* - Self-initiated striving to become what one is capable of being
    - *Maslow's Hierarchy of Needs* - Maslow theorized that people would travel up the Hierarchy through their lives so long as they did not encounter insurmountable social or environmental obstacles
        1. **Physiological needs** - Hunger, thirst, warmth, elimination of fatigue and pain
        2. **Safety needs** - Protection from the elements, crime, and financial hardship
        3. **Love and Belonging needs** - Love, acceptance,

intimate relationships, friends, social groups

4. **Esteem needs** - Achievement, prestige, status, competence, approval
5. **Self-actualization** - Fulfillment of one's unique potential

3.2.2 Physiological Drives

Physiological Drives - Unlearned drives with a biological basis (primary drives)
Learning influences what behavior is used to satisfy drives
Homeostasis - Tendency of the body to maintain a steady state

- *Hunger*
  - *Mouth* - Provides a sense of satiety - satisfied; fullness
  - *Stomach Contractions* - Hunger pangs
  - *Blood Sugar Level* - Drops with the deficit of food
  - *Hypothalamus* - Also plays a role in hunger
    - *Ventromedial Nucleus* - Central area on the underside of the hypothalamus, functions as a stop-eating center; problems cause an organism to become hyperphagic (eat excessively)
    - *Lateral Hypothalamus* - On the side of the hypothalamus, functions as a start-eating center; problems cause an organism to become aphagic (undereat)
  - Receptors in Liver - Sensitive to blood-sugar levels, food deprivation causes receptors to send messages to the brain
- *Thirst*
  - *Dry Mouth Theory* - It was once thought that receptors in the mouth determined thirst
  - *Regulation in Kidneys* - Fluid depletion reduces the flow of blood through the kidneys, which secrete a hormone to signal the hypothalamus
  - *Hypothalamus* - Osmoreceptor cells in the brain shrivel and trigger thirst; produces ADH
    - *ADH* (Antidiuretic Hormone) - conserves body fluids

by increasing reabsorption of urine

- *Receptors in Mouth and Throat* - signal hypothalamus to pause in drinking

3.2.3 Stimulus Motives

Stimulus Motives - Motives to increase the stimulus on an object

- Sensory Stimulation and Activity
    - *Sensory Deprivation* - Research method that systematically decreases the amount of stimulation on sensory receptors; sensory deprivation is intolerable; people seek different levels of stimulation
- Exploration and Manipulation
    - *Novel Stimulation* - Unusual source of arousal or excitement; people are motivated to seek it
    - People explore and manipulate their environment for reduction of primary drives or for their own sake
- The Search for Optimal Arousal
    - *Arousal* - General level of activity or motivation in an organism
    - *Optimal Arousal* - The level of arousal at which we function best
    - *Fiske and Maddi* - Theorized that people behave in ways to increase their arousal when their levels are too low and ways to decrease their arousal when their levels are too high
    - *Yerkes-Dodson Law* - A high level of motivation increases efficiency in the performance of simple tasks, whereas a low level of motivation increases the efficiency in the performance of complex tasks

3.2.4 Social Motives

Social Motives - Learned or acquired motives
Henry Murray - Developed Thematic Apperception Test (TAT)
David McClelland - Helped pioneer assessment of need for achievement; found that motives measured by the TAT permit the

production of long-term behavior patterns.

- Need for Achievement (nAch)
    - *Behavior of individuals with high nAch* - Tend to earn higher grades, and take positions of higher risks, decision making, and the chance for great success
    - *Development of nAch* - Children who develop a high nArc are encouraged to show independence and responsibility at an early age
- Need for Affiliation (nAff)
    - *Stanley Schachter* - Experimented on anxiety's effect on nAff
    - *Theory of Social Comparison* - People look to others for cues about how to act in confusing or unfamiliar situations; a high nAff may indicate anxiety
- Need for Power (nPower)
    - *Need for Power* - The need to control organizations and other people
    - *McClelland and Pilon* - Found that high nPower adults were more likely to have parents who were permissive toward their children's sexual and aggressive behavior
    - *Qualities of individuals with high nPower* - More likely to be members of important comittees and hold prominent offices in organizations

3.2.5 Emotion

Emotion - A state of feeling that can have physiological, situational, and cognitive components
Sympathetic Arousal - Rapid heartbeat and breathing, sweating, muscle tension; usually affiliated with a sense of danger
Parasympathetic Arousal - Usually affiliated with anger or a wish for revenge in a frustrating or insulting situation
Lie Detectors - Monitor physiological signals of emotional states, correlating certain signals with lying or truthfulness; often inaccurate due to the variety of motivations that can produce the same physiological effect; e.g., nervousness due to lying vs. nervousness due to the

importance of being read as truthful

- Emotional Development
    - *Katherine Bridges' Theory* - Emotions develop as babies age
        - Newborns - One emotion only: diffuse excitement
        - 3 Months - Distress and delight
        - 6 Months - Distress differentiates into fear, disgust, and anger
        - 12 Months - Delight differentiates into elation and affection
        - 2 Years - Jealousy develops from distress; joy develops from delight
    - *Alan Sroufe* - Advanced Bridges' theory by studying causes of emotions: e.g., jealousy requires a sense of possession
    - *Carroll Izard* - Theorized that infants are born with discrete emotional states, and learn to express them as they age
- Expressions of Emotion
    - *Smiling* - Universal sign of friendliness or approval
    - *Baring Teeth* - Universal sign of anger
    - *Paul Ekman* - Studied universality of expressions; most were found to be common to all humans
- The Facial-Feedback Hypothesis
    - *Facial Feedback Hypothesis* - Facial expressions affect what emotions a person feels; expression intensifies the emotion while repression lessens it
    - *McCanne and Anderson* - Tried to create more unbiased tests of the facial-feedback hypothesis

3.2.5. 1 Theories of Emotion

- James-Lange Theory
    - *William James and Karl G. Lange* - Suggested that emotions follow behavioral responses rather than cause them; responses are instinctive behavior patterns
    - Walter Cannon - Argued that emotion and action are not discrete
- Cannon-Bard Theory
    - *Walter Cannon and Philip Bard* - Suggested an event triggers an emotion and a response simultaneously

- Theory of Cognitive Appraisal
  - *Stanley Schachter* - Found that all emotions have approximately the same arousal pattern; theorizes that variation is only in strength of the impulse and actions are largely dependent on our cognitive appraisal of the situation; the way we appraise is influenced by many factors, including other people's reactions if they are present
  - *Stanley Schachter and Jerome Singer* - Found that appraisal of the same emotion can be drastically different in different situations
  - *Rogers and Decker; Maslach* - Reproducing the Schachter-Singer experiment, got different results
- Evaluation of Emotion Theories
  - Emotional responses vary more than any one theory allows depending on the situation; therefore, no emotional theory is currently accepted as completely correct

3.5.2 Love

Passion Cluster - The level of romantic love including fascination, sexual desire,exclusiveness.
Caring Cluster - The level of romantic love including being a champion or advocate and giving the utmost for one's significant other
Romantic Love - An intense, positive (not always) emotion involving:

1. Arousal in the form of sexual attraction
2. A cultural setting that idealizes love
3. The actual or fantasized presence of a person considered to be attractive
4. Caring
5. The belief that one is "in love"

- Romantic Love in Contemporary Western Culture
  - *Portrayal of Love in Western Culture* - First seen by children in tales such as Sleeping Beauty, Snow White, Cinderella, etc.; then in romantic novels, television shows and films, and personal accounts from friends and family
  - *What the absence of romantic love in some cultures means* -

Romantic love is not necessarily fake, it simply requires knowledge of a behavior pattern before it can be enacted

- Styles of Love
  - *Clyde and Susan Hendrick* - Developed a love-attitude scale suggesting six styles of love among college students
  - *Eros* - Romantic love, commitment
  - *Ludus* - Game-playing love; “I keep my lover up in the air about my commitment”
  - *Storge* - Friendship-love; “The best love grows out of enduring friendship”
  - *Pragma* - Pragmatic or logical love; “I consider whether my lover would be a good parent”
  - *Mania* - Possessive, excited love; obsession
  - *Agape* - Selfless love; put lover’s interests before one’s own
  - *What makes up a “normal” relationship* - Most romantic relationships are a mixture of the six types of love
- Love and Arousal
  - Istvan and Griffitt - Strong arousal in the presence of a reasonably attractive person may lead to the belief that we are experienceing desire
  - Valins - Found that believing one was aroused was more important than actually being aroused in labelling certain models as more attractive than others

3.3 Understanding Motivation of Cattle and Horses

Training a horse, mule, ox, or other animal is easier if you first figure out what motivates the animal. These four basic drives motivate horses and other animals to do things:

fear aggression.

learned response

instincts

Fear and aggression are often misinterpreted. Did the horse kick because he was fearful, or did he kick because he was aggressive or bad? Neurologically, fear and aggression are different emotions that may result in similar behaviors, such as kicking or pinning the ears back. Determining which emotion motivates the kicking is important, because punishing a horse for kicking will make a fear-based behavior worse.

If kicking occurs during a training exercise, it is likely to be fear based. Fear is also the likely motivation if an animal becomes agitated when it is alone, tied up, or held in a squeeze chute.

Another factor is genetics. A horse or ox with a nervous, highstrung temperament is more likely to have fear-motivated behavior than an animal with a calm, placid temperament. It is unfortunate that some breeders select for hot-blooded draft horses. This pattern of selection is likely to result in more problems with fear-motivated behavior. An animal with a hot temperament is more likely to blow up when it is suddenly confronted with a scary novel experience.

Many people have said to me, "My horse behaves well at home, but goes berserk at shows." This behavior occurs because shows have many scary things an animal never sees at home. A flighty horse must be accustomed to flags, balloons, and fast moving bikes long before he goes to a show. A safe way to introduce a horse to balloons and flags is to put them in a large pasture and allow the horse to explore them. A dangerous practice is to suddenly confront a horse that has a nervous flighty temperament with a scary object, such as a flag, when he is in a confined space where he cannot move away. Flags and balloons are scary because they make rapid movements and have bright contrasting colors. Bikes are frightening because they move rapidly and can silently sneak up on the horse. If the horse is allowed to voluntarily approach these objects, however, they may become attractive.

3.3.1 Eliminating Learned Bad Behavior

An animal often learns bad behaviors because people inadvertently reward the behavior. One common problem behavior is a horse pawing and striking the stall door at feeding time. The horse acts this way because he thinks it will speed up being fed. If feed is given while the horse is striking the stall door, his undesirable behavior will be reinforced and rewarded. He learns to associate being fed with pawing the door.

To eliminate the behavior, drop feed into the manger at the precise instant the horse stops pawing at the door. The timing must be right so the horse will associate keeping his foot still with getting fed. To stop pawing behavior, reward the horse for keeping his foot still.

3.3.2 True Aggression

True aggressive behavior occurs when an animal views a person as a herd mate that needs to be dominated. This problem occurs especially with bulls. Castration will reduce aggression in adult animals and, if done at a young age, mostly eliminate it. In grazing animals, an orphan male raised away from its own species may be imprinted to people and think he is a person. The resulting behavior is cute in a young animal, but when the male becomes fully mature he can be dangerous. At full maturity he may turn on his caretakers to prove that he is now the dominant male in the herd. Raising young bull calves in a social group helps prevent aggression toward people.

Young bulls and stallions must learn they are not people. Orphaned male grazing animals should be either castrated or placed in a social group with their own kind by 6 weeks of age. When they grow up with their own kind they learn who they are and any aggression is more likely to be directed toward their own kind.

The male aggression problem is not due to the animal being tame. It is due to mistaken identity. Social behavior in grazing animals has to be learned. Grazing animals must learn the normal give and take of social behavior. Horses or cattle that are reared alone will often be vicious fighters when mixed with other animals. A young stud colt reared alone may constantly fight other horses because he has never learned that once he has become dominant he doesn't need to keep fighting. Stallions will be easier to manage when they mature, if they are reared as young colts on a pasture full of other adult horses.

3.3.3 Instinctual Behavior

Instincts or so-called fixed action patterns are behavioral patterns that are hard wired into an animal like a computer program. These innate behavioral programs are not dependent on learning. The behavioral program runs when it is triggered by certain specific stimuli that animal behavior specialists call sign stimuli.

Birds have many more instinctual behavioral patterns than mammals. The mating dance of birds is a good example of instinctual behavior. In stallions and bulls the flehmen lip curl is an example of an instinct. Smelling a female in estrus will trigger it. Many reproductive behaviors are hard wired and instinctual. Pressing on a calf's forehead may trigger butting, which will become dangerous when he grows up. A calf should be stroked under the chin or on the withers to encourage it to take a submissive posture. Never play butting games with calves.

An instinctual behavior often interacts with learned behavior. Breeding behavior is instinctual, but who is bred is learned. Ram lambs nursed by nanny goats will attempt to breed goats when they mature. To establish normal breeding behavior, orphan animals should be reared in a pen with their own species. Bottle feeding a baby for a few weeks will usually not cause cattle to imprint to people if they are penned with their own species.

Understanding the motivating basis of a behavior makes it easier to deal with that behavior and improve an animal's performance. Punishing fear may make it worse, but some force may be required to stop true aggression. When dealing with aggression, imitate the animal's natural instinctual behavior patterns. A bull that is ready to attack will make a broadside display to show how big he is, facing sideways toward the one he plans to dominate. The broadside threat is an innate instinctual aggressive threat behavior. A bull that displays it toward people can be dangerous indeed. Some bulls will submit and move away when a person makes an imitation of the broadside threat by making themselves look big. If the bull will not submit and move away, he should be culled before he kills somebody. Any bull that charges people in an open pasture is potentially dangerous and should be culled. Aggression toward people must be prevented by rearing bulls in a social group.

Smaller animals, such as pigs and alpacas, that become aggressive may be dominated by using species typical aggressive patterns. I have successfully exerted dominance on more than one young pig by shoving on its neck with a board, in the same location where a dominant pig would bite. Rearing animals in social groups, however, is the best way to avoid problems of mistaken identity.

Exerting dominance over an animal does not mean beating it into submission. During training, all animals respond to positive reinforcement such as a feed treat, stroking, or a kind voice. Trainers should use positive reinforcements to train horses, cattle, and other animals to do tasks. Next time you watch a pulling contest, note how the loggers' horses usually pull better than horses that have been motivated to pull by whipping. Positive rewards make a better motivator than fear.

3.0 Conclusion

Student have learnt motivation and theories of motivation. They also learnt types of motivation and how motivation work with emotion.

5.0 **Summary**

Motivation is the driving force of desire behind all deliberate actions of humans. Motivation is based on emotion—specifically, on the search for satisfaction (positive emotional experiences), and the avoidance of conflict. Positive and negative is defined by the individual brain state, which may be influenced by social norms: a person may be driven to self-injury or violence because his brain is conditioned to create a positive response to these actions. Motivation is important because it is involved in the performance of all learned responses. Within psychology, conflict avoidance and the libido are seen to be primary motivators. Within economics, motivation is often seen to be based on incentives; these may be financial, moral, or coercive. Religions generally posit divine or demonic influences.

6.0 T**utor-Marked Assignment**

1.0 List six theories of motivation and explain each one of them.

2.0 Differentiate between intrinsic and extrinsic motivation.

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MODULE 5 DISPLAY, DISPLACEMENT BEHAVIOUR AND CONFLICT BEHAVIOUR DISPACEMENT

Unit 1 Display and Displacement Behaviour in Animals

Contents

1.0 Introduction

Displacement behavior is usually thought of as self-grooming, touching, or scratching, which is displayed when an animal has a conflict between two drives, such as the desire to approach an object, while at the same time being fearful of that object. With the fall of drive theory into disfavor, animal behaviorists paid little attention to displacement behavior until Maestripieri et al. (1992) pointed out that displacement behavior might be a good measure of anxiety levels.

Since then a sizeable literature evaluating the effectiveness of displacement behavior measures (also called self directed behavior, or SDB) as indicators of anxiety has grown. Particularly attention has been paid to primates, including humans. Measures of displacement behavior, for example, have been applied in psychiatric studies of anxiety (Troisi et al. 2000).
Castles et al (1999) found that SDB's increased in wild olive baboons between depending on whether the nearest animal (to the animal being watched) was dominant or not. Dominant animals caused in increase in self directed behaviors by 40 %, indicating a higher level of social anxiety caused by the proximity of a dominant animal.

Chimpanzees also display higher levels of SDB's in anxiety inducing situations. Baker and Aureli (1997) found, in captive chimps, that vocalizations from animals in neighboring cages stimulated more SDB's when the chimps were housed in groups. Socially isolated chimps, however, did not respond with SDB's to vocalizations coming from neighboring cages. The vocalizations may suggest to the chimps that an attack is imminent.

Baker and Aureli (1997) suggest that the isolated animals realize that no other chimps are in their cage, and consequently they feel safe even when hearing the vocalizations. Leavens et al. (2001) gave captive chimps problems of varying difficulty to solve. If their chimps started with an easy problem and then progressed to more difficult problems they displayed more SDB's when confronted with the difficult problems. Chimps who only received difficult problems did not display more SDB's. Positive auditory reinforcement during the problem reduced SDB's.

2.0 Objectives

At the end of this unit, students should be able to:

1 Explain displacement behavior in animals.
2 Known the displacement signs in dog and cat

3.0 Main Content

3.1 Displacement activities and arousal

In 1940 Tinbergen and Kortlandt independently drew attention to a behavioural phenomenon which has since been called displacement activity and has received a good deal of attention. Although no binding rules exist by which displacement behaviour can be recognized, the term is applied to behaviour patterns which appear to be out of context with the behaviour which closely precedes or follows them either in the sense that they do not seem functionally integrated with the preceding or following behaviour or that they occur in situations in which causal factors usually responsible for them appear to be absent or at least weak compared with those determining the behavioural envelope.

3.1.1 Displacement activities in animals

Displacement activities occur in three situations:

I. Conflict
II. frustration of consummator acts
III. physical thwarting of performance.

Several theories have been put forward to explain the causal mechanism involved. A variety of behavior patterns have been reported as displacement activities, even in a single species, but this variety needs revision.

Monographie treatments of the behavior of any one species usually indicate only two or three activities which according te the judgment of the observer occur commonly as displacement. None of the theories on displacement activities gives cogent reasons why particular behaviour patterns should be more common than others as displacement activities, apart from stating that the causal agents which usually elicit them in non-displacement situations can also be presumed te be present, if only weakly, in the displacement context, or remarking that those patterns are prepotent in the repertoire of the animal.

In the course of a systematic exploration of the forebrain and brainstem of herring and lesser black-backed gulls (Larus argentatus and L. fuscus) with electrical stimulation, information was obtained which may bear on this particular issue. The gulls with chronically implanted monopolar electrodes (conical active ares, -0-25 mm2) were stimulated with a sine current at 50 c/s ranging between 10 and 150 µamp root mean square current, in repeated trains lasting 30 sec-5 min for several testing sessions, over 2 or more months. The electrode tip locations were checked histologically.

A great variety of responses have been obtained, but here we will only consider a behavioural syndrome which is characterized by preening and staring down, and more rarely by pecking, **yawning**, squatting, relaxation (fluffing of plumage, shortening of the neck, general diminution of activity, intermittent closure of eyes) and occasional sleep. We find that several, and sometimes all, these component patterns can often be elicited from single loci with the same stimulation strength usually less than 50 µamp, either as a result of a single stimulation train or more frequently in the course of several consecutive trains.

In Table 1 all 202 loci so far explored have been classified into those which gave preening and those which did not. Within each class of loci the percentage which yielded the different other components is shown. All the component patterns wore associated with electrodes eliciting preening rather than with those which did not, and the association is significant. A similar relationship may also hold for mandibulation, shaking the body and head, wagging the tail and shaking the foot, but because those patterns are also frequent during control periods without stimulation, a decision is difficult. No such association could be dotected for some twentyfive other various behaviour patterns examined.

It is significant that the preening positive points clustered in several discrete anatomical areas of the telencephalon and diencephalon and that ten electrodes responsible for more than half the entries in the non-preening class also lay within or close to these areas. There is net sufficient information to decide whether the associations of components are stronger in some areas than in others, although some evidence points in this direction.

The conclusion that these diverse behaviour patterns reflect the activation of a more or less unitary system leading to dearousal, and are not a result of the simultaneous stimulation of contiguous but otherwise unrelated neural systems, is supported by observations on unstimulated normal gulls which suggest a high temporal and sequential association between the component patterns including sloop. Furthermore, preliminary experiments indicate that at least two hypnotic drugs, pentobarbital sodium and tribromoethanol, given systemically, reliably elicit the syndrome just described. Preening, staring down and pecking the ground are also the patterns most often involved in displacement behaviour in gulls. A similar relationship seems to hold in some other species.

The striking occurrence of sleep as displacement in several species may be regarded in this context as a regulatory overshoot. Why grooming and other patterns should be activated by a neural de-arousal system is functionally not obvious, but perhaps those types of activities are conducive to de-arousal in a similar way to other activities, possibly through stimulus reduction (cut-off), switch of attention to stimuli of little novelty or generation of repetitive stimulation.

3.2 Examples of displacement behaviour in animals

3.2.1 Displacemen behaviour in dog

There are basically two types of displacement behaviors: those that are self-directed – something the dog does to himself, and those that are re-directed to something external. A common example of a self-directed displacement behavior in dogs is self-grooming, most often licking the genital area. Another common self-directed behavior is yawning.

Common examples of re-directed displacement behaviors are finding, picking up and carrying a toy, barking, circling, grazing grass and gulping water as the reader describes. In a multi-dog household, re-directed behavior often takes the form of one dog jumping onto and engaging in play with another dog, grabbing, wrestling and the like.

This is what displacement behaviors are; now to the bigger question of why dogs and other animals (including us) engage in them.

Displacement behavior occurs at times of emotional conflict, serving as an outlet to dissipate energy. Using the reader's question for example, the behaviors that are in conflict have to do with excitement and expression of greeting behavior.

Let's explore what normal greeting behavior is, and why a dog might have conflicting emotions about it:

For a dog, greeting involves two major areas and behaviors: licking the mouth of the returning pack member (or visitor), and sniffing the genital area. While both these behaviors are normal for dogs, most of us humans discourage such expressions of friendship.

Jumping up on us in greeting is because the dog is trying to lick us around the mouth. Since we are upright rather than on all fours, dogs can't reach our mouths without jumping up. Most of us don't want our dogs to jump on us, so we discourage this normal dog behavior. In most cases, such discouragement is a verbal reprimand or scolding, and sometimes involves some form of physical punishment such as applying a knee to the dog's chest. Embarrassing sniffing behavior, as well, is most often strongly reproached.

Reprimanding or punishing what is normal behavior for a dog (inappropriate though we may consider it) makes the dog feel anxious and stressed. Over time, these feelings become intrinsically associated with the situation that triggers them, so even once the dog has learned to not jump up, he is conditioned to feel anxious in this situation.

Just as importantly, chastising the dog for what is normal does not provide an alternative outlet for the energy of this behavior. For example, teaching the dog to sit or get a toy and carry it around when someone comes to the door creates an alternative behavior outlet for his energy. Displacement behavior occurs in the absence of learning a positively reinforced alternative behavior to replace his normal greeting behavior.

It isn't just dogs that operate this way. Consider how you would feel if you suddenly find yourself in an unfamiliar culture, with different, unknown greeting rituals. You offer your hand to shake hands and the person looks at you with disgust and turns away. Standing there foolishly with your hand outstretched you might laugh uncomfortably, cough and cover your mouth with your outstretched hand, or reach to pick up something, as if that's what you intended all along: all displacement behaviors.

Now think of how much better you would feel when you have been forewarned as to proper greeting in this unfamiliar culture. Feeling no anxiety you would offer the appropriate behavior. This is just how we should approach greeting behavior, or any other “normal” dog behavior that we consider inappropriate or unacceptable in our society and culture. Rather than simply expressing our dismay or disgust, the best approach is to teach your dog an alternative, acceptable behavior so his emotions will no longer be in conflict.

While the reader’s dog doesn’t seem too terribly upset, and has found an acceptable displacement behavior, the reader could ask the dog to sit, lie down, or offer another learned behavior during greeting, and see if it doesn’t change her need to drink water.

And finally, I want to thank the reader for noticing that I invite questions. I try to answer all emails I receive, and am most appreciative of getting them. Readers’ questions often trigger column topics I hadn’t thought of, and I’m always grateful for new ideas!

3.2.2 Displacement behavior in cat

In the cat Parmeggiani stimulated several different and separate areas of the forebrain and brainstem and obtained a behavioural complex consisting of sniffing, grooming, **yawning**, lying down, curling up, dozing and sleeping. He emphasizes that this behaviour is normal in unstimulated cats. Rowland and Gluck presont some evidence that in a certain conditioning procedure grooming replaced the synchronization of the electroencephalogram shown by sleeping cats when those were tested awake. Again, Leyhausen lists grooming, sniffing and lying down as displacement behaviour for the cat.

For the rat, Caspers has shown that grooming and some other unfortunately unspecified "motorautomatisms" are associated with shifts in the cortical d.c. potential making the surface positive, which otherwise are typical of sloop, while shifts towards a negative surface are characteristic of the waking animal. Grant mentions grooming, digging and sniffing as typical displacement activities of rats.

Theee facts suggest that grooming or preening and certain other movements are largely controlled by neurophysiological mechanisms which are also responsible, for **de-arousal and sleep**. On the other hand they are often involved in displacement bohaviour. There is little doubt, however, that the behavioural situations loading to displacement, that is, conflict, frustration and thwarting, are effective in increasing arousal. I suggest that the occurrence of at least some displacement activities is the reflexion of a homeostatic process operating towards cancelling the arousal increment so generated, through the activation of an arousal inhibiting system. The existence of arousal homeotasis has been suggested by Borlyne, who also marshals supporting empirical evidence. Such regulation appears logically necessary if arousal is correlated with the rate at which information is handled and if the nervous systera is considered as a communication channel of restricted and specific capacity whore for maximum efficiency the information handling rate must be hold within certain limits.

8.0CONCLUSION

Maestripieri et al. (1992) pointed out that displacement behavior might be a good measure of anxiety levels.

5.0 SUMMARY

Research on animal welfare has used displacement behavior as a measure of anxiety induced by captivity or other manipulations. The effectiveness of interventions intended to ameliorate the effects of captivity on animals may be measured by reductions in self directed behaviors.

6.0 TUTOR –MARKED ASSIGNMENT

1. What is displacement behavior in animals.
2. List three displacement activities in animals.
3. Mention two types of displacement activities in dog.
4. List displacement activities in dog and cat.

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Unit 2 : Conflit Behaviour

CONTENT

1.0 INTRODUCTION

Conflict behavior is a state of motivation in which tendencies to perform more than one activity are expressed simultaneously. At any particular moment, an animal has many different incipient tendencies, but by a process of decision-making, one of these becomes dominant. Generally, only one tendency becomes dominant, but in certain circumstances more than one competes for dominance, and conflict arises.

2 Objectives

At the end of this topic students should have learnt:

1. What conflicts in animals is all about.
2. Types of conflicts.
3. Examples of Conflict in some animas

3.0 Main Content

3.1 Types of conflict in animals

Conflict has traditionally been divided into three main types:

3.1.1 ***Approach–approach***: conflict occurs when two tendencies in conflict are directed towards different goals. In such a case the animal may reach a point where the two tendencies are in balance. However, the tendency to approach a goal generally increases with proximity to the goal. This makes approach–approach conflict unstable, because any slight departure from the point of balance, towards one goal, will result in an increased tendency towards the other, thus resolving the conflict.

3.1.2 ***Avoidance–avoidance:*** conflict occurs when the two tendencies in conflict are directed away from different points. Since the tendency to avoid objects generally increases with proximity to the object, movement toward either object is likely to result in a return to the point of balance. Such situations are not normally stable, because the animal can escape in a direction at right angles to the line between the two objects.

3.1.3 ***Approach–avoidance***: conflict occurs when one activity is directed towards a goal, and another away from it. For example, an animal may have a tendency to approach food, but be frightened of the strange food dish. The nearer it approaches the food, the stronger the approach tendency, but the nearer it gets to the dish the stronger the avoidance tendency. The animal can reach the food, only when the approach tendency is larger than the avoidance tendency. Often there is an equilibrium point, some distance from the goal. When the animal approaches beyond this point, avoidance is greater than approach. When the animal retreats, approach is larger than avoidance. Such situations tend to be stable, because the animal is always pulled towards the equilibrium point.

Approach–avoidance conflict is by far the most important and most common form of conflict in animal behaviour. Typically such conflict is characterized by compromise and ambivalence, especially near the point of equilibrium. Irrelevant behaviour, such as displacement activity, is also common, as are various forms of display and ritualization. Ritualized conflict behaviour often occurs in territorial disputes, and often forms the basis of threat display.

3.2 Motivational Conflicts

Sometimes the urge to do something worthy or good or pleasurable is directly opposed by the fact that it involves pain or inconvenience or hard work. Then the organism is in conflict between two opposite motives. That is one form of *motivational conflict* called an *approach/avoidance conflict*. One may also feel torn between two different pleasures. Or one may be forced to choose between two pains. Each of these is a classic *motivational conflict.*

3.2.1 **Types of classic motivation conflicts**

Classic motivational conflicts are:

1. Approach/avoidance conflicts. The organism is attracted and repulsed by the same stimulus or situation.

2. Approach/approach conflicts. The organism is forced to choose between two different desirable stimuli.

3. Avoidance/avoidance conflicts. The organism is forced to choose between two different undesirable alternatives.

Avoidance tendencies tend to grow *stronger* as an event approaches. This has implications you can observe in your own life. A distant event such as a dentist appointment might seem desirable, and you make plans for it. But as the day approaches, the event seems less desirable, or you are more inclined to avoid it. This can happen with desirable goals as well as things you would rather avoid: it is called "getting cold feet."

What sort of behavior is common in situations of motivational conflict?

Vacillation (going back and forth) is common in situations of motivational conflict. If you are attracted to a person (an approach tendency) but feel shy and inhibited (an avoidance tendency) you may "go back and forth" a lot, in your thoughts, feelings, and behaviors. First you lean one way, then the other. This phenomenon is also found in control systems where opponent processes are used. In that context, it is called *oscillating* instead of *vacillating*. All control systems oscillate when trying to mediate between two opposing forces, and vacillation is one example.

Approach/avoidance conflicts cause an animal to be torn between opposite forces. Animals caught between strong but opposite drive states may vacillate, going first one direction then the other. Or they may perform displacement activities as discussed in Chapter 8. Displacement activities appear to express nervousness or divert attention from a conflict.

Approach-approach conflicts involve a choice between two desirable goals when you can only have one. Sitting in front of a display of merchandise, when you can only afford to buy one thing, you may find yourself engaged in a displacement activity such as scratching your head. The conflict between large late rewards and short early rewards is a form of approach/approach conflict.

What are signs of strong motivational conflicts in animals?

Avoidance-avoidance conflicts involve choosing "the lesser of two evils." Animals caught between a fire and a river must choose which to face. They are likely to show signs of distress, jumping around, pawing the ground, or vocalizing until they plunge into the river. Strong motivational conflicts are also accompanied by signs of *autonomic* nervous system arousal: sweating, nervousness, blushing, and defecating. Rat researchers commonly count rat droppings as a way of quantifying (attaching a number to) the level of anxiety in rats.

3.3 Vacuum, Displacement, and Redirected Activities

We have seen that action patterns are frequently triggered by a highly specific stimulus, which the ethologists called a sign stimulus or releaser. However, sometimes action patterns appear for no obvious reason at all. *Vacuum activity* is the name Lorenz gave to behaviors set off for *no apparent reason*, "in a vacuum." Lorenz suggested that animals have a need to exercise biologically natural behaviors, even if the behavior has no function.

For example, Lorenz kept a fly-catching bird as an indoor pet. Sometimes he let the bird fly around the room for exercise. He noticed that, although there were no insects present, the bird snapped at imaginary insects in the air. There was no reason to do so; the bird was just exercising its instinctive action pattern. Lorenz called this a vacuum activity.

What is a vacuum activity?

Similarly, squirrels raised from birth in a metal cage will go through the entire sequence of nut-burying activities, despite the lack of dirt or a nut in the cage. The squirrel scratches rapidly on the metal cage floor, digging an imaginary hole, takes its imaginary nut and buries it in the imaginary hole, finally patting the metal floor as if pushing dirt and leaves over a buried nut.

What is displacement activity?

Displacement activities as described by Lorenz are motor programs that seem to discharge tension or anxiety. For example, if one is trying to entice a squirrel to come up and take a peanut, the squirrel becomes conflicted-caught between two incompatible drives. It wants the nut, but it fears humans. The squirrel is caught between *approach* and *avoidance* tendencies, but it cannot do both at once. It becomes visibly edgy. It may take a few hops toward the human holding the peanut, then scratch itself suddenly or make a few digging movements. This does not mean the squirrel itches or needs to dig a hole. Lorenz suggested it was "breaking the tension" caused by competing urges.

What are examples of displacement activities in humans? What research took place in the waiting room of a dentist's office?

Humans perform displacement activities. One study involved a hidden video camera in a dentist's office waiting room. People waiting to have cavities filled showed all sorts of displacement activities, scratching their heads, stroking non-existent beards, wringing their hands, tugging at earlobes, flipping through magazines at one page per second, and so forth. People waiting for X-rays or teeth cleaning showed fewer of these activities. Like the squirrels approaching a human holding a nut, patients waiting to have cavities filled were caught between two contradictory impulses. They wanted to get the cavities filled, but they probably wanted to leave, also. So they performed nervous activities.

What is redirected activity?

Redirected activity is a third example of action patterns aroused in unusual circumstances. Lorenz defined a redirected activity as a behavior that is redirected from a threatening or inaccessible target to another target that is more convenient or less threatening.

For example, flocks of chickens form a *pecking order*. Chickens form a rigid dominance hierarchy based on status differences respected by all animals in the group. In a chicken coop, each chicken has some other chickens it can peck (because they are less dominant) and some it cannot peck (because they are more dominant, usually larger). At the top of the hierarchy is a chicken that can peck all the others but gets pecked by nobody. At the bottom of the pecking order is a chicken, usually scrawny or unhealthy, which gets pecked by all the others. Sometimes the chicken at the bottom of the pecking order dies from this treatment.

Similar phenomena occur in human organizations, when "higher ups" are disciplined by their superiors but cannot respond in kind, so they take it out on their subordinates. One student wrote:

I was in the Marines for four years and in this time I noticed the pecking order in humans all the time.

I was a sergeant and one week we had company inspection all that week. For some reason our colonel was in a real bad mood. This meant that our major would get chewed out and then the captains. And then the captain would chew out the lieutenants and the lieutenants would chew out the gunnery sergeant and then it would get down to me. And like everyone else I made it rough on my corporals and it just would go right on down the line where the lowest one in rank would be in real trouble. This happened all the time, because if one person wasn't in a bad mood, someone else would get that way before the day was finished. So, in the military, the pecking order is almost a daily happening. "Everything rolls downhill" and like a snowball it gets bigger closer to the bottom. [Author's files]

A different form of redirected activity may have played a role in early American comparative psychology, although it was not recognized as such. E.R. Guthrie was studying *trial-and-error learning* of a cat in a puzzle-box. Guthrie required the cat to push against a wooden pole in the middle of the box. When the cat pressed the pole, a glass door on the front of the cage swung open, and the cat escaped. Guthrie interpreted this as an act of learning based on the Thorndike's Law of Effect. As Moore and Stuttard (1979) note:

3.4 EXAMPLE: CAT

A behavior similar to what Guthrie observed in the puzzle-box

Great importance was attached to the manner in which their "learning" was expressed. The animals' responses were described as highly stereotyped, with long series of movements repeated "in remarkable detail" from trial to trial.

How did Guthrie's cat show redirected activity?

Each experimental session began with the cat being placed in the cage, while Guthrie, Horton, and "as many as eight guests sat in front of the glass-fronted cha.mber, unconcealed by any blind." Pictures from Guthrie's article show the cat rubbing on the pole in the middle of the cage. Obviously (to Moore and Stuttard) the cat was *greeting* its visitors. Rubbing is a cat's stereotyped greeting behavior. Because the humans were not physically available for rubbing, the cat *redirected* the motor program to the pole in the cage. You can see the same thing in any friendly pet cat. It will rub not only your ankles but also nearby furniture

This illustrates how times change and perceptions change with them. In the same situation where comparative psychologists of the 1930s saw trial-and-error learning (in accordance with "universal laws of learning") animal behaviorists of the late 1970s saw a species-typical behavior, redirected in the classic manner described by Lorenz. Psychologists studying animal behavior had adopted the concepts of the ethologists.

4.0 Conclusion

In this topic students have learnt conflicts in animals and types of conflicts

5.0 Summary

Ritualized conflict behaviour often occurs in territorial disputes, and often forms the basis of threat display.

6.0 Tutor- Marked Assignment

1.0 What is conflict behavior?
2.0 Explain the following types of conflict:

1 approach-approach conflict.

2 avoidance avoidance conflict

3 and approach- approach conflict.

3.0 Explain conflict behavior of cat in puzzle box

7.0 References

•Read more: conflict - Approach–approach, Avoidance–avoidance, Approach–avoidance - Tendency, Animal, Approach, Goal, Tendencies, and Towards http://animals.jrank.org/pages/5154/conflict.html#ixzz1GETzPy3w

MODULE 6: LEARNING, COMMUNICATION AND SOCIAL BEHAVIOR

Unit 1: Categories of learning namely: habituation, classical conditioning, instrumental conditioning, latent learning and insight learning.

CONTENTS

1.0 INTRODUCTION

Through learning, animals can adjust quickly to changes in their environment. Learning is adaptive for animals in an environment where changes are not predictable. Learning produces changes in the behavior of an individual that are due to experience. Once an animal learns something, its behavioral choices increase.

An animal's ability to learn may correlate with the predictability of certain characteristics of its environment. Where certain changes in the habitat occur regularly and are predictable, the animal may rapidly respond to a stimulus with an unmodified instinctive behavior. An animal would not necessarily benefit from learning in this situation. However, where certain environmental changes are unpredictable and cannot be anticipated, an animal may modify its behavioral responses through learning or experience. This modification is adaptive because it allows an animal to not only change its response to fit a given situation, but also to improve its response to subsequent, similar environmental changes.

There are five categories of learning namely: habituation, classical conditioning, instrumental conditioning, latent learning and insight learning.

2.0 OBJECTIVES

At the end of lecture, the students should be to:

1. Understand the biological meaning of learning and discuss the different categories.

2. Give examples of different categories of learning

3.0 MAIN CONTENTS

3.1 Habituation

Habituation is the simplest and perhaps most common type of behavior in many different animals. It involves a waning or decrease in response to repeated or continuous stimulation. Simply an animal learns not to respond to stimuli in its environment that are constant and probably relatively unimportant thereby saving time as well as conserving energy. For example, after time, birds learn to ignore scarecrows that previously cause them to flee. Squirrels in a city park adjust to the movements of humans and automobiles. Habituation is believed to be controlled through central nervous system and should be distinguished from sensory adaptation. Sensory adaptation involves repeated stimulation of receptors until they stop responding. For example, if you enter a room with an odor, your olfactory sense organs soon stop responding to these odors.

3.2 Classical conditioning

Classical conditioning is a type of learning documented by Russian physiologist, Ivan Pavlov (1849-1936). In his classic experiment on the salivary reflex in dogs, Pavlon presented food right after the sound of bell. After a number of such presentations, the dogs were conditioned--- they associated the sound of the bell with food. It was then possible to elicit the dog’s usual response to food – salivation—with just the sound of the bell. The food was a positive reinforcement for salivating behavior, but responses could also be conditioned using negative reinforcement.

Classical conditioning is very common in the animal kingdom. For example, birds learn to avoid certain brightly colored caterpillars that have a noxious taste. Because birds associate the color pattern with the bad taste, they may also avoid animals with a similar color pattern.

3.3 Instrumental conditioning

In instrumental conditioning (also known as trial-and-error learning), the animal learns while carrying out certain searching actions, such as walking and moving about. For example, if the animal finds food during these activities, the food reinforces the behavior and the animal associates the reward the reward with the behavior. If this association is repeated several times, the animal learns that the behavior leads to reinforcement; the animal then tends to repeat or avoid that behavior, depending on whether the reinforcement is positive or negative. For example, an American psychologist B.F. Skinner placed a rat in a “Skinner box’’ which have a choice of various levers it might push, some of which reward the animal by releasing food. The animal’s choices may be random at first, but quickly learns to choose those levers that provide food. Such learning is the basis for most of the animal training done by humans, in which the trainer typically induces a particular behavior at first by rewarding the animal.

Instrumental conditioning is undoubtedly very common in nature. For example, animals quickly learn to associate eating particular food items with good or bad tastes and modify their behavior accordingly. In some cases animals may be able to skip some of their own trial and error and learn simply by watching the behavior of others. A good example is that of tits (chickadee-like birds) in England. Sometime in the early 1950s, one of these birds apparently learned to peck through the paper tops of milk bottles left on doorsteps and drink the cream on top. This was probably a case of instrumental conditioning with the bird learning that its general pecking, probing behavior was rewarded if directed at the bottles. But the behavior quickly spread through the population and was “handed down” to the succeeding generation that that learned the behavior by watching adults.

3.4 Latent learning

Latent learning sometimes called exploratory learning, involves making associations without immediate reward. The reward is not obvious. An animal is apparently motivated, however, to learn about its surroundings. For examples, if a rat is placed in a maze that has no food or reward, it explores the maze, although rather slowly. If food or another reward is provided, the rat quickly runs the maze. Apparently previous learning of the maze had occurred but remained latent, or hidden, until an obvious reward was provided. Latent learning allows an animal to learn about its environment as it explores. Knowledge about an animal's home area may be important for its survival, perhaps enabling it to escape from a predator or capture pray.

3.5 Insight learning

Insight learning is the ability to perform a correct or appropriate behavior on the first attempt in a situation with which the animal have no previous experience (some prefer to call it reasoning, rather than learning). For example, if a chimpanzee is placed in an area with a banana hung too high above its head to be reached and several boxes on the floor, the chimp can size up the situation and then stack the boxes to allow it reach the food. In general insight is best developed in primate and other mammals but even in these groups the level of insight often varies from one situation or species to another. The great majority of animals display little or no ability to use insight.

Very broadly the capacity to learn can be thought of as another adaptation that enhances survival and reproductive success and must have some genetic bases. However, the internal mechanisms of learning are very poorly known and it is only recently that progress has begun on linking some simple kinds of learning to internal biochemical or physiological changes. Although animals frequently appear to do complex things, most behaviors can be understood as relatively fixed patterns that are often modified in their frequency and orientation by simple kinds of learning. Put in another way, animals in general are not all that "smart" rather they have been fine tuned by natural selection and their limited repertoire of abilities work very well in normal circumstances.

4.0 Conclusion

In conclusion animal behavior is being modified by learning which is an essential part of animal behavior.

5.0 summary

Through learning an animal can adjust quickly to changes in its environment. Learning is adaptive for animals in an environment where changes are not predictable. The types of learning known to occur in animals include habituation, classical conditioning, instrumental conditioning, latent learning and insight learning.

6.0 Tutor-marked assignment

1. what do you understand by the term learning

2. What are the five categories of learning? Give an example of each kind

7.0 References

•Miller, S. A. and Harley, J. B. (1999) Zoology (fourth edition). WCB McGraw-Hill Boston 750

•*http://www.wam.und.edu/~jaguar/behavior/behavior.html*

•*http://ccp.uchicgo.edu/~jyin/evolution.html*

Unit 2: Communication in Animals

1.0 INTRODUCTION

Communication is the transfer of information from one animal to another. It requires a sender and receiver that are mutually adapted to each other. The sender must send a clear signal to the receiver. Communication can occur within species (intraspecific) or between species (interspecific). Intraspecific communication in animal is very important for reproductive success. Examples of intraspecific communication include warning signals, such as the rattle of a rattle snake's tail and the skunk's presentation of its hindquarters and tail.

Animals use a variety of modalities for communication, including visual, auditory, tactile, and chemical signals. Natural selection has influenced the characteristics of a signal system. Animals have evolved combinations of signals that may be more effective than any single signal.

2.0 OBJECTIVES

At the end of lecture the students should be able to

1. Define communication and the different types of communication.

2. Know the modalities for communication

3.0 MAIN CONTENT

3.1 Visual communication

3.2 Acoustic communication

3.3 Tactile Communication

3.4 Chemical communication

3.5 Communication systems

4.0 Conclusion

5.0 summary

6.0 Tutor-marked assignment

7.0 References

3.1 Visual communication

Visual communication is important to many animals because a large amount of information can be conveyed in a short time. Most animals (e.g., cephalopod mollusk, arthropods and most vertebrates other than mammals) with well-developed eyes have color vision. Many fishes, reptiles and birds exhibit brilliant color patterns that usually have a signaling function. Most mammals have plain, darker colors and lack color vision because they are nocturnal, as were their probable ancestors- nocturnal insectivores. Primates are a notable exception in that they have both color vision and colorful displays.

A visual signal may be present at all times, as are the bright facial markings of a male mandrill. The signal may be hidden or located on a less exposed part of an animal's body and then suddenly presented. Some lizards, such as green anoles can actually change their color through activities of pigment cells in the skin.

Visual signals have some disadvantages in that various objects in the environment may block the line of sight and / or the signals may be difficult to see over a long distance. Also, the signals are usually not effective at night and may be detected by predators.

3.2 Acoustic communication

Arthropods and vertebrates commonly use acoustic or sound communication. These animals must expend energy to produce sounds but sounds can be used during the night or day. Sound waves also have the advantage of traveling around objects and may be produced or received while an animal is in the open or concealed. Sounds can carry a large amount of information because of the many possible variations in frequency, duration, volume and tone.

Acoustic communication systems are closely adapted to the environmental conditions in which they are used and the function of the signal. For example, tropical forest birds produce low frequency calls that pass easily through dense vegetation. Many primates in tropical forests produce sounds that travel over long distances. Other examples include the calls of territorial birds that sit on a high perch to deliver the signal more effectively and the alarm calls of many small species of birds. Some of the more complex acoustic signals that have been studied are birdsong and human speech.

3.3 Tactile Communication

Tactile communication refers to the communication between animals in physical contact with each other. The antennae of many invertebrates and the touch receptors in the skin of vertebrates function in tactile communication. Some examples of tactile communication are birds preening the feathers of other birds and primates grooming each other.

3.4 Chemical communication

This is another common mode of communication. Unicellular organisms with chemoreceptor can recognize members of their own species. Chemical signals are well developed in insects, fishes, salamanders and mammals. Advantages of chemical signals are that they (1) usually provide a simple message that ca last for hours or days; (2) are effective night or day (3) can pass around objects; (4) may be transported over long distances; (5) take relatively little energy to produce.

Disadvantages of chemical signals are that they can not be changed quickly and are slow to act.

Chemicals that are synthesized by one organism and that affect the behavior of another member of the same species are called **pheromones**. Olfactory receptors in the receiving animal usually detect chemical signals. Many animals mark their territories by depositing odors that act as chemical signals to other animals of the same species. For examples, many male mammals mark specific points in their territories with pheromones that warn other males of their presence in the area. The same pheromones may also attract females that are in the breeding condition.

Differences in the chemical structure of pheromones may be directly related to their function. Pheromones used for making territories and attracting mates usually last longer because of their higher molecular weights. Airborne signals have lower molecular weight and disperse easily. For example, the sex attractant pheromones of female moths that are ready to mate are airborne and males several kilometers away can detect them.

3.5 Communication systems

Auditory - birds and humans, some insects (crickets)

Olfactory - most mammals, moths

Visual - bees and dancing, fireflies at night

Altruism - personal sacrifice for the good of the group

Alarm call of mammals - Belding's Ground Squirrels

Cooperative breeding - African bee-eaters, Scrub Jays

Bees and other hymenopterous insects

4.0 CONCLUSION

Communication is an essential aspect of animal behavior which enhances continuity in existence. The four defined types of communication showed how animals relate to one another.

4.0 SUMMARY

Communication in animals requires the use of clear signals by one animal and their reception by another. Visual, acoustic, tactile, and chemical signals are important channels in communication systems. Communication can occur within species (intraspecific) or between species (interspecific). Intraspecific communication in animal is very important for reproductive success

6.0 Tutor-marked assignment

1. What is the meaning of communication and explain the different types of communication.

2. What are the means by which animals communicate to one another?

7.0 References

•Miller, S. A. and Harley, J. B. (1999) Zoology (fourth edition). WCB McGraw-Hill Boston 750

•*http://www.wam.und.edu/~jaguar/behavior/behavior.html*

•*http://ccp.uchicgo.edu/~jyin/evolution.html*

Unit 3: Social behavior

CONTENT

1.0 Introduction

2.0 Objectives

3.0 Main Content

3.1 Living in groups

3.2 Various examples of social behavior in animals:

4.0 Conclusion

5.0 summary

6.0 Tutor-marked assignment

7.0 References

1.0 INTRODUCTION

Social behavior typically refers to any interactions among members of the same species, but it also applies to animals of different species, excluding predator- prey interactions. A group of animals may form an aggregation for some simple purpose, such as feeding, drinking or mating. A true animal **society** is a stable group of individuals of the same species that maintains a cooperative social relationship. This association typically extends beyond the level of mating and taking care of young. Social behavior has evolved independently in many species of animals; invertebrates have complex social organizations.

2.0 OBJECTIVES

At the end of lecture the students should be able to

1. Understand the meaning of social behavior and the reasons why animals live in group

2. Identify different types of social behavior found among animals

3.0 MAIN CONTENT

3.1 Living in groups

Animal populations are often organized into groups. A group of animals may form an aggregation for some simple purpose, such as feeding, drinking or mating. Several Drosophila flies on a piece of rotting fruit are an example of an aggregation. A true animal **society** is a stable group of individuals of the same species that maintains a cooperative social relationship. This association typically extends beyond the level of mating and taking care of young. Social behavior has evolved independently in many species of animals; invertebrates have complex social organizations.

One major benefit of belonging to a group may be that it offers protection against predators. There is safety in numbers and predator detection may be enhanced by having several group members on alert to warn against an intruder. Also, cooperative hunting and capture of prey increase the feeding efficiency of predators. Living in social groups is also advantageous in some instances due to the ability to gain protection from the elements (e.g. huddling together in cold weather) and during the processes of mate finding and rearing of young. In many species, most notably the social insects, living groups has resulted in the evolutionary division of labor, with specific individuals performing specialized tasks (defense, food procurement, feeding of young).

A disadvantage of group living may be competition for resources. Other disadvantages include the diseases and parasites that may spread more rapidly in group-living animals and interference between individuals with regard to reproduction and rearing of young. The value of group living depends on the species and behaviors involved.

3.2 Various examples of social behavior in animals:

Social Behavior - any interactions between 2 or more individuals

Anti-predatory behavior - group defense in Musk Ox

Agonistic behavior - ritualized behaviors that substitute for physical contact and fighting - yawn of baboons, dogs and baring their teeth, cats and raising their fur, birds raising their feathers

Fighting and physical contact, wolves, coyotes, seals, walruses, etc,

Dominance hierarchies - Peck order of turkeys and chickens

- Wolves and primates - alpha males......

Territoriality - Birds and birdsong - breeding, wintering, year-round territories, size of territory related to size of bird (small birds with small territories, large birds with large territories, some exceptions - colonial nesting species - large birds with small territories

Marking territories can be found in Birds – birdsong; Mammals - urine; Carpenter bees - constantly standing guard

Reproductive behavior – Courtship is highly ritualized, species specific behavior

Examples:

Mole rats of Asia - similar to hymenopterous insect colonies with Queen and workers, workers protect and feed the Queen, sacrifice reproductive opportunities

Example - sticklebacks

Reproductive behavior - mating systems

Monogamy - one male and one female

Polygamy- one male and many females

Polygon - one male and many females

Polyandry - one female and many males

Promiscuity - anything goes

4.0 CONCLUSION

Animals live in groups for different reasons. Social behaviors in animals have both advantages and disadvantages. The value of group living depends on the species and behaviors involved.

5.0 SUMMARY

Many animals' species live in groups that provide various benefits. Groups range from simple aggregations to more complex social organization or societies

6.0 Tutor-marked assignment

1. What do you understand by social behavior

2. What are some benefits of being a member of a group? And give examples of different forms of group in animals.

References

•Miller, S. A. and Harley, J. B. (1999) Zoology (fourth edition). WCB McGraw-Hill Boston 750

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Module 7: SOCIAL BEHAVIOR OF PRIMATES

Unit 1 Basic Concepts in the Study of Social Behavior of Primates and Social Structure

CONTENT

1.0 INTRODUCTION

Most primates, including humans, spend their lives in large social groups. In the case of semi-terrestrial species, such as baboons, being in a large community helps provide protection against predatory cats, dogs, and hyenas. It also helps protect scarce food resources. This is especially true for non-human primates when the food is fruit. Leaf-eaters, such as colobus monkeys and langurs, tend to form smaller social groupings since there is little competition for their food. The very few nocturnal species of primates are mostly small, relatively solitary hunters.

As noted earlier, all primates (including us) form groups. Groups involve such cohesive (bonding) activities such as grooming and mother-infant bonding. It is a way to defend resources against intruders and to fend off predators, such as leopards that inhabit the forests. Group behavior among primates is the most complex among all gregarious animals (animals that form groups, which also include gazelles, cattle, bison, zebras, and others).

Most non-human primate communities are more or less closed to contact with members of other communities. Most often, they are tied to a particular locale and rarely migrate outside of their home range. This aloofness from other troops prevents high concentrations of individuals which could result in rapid depletion of local resources. Communities usually avoid each other and are aggressive towards outsiders. As a result, social interactions between members of different troops are usually very rare, especially for females. Chimpanzees are a notable exception. When chimpanzees from different troops come together, there is often an exciting, friendly encounter lasting several hours, following which, some of the adult females switch groups. Apparently, they are seeking new mates.

2.0 OBJECTIVES

At the end of this lectures

1. The students should be able to understand the types of social behavior found among primates

2. Know some terminologies and basic concept used in the study of primate behavior

3. Take note of the different social groups in primates

3.0 : MAIN CONTENT

Unit 1: Basic Concepts in the Study of Social Behavior of Primates and social structure

1.0 INTRODUCTION

Most primates, including humans, spend their lives in large social groups. In the case of semi-terrestrial species, such as baboons, being in a large community helps provide protection against predatory cats, dogs, and hyenas. It also helps protect scarce food resources. This is especially true for non-human primates when the food is fruit. Leaf-eaters, such as colobus monkeys and langurs, tend to form smaller social groupings since there is little competition for their food. The very few nocturnal species of primates are mostly small, relatively solitary hunters.

As noted earlier, all primates (including us) form groups. Groups involve such cohesive (bonding) activities such as grooming and mother-infant bonding. It is a way to defend resources against intruders and to fend off predators, such as leopards that inhabit the forests. Group behavior among primates is the most complex among all gregarious animals (animals that form groups, which also include gazelles, cattle, bison, zebras, and others).

3.1 Here are some concepts.

1. Ethology: (not to be confused with ethnology, study of cultures) is the study of animal behavior.

2. **Primatology** is a sub-branch of ethology that involves the study of nonhuman primates. One major subfield of physical anthropology is primatology, the study of nonhuman primates (monkeys and apes, including gibbons and orangutans of Southeast Asia and the gorillas, chimpanzees, and bonobos of Africa. Why are they relevant to cultural anthropology...? Well, apart from jokes about monkey wrenches and Bonzo their behavior parallels our own in many ways. They do have features of language, and some have used sign language derived from ASL. There is evidence they have protoculture; they can use tools, and the kind of tools they use differ by region. Gombe (Tanzania) chimps fish for termites, those in Tai (Ivory Coast) scoop

up army ants and crack open nuts using stones or heavy tree branches, suggesting different cultures. Primatology: Basic Concepts

3. **Field Research**: To avoid influencing primate behavior

4. **Provisioning:** Providing food to primates to shorten time in field

5. **Drawback**: Provisioning does influence primate behavior

3.2 Social Structure

Most primates, including humans, spend their lives in large social groups. In the case of semi-terrestrial species, such as baboons, being in a large community helps provide protection against predatory cats, dogs, and hyenas. It also helps protect scarce food resources. This is especially true for non-human primates when the food is fruit. Leaf-eaters, such as colobus monkeys and langurs, tend to form smaller social groupings since there is little competition for their food. The very few nocturnal species of primates are mostly small, relatively solitary hunters.

Most non-human primate communities are more or less closed to contact with members of other communities. Most often, they are tied to a particular locale and rarely migrate outside of their home range. This aloofness from other troops prevents high concentrations of individuals which could result in rapid depletion of local resources. Communities usually avoid each other and are aggressive towards outsiders. As a result, social interactions between members of different troops are usually very rare, especially for females. Chimpanzees are a notable exception. When chimpanzees from different troops come together, there is often an exciting, friendly encounter lasting several hours, following which, some of the adult females switch groups. Apparently, they are seeking new mates.

Interactions within non-human primate communities are usually unlimited. Subgroups are rarely closed from group interaction. All members of a community have daily face to face, casual communication. The most common type of subgroup consists of a mother and her young offspring.

Mother- infant subgroup (patas monkeys)

In some forest living primates, contact between groups of the same species is in the form of a specialized territorial defense behavior. Instead of avoiding each other, groups actively converge near their common territorial border and make hostile displays. Howler monkeys, indris, siamangs, and gibbons all produce exceptionally loud vocalizations for this purpose. This is a ritualized, essentially harmless form of aggression that is intended to intimidate members of the neighboring community. All four of these species live in home ranges that are usually so small that the food resources of neighboring territories can be seen and become attractive

Group behavior among primates is the most complex among all gregarious animals (animals that form groups, which also include gazelles, cattle, bison, zebras, and others).

Primates live in social groups that provide various benefits like food, protection, mates, learning of skills, grooming and parental care.

4.0 CONCLUSION

All primates live in group.

5.0 SUMMARY

Most primates, including humans, spend their lives in large social groups. Group behavior among primates is the most complex among all gregarious animals (animals that form groups, which also include gazelles, cattle, bison, zebras, and others).

Primates live in social groups that provide various benefits like food, protection, mates, learning of skills, grooming and parental care.

6.0 TUTOR-MARKED ASSIGNMENT:

1. Explain the concepts used in the study of primate behavior

2. Are there similarities between the behavior of nonhuman primates and humans?

3. Why Study Primate Behavior?

7.0 REFERENCES

•*www.slideshare.net/paulVMcDowell/primate-social-behavior-510637*

•*anthro.palomar.edu/behavior/behave_2.htm*

•*en.wikipedia.org/wiki/primatology*

Unit 2. Non-human Primate Social Group Composition

CONTENT

1.0 INTRODUCTION

Most non-human primate communities are more or less closed to contact with members of other communities. Most often, they are tied to a particular locale and rarely migrate outside of their home range. This aloofness from other troops prevents high concentrations of individuals which could result in rapid depletion of local resources. Communities usually avoid each other and are aggressive towards outsiders. As a result, social interactions between members of different troops are usually very rare, especially for females. Chimpanzees are a notable exception. When chimpanzees from different troops come together, there is often an exciting, friendly encounter lasting several hours, following which, some of the adult females switch groups. Apparently, they are seeking new mates.

2.0 OBJECTIVE

At the end of this lectures

1. The students should be able to understand the types of social behavior found among primates

2. Take note of the different social groups in primates

3.0 MAIN CONTENT

3.1 social group compositions among primates

While there is considerable variation in social group composition among the primates, there is very little variability within each species. In fact, most non-human primate species are limited to only one of six basic patterns:

1. Single female and her offspring
2. Monogamous family group
3. polyandrous family group
4. one-male-several-female group
5. multimale-multifemale group
6. fission-fusion society

Humans are an exception in that we form a variety of social group patterns. However, each human society usually defines one of them as being acceptable and condemns the others. Only the multimale-multifemale group pattern is not normally found in any human society.

3.1.1. Single Female and Her Offspring

The single female and her offspring group pattern is rare for primates but common for other mammals. It is found among the orangutans and some of the small nocturnal prosimians (e.g., mouse lemurs and galagos). The adult males lead their lives mostly alone. However, they come together with females occasionally for mating. The males of these species generally have large territories that overlap those of several females. Both male and female children usually leave their mother when they reach sexual maturity.

Single female and her offspring

(orangutan mother with child carried on her back)

3.1.2. Monogamous Family Group

Monogamous groups consist of an adult male and female with their children. When they are grown, the children leave to create their own nuclear families. While this group pattern is the most common one for humans, it is rare for non-human primates. It is found among the small Asian apes as well as some of the New World monkeys and prosimians. Specifically, monogamous family groups are the common pattern for gibbons, siamangs, titi monkeys, indris, tarsiers, and apparently some pottos.

3.1.3. Polyandrous Family Group

The smallest New World monkeys, the marmosets and tamarins, form both monogamous and polyandrous family units. They generally start with a monogamous mating pair. Later, a second adult male may join the family and assist in child rearing. When this occurs, both adult males will potentially mate with the adult female. This polyandrous mating pattern is extremely rare among non-human primates but does occur in some human societies in isolated rural regions of India, Sri Lanka, and especially Nepal, and Tibet.

Polyandrous family group

(three pygmy marmoset adults sharing child rearing chores)

3.1.4. One-Male-Several-Female Group

One-male-several-female groups have **polygynous** mating patterns. That is to say, one male regularly mates with more than one female. Polygyny is generally not a promiscuous mating pattern. Rather, the male and his female mates form a distinct mating and child rearing group. This pattern is found among hamadryas baboons, geladas, langurs, howler monkeys, gorillas and many human societies. It has been a culturally preferred marriage pattern in numerous Native American, African, and South Asian cultures. However, polygyny is not as common among humans as monogamy, even in cultures that advocate it.

It would be a mistake to automatically assume that non-human primate one-male-several-female groups are dominated by males. Among geladas, females largely control the social group. This is despite the fact that the males are larger, stronger, and more aggressive. Mothers, sisters, and aunts act as a team in chasing off other unrelated females. They also collectively select their mutual mate among a number of potential suitors roaming in and out of their territory. The male that is chosen usually is one that does not act abusively towards them and is willing to cooperate with them in defending their territory. The relationship with any particular male may be short-term. The stable core of the community is the group of related females. This is a long way from stereotypical male domination.

One-male-several female groups may take a different form when predator pressure is a problem. In open grasslands, hamadryas baboon communities are much larger, often consisting of a number of polygynous families. In such multiple one-male-several-female group societies, males are the dominant, controlling members. The adult males not only "herd" their own sexually mature females, but also maintain order and protect the community from predators. This is not unlike the traditional Arab polygynous marriage pattern in which wealthy men acquire harems.

In contrast, gorillas rarely have to be concerned about predator dangers. Subsequently, their communities usually consist of a single dominant adult male, his mates, and their children. When males reach maturity, they usually are driven off by the dominant silverback male. These exiled males ultimately form their own one-male-several-female groups. As females reach sexual maturity, they also leave their natal families and disperse. They later join with single males to form new families or they join the families of males who already have mates. When the silver back males have unusually peaceful personalities, the gorilla community may have several of them.

3.1.5. Multimale-Multifemale Group

The most common social group pattern among semi-terrestrial primates is the multimale-multifemale group. With this pattern, there are no stable heterosexual bonds--both males and females have a number of different mates. This is characteristic of savanna baboons, macaques, as well as some colobus and New World monkey species.

Multimale-multifemale groups commonly have a **dominance hierarchy** among both males and females. Each individual is ranked relative to all other community members of the same gender. This tends to reduce serious violence within the community since everyone knows in advance who they must defer to and who must be submissive to them. Among rhesus macaques, one's position in the dominance hierarchy is determined by the rank of his or her mother. The top ranking individuals are referred to by primatologists as the **alpha male** and the **alpha female**. All other community members defer to them. A female's rank in the hierarchy stays with her throughout life. However, most young adult male rhesus macaques leave their natal community and ultimately join others to find mates. When they do so, they start at the bottom of the male dominance hierarchy again. Alpha males usually mate more often than others. This makes the social organization superficially look like one-male-several-female group. However, younger females often sneak off to mate with males lower down on the dominance hierarchy. The stable core of rhesus macaque communities is the group of female relatives. They stay within their natal community throughout life and work as a team to defend it against other females.

3.1.6. Fission-Fusion Society

A fission-fusion society is one in which the social group size and composition change throughout the year with different activities and situations. This is the social pattern typical of chimpanzees. Individuals enter and leave communities from time to time. Adult males occasionally wander off and forage alone or join a few other males in a hunting party. Females casually change membership from one group to the other. This occurs especially when females are in estrus and seeking mates. As a result, foraging and sleeping groups reform frequently. Male chimps are the relatively stable core of the community since they rarely join other troops.

What allows for the generally loose relationship between chimpanzee communities is that they apparently recognize a wider range of social bonds than do monkeys. They often have relatives and friends in several different neighboring troops. When chimpanzee communities come together, they usually exchange friendly greetings rather than show aggression. However, it would be a mistake to assume from this that chimpanzee society is always peaceful. The adult males within each community are frequently engaged in complex political activities involving scheming and physical intimidation in order to move up the dominance hierarchy. They develop short-term alliances with other males by mutual support, sharing meat, and **allogrooming** (grooming others). It isn't always the largest and strongest males who make it to the top of the hierarchy. Often teamwork used to frighten and impress is more effective than any one individual's muscles in achieving chimpanzee goals. This is an indication of their intelligence.

Chimpanzees are not the only primates that change group membership from time to time. For instance, adult rhesus macaque males usually must permanently leave the community of their birth and try to join others in order to find mates. This is not easy since they are not warmly welcomed in their adoptive troop. Group composition of some langur and baboon species also change as a result of the availability of food and mates. Evidently, none of these monkey species change group composition with the ease and frequency of chimpanzees. As a result, their societies are not usually referred to as fission-fusion types.

Social Group Pattern	**Primate Species Following This Pattern**
single female and her offspring	orangutans, some of the small nocturnal prosimians (mouse lemurs and galagos), and some humans
monogamous family group	some New World monkeys (titi monkeys), some prosimians (indris, tarsiers, and some pottos), the small Asian apes

	(gibbons, siamangs), and some humans
polyandrous family group	the smallest New World monkeys (marmosets and tamarins) and some humans
one-male-several-female group	hamadryas baboons, geladas, langurs, howler monkeys, gorillas, and some humans
multimale-multifemale group	savanna baboons, macaques, colobus, and some New World monkeys
Fission-fusion society	Chimpanzees

4.0 CONCLUSION

The different social groups in primate explain the kind of behavior they exhibit.

5.0 SUMMARY

Group behavior among primates is the most complex among all gregarious animals (animals that form groups, which also include gazelles, cattle, bison, zebras, and others).

Primates live in social groups that provide various benefits like food, protection, mates, learning of skills, grooming and parental care.

6.0 TUTOR-MARKED ASSIGNMENT:

1. Are Chimps Like Us?

2. Are there similarities between the behavior of nonhuman primates and humans?

3. Why Study Primate Behavior?

4. Can nonhuman primate behavior give us a clue to our behavior?

7.0 REFERENCES

•*www.slideshare.net/paulVMcDowell/primate-social-behavior-510637*

•*anthro.palomar.edu/behavior/behave_2.htm*

•*en.wikipedia.org/wiki/primatology*

Unit3. Various Forms of Social Behavior Found Among Primates

CONTENT

1.0 INTRODUCTION

Primates live in social groups that provide various benefits like food, protection, mates, learning of skills, grooming and parental care. Primates exhibit a lot of social behavior like grooming, foraging and feeding, tools making, parental care, sexual behavior and mate selection, territoriality, dominance hierarchy, agonistic behavior and warfare, communication and so on. All these behavioral act enhances the group for continuity and survival.

2.0 OBJECTIVES

At the end of this section the students should be able to

1. Explain the various forms of social behavior found among primates with useful examples

3.0 MAIN CONTENT

3.1 Grooming

All primates groom

One combs fur of another

Pick out dried skin, parasites

Main function: interaction to maintain social bonds

All primates but prosimians use fingers

We haven’t lost the grooming habit

All primates groom, from prosimians to monkeys to apes to us. They have cleaning functions, but among nonhuman primates, their primary function seems to reinforce bonds. Among chimps, grooming may entail currying favor from dominant males. As you can see in the lower photo, humans have not lost the grooming habit, as can be seen in every barbershop or beauty salon worldwide

3.2 Territoriality

Home range: area of cyclical migration

Core area: smaller unit which is the primary area of activity

Chimps defend their core area against other troops

These chimps are on patrol for that purpose

Baboons are more tolerant of baboons from other troops We seem not to have lost the territorial habit either. Here, a line of males patrol the boundaries of their territory in search of intruders. There is a core area, in which individuals conduct their main activities—hunting, foraging for food, sleeping, and so on. There is also a home range, within which they migrate on a cyclical basis. Baboons are more tolerant of other troops than chimps are.

3.3 Communication

Gibbon calls (like this one) are closed

Danger: high-pitched shouts

Assembling: clatters and clicks

Chimps have some aspects of language

Kanzi—bonobo capable of making requests by pressing computer keys with symbols

Chimpanzees—able to use American Sign Language

Spoken language does not exist among nonhuman primates

Communication: Threats

Calls of greeting or threats when two troops meet

Threat gestures

Baboons: baring canines (top)

Chimpanzees

Slack jaw: sign of anger

Chimpanzee : Displays, screams (bottom), tearing vegetation

Reactions of target individuals :

Grimacing; crouching; presenting rear end

Communication: Reconciliation

Embracing

Extending hand for reassurance (top)

Grooming (to curry favor)

Even kissing

Nonhuman primates communicate, but in various ways. Gibbons, like this one, have calls, but the communication system is closed. High-pitched shouts, for example, indicate danger, whereas clatters and clicks might mean “come here, boys!” They cannot be combined to create a third meaning. On the other hand, chimps and gorillas are able to use their variant of American Sign Language, and can create new signals with new meaning—their system is open, although limited. Koko the gorilla, Kanzi the bonobo, and Washoe the chimp are three classic examples of apes using language

Hoe do primates get their way. They do so, often by threats. Baboons threaten each other with an open “yawn” baring their canines (above). Among chimps, threats may involve screaming (below), staring at an adversary, and/or rushing about tearing vegetation and generally scaring the others. Submission may be indicating with a grimace, crouching, or presenting the rear end to the victor.

After an encounter, chimps seek reconciliation, even the dominant male. Above, one chip extends his hand to offer friendship to the other one. Below, two chimps literally kiss and make up. Grooming is another part of the repertoire of reconciliation.

3.4 Dominance Hierarchies

Dominance hierarchies: system of rank among nonhuman primates

Here, the alpha chimp touches the back of the lower ranked one (top)

Bonobo dominance behavior centers on females (bottom)

Sons' hierarchy depends on that of their mothers

All primates have dominance hierarchies of some short. In the top photo, one chimp asserts its lordship over another individual. Chimps do shift in who is the top chimp. In Gombe, Freud was the alpha male, then his brother Frodo use bullying to displace Freud, who was getting ill. Then, having had enough bullying, the other chimps kicked out Frodo. Baboons have more rigid hierarchies. Bonobos (below) have another system. The females form a hierarchy, and they pass it down to their sons. Yet, ironically, sisterhood is not possible. For one thing, there is no sisterhood. Females leave their troops to join another one, and the hierarchy is formed among total strangers.

3.5 Sexual Behavior: Individual

Estrus: cyclical female receptivity

Swelling of sexual skin among monkeys and some apes (such as this hamadryas baboon)

Receptivity longer among bonobos and humans

Sexual positioning in copulation

Most primates: male copulates with female from rear

Bonobos and human: frontal (ventro-ventral) copulation, as between this couple

Sexual Behavior: Partners

Gibbons form lifetime monogamous pairs (top)

Other species:

Harems among baboons and gorillas (such as these two females, bottom)

Multiple male-female sexuality among chimpanzees and especially bonobos

“Homosexual” behavior found among bonobos Like all mammals, primates reproduce sexually. In some species, such as baboons, females in estrus (i.e. in heat) are visibly so. Here, this female baboon’s rear end is red and swollen. Mating is seasonal. In other species, like bonobos, the female is almost always receptive. As you can see n the lower photo, bonobos copulate front-to-front, as humans do. Sex is one way to defuse tension among bonobos, and it is often homosexual as well as heterosexual.

Sexual partnerships run the spectrum. Gibbons are monogamou s, as the upper photo shows; they form lifetime pairs. Baboons and gorillas both form harems: one male, two or more females, as shown in the lower photograph. Still others are promiscuous; chimpanzee and especially bonobos. Some may practice homosexuality; bonobos can be either, and usually are

3.6 Phases of Growth

Newborns: cling to mother’s stomach

Up to a year: start riding mother’s back

Juveniles form play groups, a good way to learn basic skills

Juveniles may also show empathy, as with this distressed adult

Imitative behavior gradually integrates subadults into the troop

Typically, among both monkeys and ape, newborns learn to cling to the mother’s stomach; after a year or so, infants ride on their mother’s back, jockey fashion (upper photograph). As infants become juveniles, they do what human juveniles do—they play. Play behavior, especially in groups, helps them to learn basic skills and to become part of the troop. As the bottom photo shows, juveniles are not without empathy; here, a juvenile tries to console a distressed adult.

3.7 Foraging and Sharing

Prosimians: insects and plant foods

Most anthropoids: roots, fruits, seeds—some species eat meat of small animals

Gorillas: strict vegetarians

Chimpanzees: often cooperate in stalking, killing prey, and sharing the meat

Bonobos: Share food of all kinds

Yes, Chimps do eat meat

Chimps feeding on red colobus monkey

About 10% of these monkeys are killed by chimps in the Gombe reserve

All primates, including our ancestors up to 10,000 years ago, forage for food. Some hunt, but most of the diet consists of nuts, fruits, roots, leafy greens, and others. Gorillas, despite their fearsome appearance to some people, are strict vegetarians. Chimpanzees, on the other hand, are omnivores: they eat both meat and plant foods when they hunt; they often cooperate in groups (see next slide). Bonobos are also omnivores, but do not eat the volume of meat that chimps do.

Chimps in both east and West Africa have made hunting monkeys, especially red colobus monkeys (photo) a fine science. Primatologists have described two hunting styles: a somewhat cooperative free-for-all in Gombe, whereby everyone cooperates, but out of self-interest. As many as 70 colobus monkeys are taken every year. In the western rainforest of Tai, chimps are organized into those who case the monkeys while others block the escape routes. The density of the forest requires better organization.

3.8 Tool Making and Tool Use

Chimpanzees at Gombe are famous for termite fishing with twigs

They also use leaves as sponge

May be culturally derived:

Chimps in West Africa crack nuts but don't fish for termites

Bonobos make rain hats from leaves

Orangutans also use tools

Gorillas and gibbons do not make or use tools—so far as we know

Tool Making and Use: Chimps are also tool makers and users. When she first started observing the chimps at Gombe, Jane Goodall discovered that chimps fish for termites at mounds the insects construct. The tool making showed their ability to plan ahead: strip a twig of its leaves, insert the stick into the hill, then extract the stick with the termites clinging onto it and lick them off. Chimps in Tai, on the other hand, do not fish for termites, but rather crack nuts using rocks or heavy branches; Gombe chimps do not crack nuts, though termites and nuts are abundant in both places. This suggests that chimps have at least the rudiments of culture.

Tool-making behaviors of other species are various. Bonobos make rain hats; orangutans use tools as well. However, neither gibbons nor gorillas have been observed to make or use tools other species:

3.9 Agonistic Behavior and Warfare

Agonistic behavior characteristic of all species

mostly over mating females

competing for dominance

Primates were once thought incapable of killing their own kind.

Conflict: Comparing Chimps and Bonobos

Chimpanzees

Warfare actually was observed between one troop and a breakaway group.

Cannibalism observed and reported

Bonobos

Frequent sexual contact between sexes and within one sex

Philosophy: “Make love, not war” All species of primate (including us—are you shocked?} engage in conflict; agonistic behavior has been observed for all species of primates, and, for that matter, almost all animals. Among primates, the conflict is mostly over females or for dominance. Fights are rarely fatal; sooner or later, one gives up the fight. Until 1975, it was thought that chimps, among other primates, were in capable of killing their own kind. .

In the past, chimpanzees were thought to be gentle, if rambunctious creatures. Then in 1973, the troop Goodall was observing spit into two groups. Two years later, the larger group hunted down the smaller troop and over the next two years, exterminated it. Another development is cannibalism, also observed by Goodall and in another troop in Mihale, located south of Gombe. In contract, bonobos use another technique to settle conflicts; they use sex rather than fighting to settle issues. Male-male, male-female, or female-female—it makes no difference; all three types of pairs mate.

4.0 CONCLUSION

Various forms of social behavior is carried out by primates.

5.0 SUMMARY

Social behavior has evolved independently in many species of animals; invertebrates as well as vertebrates have complex social organization. Group behavior among primates is the most complex among all gregarious animals (animals that form groups, which also include gazelles, cattle, bison, zebras, and others).

Primates live in social groups that provide various benefits like food, protection, mates, learning of skills, grooming and parental care.

6.0 TUTOR-MARKED ASSIGNMENT:

1. Explain the various forms of social behavior found among primates.

2. Are there similarities between the behavior of nonhuman primates and humans?

7.0 REFERENCES

•www.slideshare.net/paulVMcDowell/primate-social-behavior-510637

•anthro.palomar.edu/behavior/behave_2.htm

•en.wikipedia.org/wiki/primatology

MODULE 8: HIERARCHICAL ORGANIZATION

Unit1: Definition, Visualization and Common models of hierarchical organization

CONTENT

1.0 INTRODUCTION

A hierarchical organization is an organizational structure where every entity in the organization, except one, is subordinates to a single other entity. This arrangement is a form of a hierarchy. In an organization, the hierarchy usually consists of a singular/group of power at the top with subsequent levels of power beneath them. This is the dominant mode of organization among large organizations; most corporations, governments, and organized religions are hierarchical organizations with different levels of management, power or authority. For example, the broad, top-level overview of the general organization of the Catholic Church consists of the Pope, then the Cardinals, then the Archbishops, and so on.

Members of hierarchical organizational structures chiefly communicate with their immediate superior and with their immediate subordinates. Structuring organizations in this way is useful partly because it can reduce the communication overhead by limiting information flow; this is also its major limitation

2.0 OBJECTIVES

At the end of this lecture the student should be able to

1. Understand the meaning of hierarchical organization

2. Give various examples and models of hierarchical organization.

3. Identify the advantages and disadvantages of this structure of organization

3.0 MAIN CONTENTS:

3.1 DEFINITION

Common, pyramid-like organization where one person is in charge of a functional area (engineering, finance, marketing) with one or more subordinates handling the sub-functions. In a hierarchical organization (whether business, military, political, or religious) higher levels imply greater superiority and domination than the lower ones, and the chain of command extends straight from the top to the bottom.

3.2 Visualization

A hierarchy is typically visualized as a pyramid, where the height of the ranking or person depicts their power status and the width of that level represents how many people or business divisions are at that level relative to the whole—the highest-ranking people are at the apex, and there are very few of them; the base may include thousands of people who have no subordinates). These hierarchies are typically depicted with a tree or triangle diagram, creating an organizational chart or organigram. Those nearest the top have more power than those nearest the bottom, and there being fewer people at the top then at the bottom. As a result, superiors in a hierarchy generally have higher status and command greater rewards than their subordinates.

3.3 Common Models

All governments and most companies have similar structures. Traditionally, the monarch was the pinnacle of the state. In many countries, feudalism and manorialism provided a formal social structure that established hierarchical links at every level of society, with the monarch at the top.

In modern post-feudal states the nominal top of the hierarchy still remains the head of state, which may be a president or a constitutional monarch, although in many modern states the powers of the head of state are delegated among different bodies. Below the head, there is commonly a senate, parliament or congress, which in turn often delegates the day-to-day running of the country to a prime minister. In many democracies, the people are considered to be the notional top of the hierarchy, over the head of state; in reality, the people's power is restricted to voting in elections.

In business, the business owner traditionally occupied the pinnacle of the organization. In most modern large companies, there is now no longer a single dominant shareholder, and the collective power of the business owners is for most purposes delegated to a board of directors, which in turn delegates the day-to-day running of the company to a managing director or CEO. Again, although the shareholders of the company are the nominal top of the hierarchy, in reality many companies are run at least in part as personal fiefdoms by their management; corporate governance rules are an attempt to mitigate this tendency.

4.0 CONCLUSION

It is common in social animals to form hierarchical structure

5.0 SUMMARY

Many animal species live in groups that provide various benefits. Groups range from simple aggregations to more complex social organizations or societies. Some animals organize themselves in hierarchies which rank members in order from the most dominant individual to the most subordinate individual. Once the hierarchy is established, agonistic behavior is reduced in the group.

6.0 TUTOR- MARKED ASSIGNMENT

1. What do you understand the term hierarchical organization?

7.0 REFERENCES

•Zhao, Rosson, Rosson (2007). The Future of Work: What Does Online Community Have to Do with It? 40th Annual Hawaii International Conference on System Sciences (HICSS'07)

•http://en.wikipedia.org/wiki/Hierarchical_organization

•Miller, S.A. and Harley, J.B. (1999): Zoology (Fourth Edition). WCB McGraw-Hill, Boston

Unit2. Studies of hierarchical organizations, Criticism and alternatives; Simple illustration of hierarchical and Dominance Hierarchies

CONTENT

6.0 Tutor-marked assignment

7.0 References

1.0 INTRODUCTION

Hierarchiology, although a relatively recent discipline, appears to have great applicability to the fields of public and private administration. Hierarchiology is the term coined by Dr. Laurence J. Peter, originator of the Peter Principle described in his humorous book of the same name, to refer to the study of hierarchical organizations and the behavior of their members. Some authors criticize this act and suggested alternative options.

2.0 OBJECTIVES

At the end of this section the students should know

1. The people that actually studied the science of hierarchical organization
2. Be able to criticize this organizational structure and provide useful alternatives

3.0 MAIN CONTENT

3.1 Studies of hierarchical organizations

The organizational development theorist Elliott Jacques identified a special role for hierarchy in his concept of requisite organization.

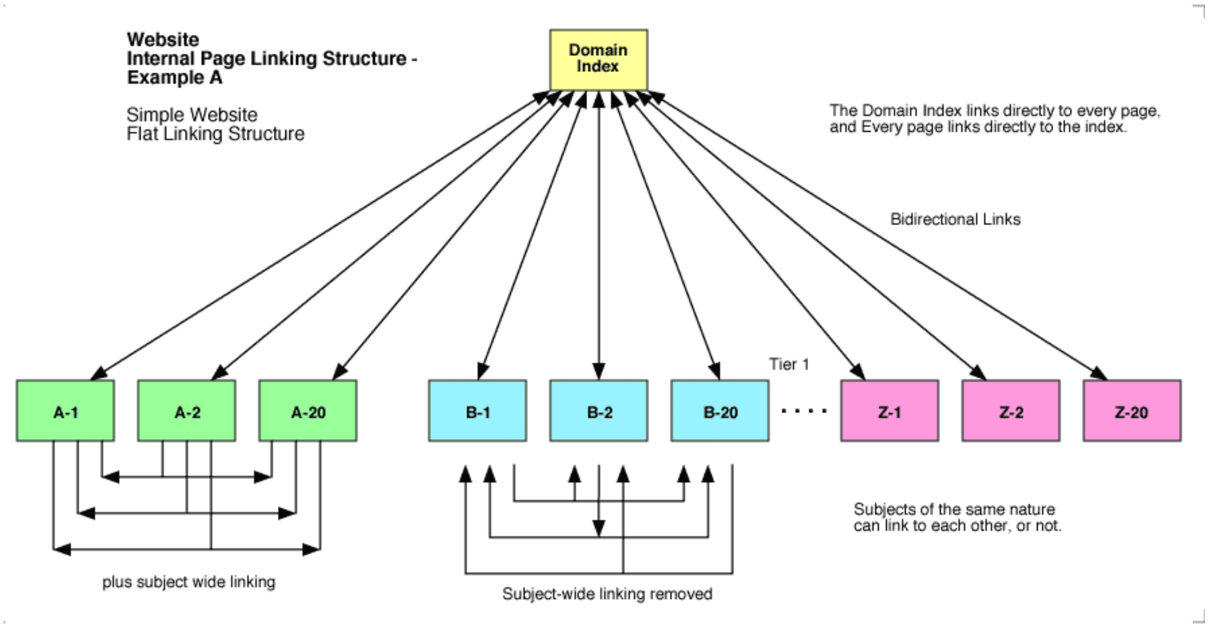
The iron law of oligarchy, introduced by Robert Michel, describes the inevitable tendency of hierarchical organizations to become oligarchic in their decision making.

Hierarchiology is the term coined by Dr. Laurence J. Peter, originator of the Peter Principle described in his humorous book of the same name, to refer to the study of hierarchical organizations and the behavior of their members.

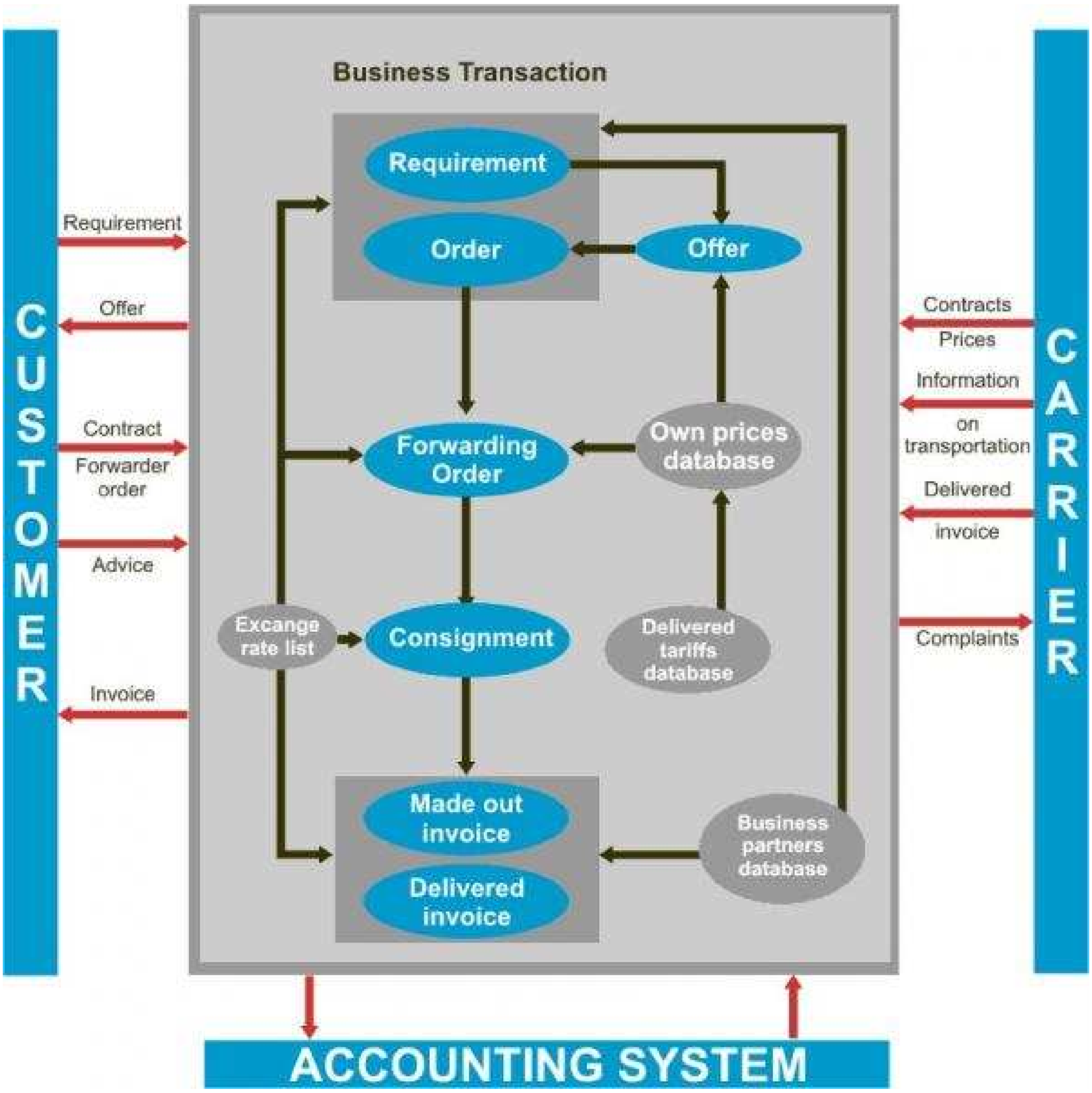
Having formulated the Principle, I discovered that I had inadvertently founded a new science, hierarchiology, the study of hierarchies. The term hierarchy was originally used to describe the system of church government by priests graded into ranks. The contemporary meaning includes any organization whose members or employees are arranged in order of rank, grade or class. Hierarchiology, although a relatively recent discipline, appears to have great applicability to the fields of public and private administration.

—Dr. Laurence J. Peter and Raymond Hull, The Peter Principle: Why Things Always Go Wrong

The IRG Solution - hierarchical incompetence and how to overcome it argued that hierarchies were inherently incompetent, and were only able to function due to large amounts of informal lateral communication fostered by private informal networks.



Example A - Small web site - Flat linking structure


Business Transaction
Requirement
Order
Offer
Forwarding Order
Own prices database
Excange rate list
Consignment
Delivered tariffs database
Made out invoice
Delivered invoice
Business partners database
CUSTOMER
Requirement
Offer
Contract
Forwarder order
Advice
Invoice
CARRIER
Contracts
Prices
Information
on transportation
Delivered
invoice
Complaints
ACCOUNTING SYSTEM

3.2 Criticism and Alternatives

In the work of diverse theorists such as William James (1842-1910), Michel Foucault (1926-1984) and Hayden White, important critiques of hierarchical epistemology are advanced. James famously asserts in his work "Radical Empiricism" that clear distinctions of type and category are a constant but unwritten goal of scientific reasoning, so that when they are discovered, success is declared. But if aspects of the world are organized differently, involving inherent and intractable ambiguities, then scientific questions are often considered unresolved. A hesitation to declare success upon the discovery of ambiguities leaves hierarchy at an artificial and subjective disadvantage in the scope of human knowledge. This bias is an artifact of an aesthetic or pedagogical preference for hierarchy, and not necessarily an expression of objective observation.

Hierarchies and hierarchical thinking has been criticized by many people, including Susan McClary and one political philosophy which is vehemently opposed to hierarchical organization: anarchism is generally opposed to hierarchical organization in any form of human relations. Hierarchy is the most commonly proposed alternative to hierarchy and this has been combined with responsible autonomy by Gerard Fairtlough in his work on Triarchy theory.

Amidst constant innovation in information and communication technologies, hierarchical authority structures are giving way to greater decision-making latitude for individuals and more flexible definitions of job activities and this new style of work presents a challenge to existing organizational forms, with some research studies contrasting traditional organizational forms against groups that operate as online communities that are characterized by personal motivation and the satisfaction of making one's own decisions.

3.2.1Dominance Hierarchies

In dominance hierarchies, a group of animals is organized so that some members of the group have greater access to recourses, such as food or mates than others. Those near the top of the order have first choice of recourses, whereas those near the bottom go last and may do without if resources are in short supply. An example of dominance hierarchy is the pecking order of chickens in pen. When chickens are placed together, they fight among themselves until a linear hierarchy of dominance is established. Higher-ranked chickens are among the first to eat and may peck lower–ranked chickens. Once the hierarchy is set, peaceful coexistence is possible. Occasional fights will occur if bird tries to move up in the order.

Dominance hierarchies exist in many vertebrate groups, the most common being in the form of linear relationships, although triangular relationships may form. In baboons, the strongest male is usually highest in the rank order. But sometimes, older males may form coalitions to subdue a stronger male and lead the troop.

All primates have dominance hierarchies of some short. One chimp asserts its lordship over another individual. Chimps do shift in who is the top chimp. In Gombe, Freud was the alpha male, then his brother Frodo use bullying to displace Freud, who was getting ill. Then, having had enough bullying, the other chimps kicked out Frodo. Baboons have more rigid hierarchies. Bonobos (below) have another system. The females form a hierarchy, and they pass it down to their sons. Yet, ironically, sisterhood is not possible. For one thing, there is no sisterhood. Females leave their troops to join another one, and the hierarchy is formed among total strangers.

4.0 CONCLUSION

Some animals organize themselves in hierarchies which rank members in order from the most dominant individual to the most subordinate individual. This organization makes administration easier in a society.

5.0 SUMMARY

Many animal species live in groups that provide various benefits. Groups range from simple aggregations to more complex social organizations or societies. Some animals organize themselves in hierarchies which rank members in order from the most dominant individual to the most subordinate individual. Once the hierarchy is established, agonistic behavior is reduced in the group.

6.0 TUTOR- MARKED ASSIGNMENT

1. How was this hierarchical organization criticized and what are the alternatives

2. How does a dominance hierarchy become established in a group of animals?

3. Give an annotated diagram of hierarchical organization

7.0 REFERENCES

•Zhao, Rosson, Rosson (2007). The Future of Work: What Does Online Community Have to Do with It? 40th Annual Hawaii International Conference on System Sciences (HICSS'07)

•http://en.wikipedia.org/wiki/Hierarchical_organization

• Miller, S.A. and Harley, J.B. (1999): Zoology (Fourth Edition). WCB McGraw-Hill, Boston

MODULE 9: PHYSIOLOGY OF BEHAVIOR

Unit 1: Proximate and ultimate causes and the four approaches to animal behavior

CONTENT

1.0 INTRODUCTION

Behavior is the varied activities that an animal perform during its lifetime. Internal physiological conditions, environmental stimuli and social situations influence specific behavioral responses. Animals are faced with two key problems finding food and a place to live. The evolution of various social systems, in which animals live in groups, affects many aspects of their behavior.

DEFINITION: Animal behavior refers to the activities animals perform during their lifetime, including locomotion, feeding, breeding, capture of prey, avoidance of predators and social behavior. Animals send signals, respond to signals or stimuli, carry out maintenance behavior, make choices and interact with one another.

2.0 OBJECTIVES

At the end of the lecture the students should be able to:

1. Understand the meaning of behavior and causes of behaviorial changes in animals.

2. Identify the different factors that influence the behavior of an animals

3.0 MAIN CONTENT

3.1 The Four Approaches to Animal Behavior

Naturalists and philosophers have observed animal behavior for centuries. Only in the last century, however has there been significant progress in understanding this behavior.

One approach to the study of animal behavior is comparative psychology. Comparative psychologists emphasize studies of the genetic, neural and hormonal bases f animal behavior. Psychologists conduct experimental studies in both laboratory and field settings, that relate to animal learning and to development behavior. They explore how animals receive information and the processes and nature of the behavior patterns constituting the animals' responses to the surroundings.

Ethology is the study of animal behavior that focuses on evolution and natural environment. The leaders of this approach have been Konrad Lorenz, Niko Tinbergen and Karl von Frisch, who were awarded the Noble price in physiology or Medicine in 1973. Ethologists observe the behavior of a variety of animals in their natural environment and study the behavior of closely related species to consider the evolution and origin of certain behavior patterns. Ethologists rarely deal with learning and are interested instead in animal communication, mating behavior and social behavior.

Behavioral ecology emphasizes the ecological aspects of animal behavior. Predator-prey interaction, foraging strategies, reproductive strategies, habitat selection intraspecific and interspecific competition and social behavior are topics of interest to behavioral ecologists.

Sociobiology is the study of the evolution of social behavior. It combines many aspects of ethology and behavioral ecology. Sociobiologists emphasize the importance of natural selection on individuals living in group.

3.2 Causes of behavior

There are two major causes of behavior namely **PROXIMATE AND ULTIMATE CAUSES**

3.2.1. Proximate causation - immediate causes. This explains how behavior works - what stimulates behavior to occur. It could be studied by measuring or describing the stimuli that elicit behavior. It involves Internal - physiological events (hormones, nervous system) and External - environmental stimuli like changes in daylength

3.2.2. Ultimate causation - historical explanations: this explains why a behavior evolved. It is studied by measuring influence on survival or reproduction Example - bird migration - birds that migrate have a selective advantage over birds that don't/didn't, selected for over time, could be due to long term climate changes, glaciation, disease, taking advantage of food sources, etc.

Behavioral scientists frequently ask, “Why do animals do what they do?” more immediate ecological and physiological causes of behavior, such as eating to satisfy hunger, are called proximate causes. Another level of causation in behavior occurs on the evolutionary time scale and that is of ultimate causes. For example, a display not only attracts a male, but also increases the likelihood of passing genetic information to the next generation.

Timing of behavior

circaannual - behavior occurs on a seasonal/annual basis

Examples - hibernation in bears, frogs, toads, salamanders bury themselves in mud during the winter

Circadian - behavior occurs on a daily basis

3.3 Components of Behavior

There are two Components of behavior

1. Nature/innate: instinct and genes determine behavior

2. Nurture/learned: experience and learning influence behavior

Two extremes are not mutually exclusive, but work together to influence behavior

Examples of Innate behavior

1) Nest building in Lovebirds by Dilger

Fischer's Lovebird - uses long strips of nest materials, carries in beak, one at a time

Peach-faced Lovebird - tucks several short strips in feathers

Hybrids - intermediate lengths of nest materials, clumsy behavior trying to tuck strips into feathers, later will carry strips in bill but will still try and tuck into feathers

2) Egg ejection by cuckoos (brood parasites)

3) Freezing behavior of nestling birds when exposed to silhouettes (raptors versus waterfowl)

4) Parental feeding - brood parasites take advantage of parents

5) Freezing behavior of nestlings

6) Incubation behavior of some birds (Oystercatchers)

7) Drosophila - 2 alleles of the Dg2 gene

sitter allele (sedentary behavior)

rover allele (hyperactive, mobile)

Components of Innate Behavior

FAP - fixed action pattern, all or none response

Sign stimulus - causes release of FAP

Examples - colors of stickleback males during mating, oystercatchers and eggs during incubation (super-normal releaser)

Nature of sign stimulus - usually an obvious aspect of the morphology: red mark on beak of Herring Gulls, red belly of Sticklebacks, detection of ultrasounds from bats by prey species of moths

Learned Behavior

Simple learning - habituation, species of prey and the presence of predators. Lehrman's study of gull chick feeding behavior - how an instinct is learned

Learning and development - imprinting and Lorenz's classic experiments with Greylag Goose (critical period for learning) - geese forms social attachments shortly after birth , salmon and home stream, birds and breeding range, nesting materials, etc.

Sexual imprinting - Direct sexual behavior at member of one’s own species - cross-fostering studies, individuals raised by another species, recognizes foster species as its own when sexually mature, will attempt to mate with foster species

Imprinting in conservation biology - minimize/eliminate human presence while raising California Condors

Song learning in birds

White-crowned sparrows reared under 3 conditions: 1) normal, 2) deafened, 3) in isolation, critical period

Continuous song learning - mimic thrushes, starlings and mynahs, some parrots and Cardueline finches

Classical/Pavlovian conditioning

Animals make associations - Pavlov's dog associates bell with food, begins to salivate, can be extinguished and later followed by recovery (unconditioned stimulus - meat, unconditioned response - salivation, conditioned stimulus - bell, conditioned response - salivation)

Operant conditioning

Reward/punishment for behavioral response, rats bar press for food

Observational learning - social imitation

Insight Learning

Chickadees/tits and opening milk bottles

All examples of tool-using

Egyptian Vulture - uses rocks

Cocos Finch - uses splinters of wood

North American Gulls, Northwestern Crow - smash clams on sandy beaches

3.4 ANTHROPOMORPHISM

Anthropomorphism is the application of human characteristics to anything not human. In observations animals, assigning human feelings to animal behavior is not likely to be accurate, especially with invertebrate animals. Consider the example of placing an earthworm, on a fishhook. Does the fishhook hurt the earthworm, causing it to writhe in pain? Both of the descriptive words hurt and pain, are based on human experience and conscious awareness. A better explanation that reduces the anthropomorphic interpretation is that placing the earthworm on the hook stimulates certain receptors which generate nerve impulses that travel along reflex neural circuits. The impulses stimulate muscles that allow the worm to wriggle in an attempt to escape from the hook. This explanation more closely describes what has been observed and does not attempt to suggest what earthworm "feels."

4.0 CONCLUSION

Natural selection influences animal behavior just as it does other animal characteristics. Certain behavioral traits that allow animals to survive and reproduce are favored. Certain behavioral patterns require time for maturation, during which performance of behavior improves as parts of the nervous system and other structures complete development

5.0 SUMMARY

Animal behavior includes the many activities of an animal during its lifetime. Four approaches to the study of animal behavior are comparative psychology, ethology, behavioral ecology and sociobiology. Natural selection influences animal behavior just as it does other animal characteristics. Certain behavioral traits that allow animals to survive and reproduce are favored. Certain behavioral patterns require time for maturation, during which performance of behavior improves as parts of the nervous system and other structures complete development. Many behavior patterns require instinctive and learned components for efficient performance. In some instances, an animal may inherit a disposition to learn a specific behavior. Also, an animal may learn certain behavior patterns only during a specific sensitive period early in life.

6.0 TUTOR- MARKED ASSIGNMENT

1. What are the four ways to study animal behavior?

2. How would you differentiate proximate and ultimate causation?

3. Why is anthropomorphism a problem when describing the behavior of animals?

7.0 REFERENCES

•Campbell, N.A (1987): Biology. The Benjamin/Cummings publishing company, Inc, California 1101pp

•Miller, S.A. and Harley, J.B. (1999): Zoology (Fourth Edition). WCB McGraw-Hill, Boston

Unit 2: DEVELOPMENT OF BEHAVIOR

CONTENT

1.0 Introduction

2.0 Objectives

3.0 Main Content

- 3.1 Maturation
- 3.2 Instinct Learning Interactions
- 3.3 Imprinting

4.0 Examples of various documented behaviors in animals

- 4.1 Play Behavior

1.0 INTRODUCTION

Development of a normal behavior pattern requires the genes that code for the formation of the structure and organs involved in the behavior. For example, in some Higher animals, normal locomotion movements will not occur without proper development and growth of the limbs. This process requires some interaction with the animal's environment because proper nourishment, water balance and other factors must be maintained at some stages for normal development to occur properly.

2.0 OBJECTIVES

At the end of the lecture the students should be able to:

1. Know how behavior is being developed in animals

3.0 MAIN CONTENT

3.1 Maturation

Some behavior pattern appears only after a specific developmental stage or time. During maturation, performance of the behavior pattern improves as parts of the nervous system and other structures complete development. A classic example is tail movement in frog embryos that are near hatching. While still in the egg membranes, they start moving their tail as they would if they were swimming and movement coordination improves with time. These improved movements are due to maturation, not practice or experience.

3.2 Instinct Learning Interactions

In recent years, many behavioral scientists have concluded that both instinct and learning are important in animal behavior. Interaction of inherited (i.e. instinctive) and learned components shapes a number of behavior patterns. For example, young bobcats raised in isolation without the chance to catch live prey did not attack a white rat placed with them, unless the rat tried to escape. At first, their attacks were not efficient, but after some experience, they were seizing prey by the neck and rapidly killing them. Apparently, learning refines inherited components of this behavior. Under the normal conditions, the learning or experiences occur during play with littermates.

Another example involving instinctive and learned components to behavior is the nut-cracking behavior of squirrel. Squirrels gnaw and pry to open a nut. Inexperienced squirrels are not efficient; they gnaw and pry at random on the nut. Experienced squirrels, however, gnaw a furrow on the broad side, and then wedge their lower incisors into the furrow and crack the nut open

3.3 Imprinting

During imprinting, a young animal develops an attachment toward another animal or object. The attachment usually forms only during a specific critical period soon after hatching or birth and is not reversible. Imprinting is a rapid learning process that apparently occurs without reinforcement.

Konrad Lorenz (1903-1989) conducted experiments with geese in which he allowed the geese to imprint on him. The goslings followed him as though he was their mother. In nature, many species of birds in which the young can identify with or recognize their parents. They can then be led successfully to the nest or to water. Both visual and auditory cues are important in imprinting systems.

4.0 Examples of various documented behaviors in animals

4.1 Play Behavior

Young animals engage in play, precursors for adult behavior (e.g., fighting, sexual behavior, predation - cats, birds, Killer Whales), also stay in good physical condition

4.2 Migration

Definition - usually defined as regular, seasonal movements from one area to another (wintering area to a breeding area), seasons can be fall/spring in temperate areas and rainy versus dry in tropical areas

Examples

Waterfowl flyways - well documented, due in part to hunting regulated and studied by US Fish and Wildlife Service, State fish and game agencies

Arctic Tern, North Pole to South Pole

Some species of Gallinaceous and raptorial birds, altitudinal migration (valley to mountain peaks)

Salmon - return to native streams to breed after several years at sea

Deer and Caribou, African ungulates - mammals engaged overland

migrations

Some sharks, whales (northern oceans for calving, southern areas for breeding) and other marine mammals - engaged in long distance oceanic migrations

4.3 Navigation and Orientation

Animals use cues in the environment to guide them during migration, must orient and navigate

Orientation - organism is capable of detecting compass direction (N, S, E, W) using cues from the environment

Navigation - organism is capable of detecting its position as well as orientation, (N, S, E, W of something - river. ocean, mountain range)

Example - study of migration in European Startlings

Juveniles - displaced individuals were able to orient only, could not navigate (never corrected for their displacement)

Adults - displaced individuals were able to orient and navigate (adults did correct for their displacement)

Birds can use several cues from their environment for navigation - visual (sun, stars, visual landmarks) and magnetic cues

Emlen's classic study of Indigo Buntings and their use of star constellations during spring and fall migrations

4.4 Timing of behavior

circaannual - behavior occurs on a seasonal/annual basis

Examples - hibernation in bears, frogs, toads, salamanders bury themselves in mud during the winter circadian - behavior occurs on a daily basis

cues

endogenous - hormonal

exogenous - external cues from the environment

Example - bird migration caused by exogenous cues like decreasing/increasing daylight, picked up by eye and visual cortex; endogenous - pineal gland and brain processes daylight information, brain contacts endocrine system, alters timing of secretion of prolactin, corticosterone and leptin.

4.5 Predatory Behavior

Active pursuit - tarantula, scorpions, wasps, bats

Cooperative hunting

Wait and hide - web-building spiders, trap-door spider, many raptorial birds

Fishing by Angler Fish

Other - deception and camouflage

Anti-predatory Behavior

Batesian Mimicry

Mullerian mimicry

Camouflage, disruptive, cryptic coloration

Warning coloration

Maintenance Behavior

autopreening

allopreening

Behavioral Ecology - study of behavior in an ecological context, study ecological variables and relationship to behavior

Optimal foraging behavior - do species forage in an efficient manner that maximizes benefits and minimizes costs

1) Example - Zach's study of Northwestern Crows dropping shellfish to break the hard outer shell and make available the clam for food, experimenter dropped shells from various height to find the optimal height necessary to break shells, observed crows dropping shells and found their average height of 5.23 m was similar to the experimenter's optimal height

2) Example - Sunfish, provide predator with prey of different sizes and different densities, fish respond by foraging optimally (taking the most energetically rich prey under the appropriate conditions)

4.0 CONCLUSION.

Natural selection influences animal behavior just as it does other animal characteristics. Certain behavioral traits that allow animals to survive and reproduce are favored. Certain behavioral patterns require time for maturation,

5.0 SUMMARY

Animal behavior includes the many activities of an animal during its lifetime. Natural selection influences animal behavior just as it does other animal characteristics. Certain behavioral traits that allow animals to survive and reproduce are favored. Certain behavioral patterns require time for maturation, during which performance of behavior improves as parts of the nervous system and other structures complete development. Many behavior patterns require instinctive and learned components for efficient performance. In some instances, an animal may inherit a disposition to learn a specific behavior. Also, an animal may learn certain behavior patterns only during a specific sensitive period early in life.

6.0 TUTOR- MARKED ASSIGNMENT

1 what happens during the maturation of a behavior pattern?

2 What interactions are there between inherited and learned components of behavior?

7.0 REFERENCES

•Campbell, N.A (1987): Biology. The Benjamin/Cummings publishing company, Inc, California 1101pp

•Miller, S.A. and Harley, J.B. (1999): Zoology (Fourth Edition). WCB McGraw-Hill, Boston

MODULE 10: HABITAT SELECTION, HOMING AND NAVIGATION

Unit 1 Habitat Selection

CONTENTS

1.0 INTRODUCTION

Habitat selection is the choice by an organism of a particular habitat in preference to others. E.g may fly nymphs inhabit the underside of stones in fast-flowing streams and burrow in sediment in still water while habitat is a place where species get what they need to survive: food, water, cover, and a place to raise young. In other words, a habitat is a plant or animal's home. For people, habitat might stretch from their home (where they have water, cover and a place to raise young), to the supermarket (where they buy food). All the places people go to get what they need to survive can be considered part of their habitat.

2.0 OBJECTIVES:

By the end of this unit, you should be able to;

1. Define habitat and habitat selection
2. Explain different types of habitat.
3. Give some example of animals and explain their habitat selected.

3.0 Main Content

3.1 Types of Habitat

The habitats are:

1. Polar/arctic areas
2. Mountains
3. Oceans
4. Deserts
5. Savannah/grasslands/prairies
6. Tropical rainforest

7. Woodland/forest
8. Tundra
9. Taiga
10. Wetland areas/marshes
11. Pond
12. Rivers/lakes
13. Coral reef
14. Deciduous forest
15. Tide pool
16. Cave

3.2 Forests

Forests are fascinating ecosystems. How can you recognize a forest? The defining feature of a forest is its dense growth of trees. But why do forests grow where they do? Generally speaking, two key variables dictate the geographical distribution of Earth's different habitat types: Humidity and temperature. Forests grow where there is enough water available to fulfill trees' needs. The extent of forest growth also depends on temperature ranges, soil nutrients, adequate growing season and altitude.

All of the forests in the continental United States are temperate forests (located between the boreal and sub-tropical zone). Eastern temperate forests tend to have cold winters and wet, hot summers. Deciduous trees (those that lose their leaves in the fall) like oak and maple thrive in these conditions. In fact, most eastern forests are defined by the mix of oak, maple, birch and other trees that grow there. These trees create a canopy that shades the forest floor and provides a variety of habitats for many creatures, such as gray squirrels, white-footed mice, white-tailed deer, blue jays. Deciduous trees are also found in continental Africa and Nigeria Southwest.

Generally speaking, deciduous trees dominate the forests of the Eastern United States, while coniferous trees (those that keep their leaves year-round) predominate in western forests. What kind of wildlife would you expect to live in the forests Western United States?

3.3 Grasslands

Grasslands are characterized as areas where grasses are the predominant vegetation and the subsoil is dry with seasonal moisture in the upper soil layers. Their evolution was shaped by periodic fires and the presence of grazing animals. These conditions resulted in the establishment of vast areas of grassland on all of the continents except Antarctica. Today, a quarter of the earth's land surface remains covered by this rapidly vanishing ecosystem. Example in Nigeria is Osun State extending to part of kwara / kogi.

All grasslands share several common traits. In general, the term grassland refers to land which:

- is dominated by grasses;
- occurs on flat or rolling terrain;
- has similar soils (alkaline, lots of organic matter, very fertile, and fine-grained);
- has soil that is almost completely covered by vegetation;

- commonly has fires and high winds (which lead to high evaporation rates and the spread of fires);
- is characterized by periods of rain followed by periods of drought.

3.4 Deserts

As different from one another as deserts of the world are, they all share one characteristic: they are very dry. Scientists define deserts as areas that get less than 10 inches of rainfall a year and have a very high rate of evaporation. If the annual evaporation rate of an area is higher than the annual amount of rainfall, the area is considered a desert. Evaporation rates are high because deserts tend to have very little cloud cover and strong winds.

Another characteristic of deserts is sporadic rainfall. If the limited rainfall in deserts fell a little at a time throughout the year, many deserts probably would not look much like deserts. Instead, they'd have a lot more vegetation. Rain doesn't fall evenly throughout the year in a desert, though. It usually comes in big bursts. In some deserts, none at all may fall for more than a year. And then a huge thunderstorm may dump over 5 inches all at once!

Deserts have some of the most variable temperatures of any places on earth. Because the desert skies are nearly cloudless, the temperatures during the day may sizzle. But without cloud cover to hold in the heat, it radiates into the atmosphere very quickly once the sun goes down. In some deserts, the temperature may drop as much as 77 degrees Fahrenheit in 12 hours. For example Bauchi and Maiduguri.

3.5 Wetlands

As the name implies, wetlands are areas where water is present at least part of the year, generally for at least a portion of the plant-growing season. In addition, wetland soils differ considerably from nearby or surrounding uplands. Hydric soils, found in wetlands, are wet, low in oxygen, and often black with muck. Finally, wetlands support plants — called hydrophytes — that are adapted to living in wet, oxygen-poor soils. Together, these water, soil and vegetation characteristics make up a broad definition for wetlands.

Though all wetlands contain water at least periodically, the volume of water and the amount of time a wetland is "wet" varies greatly. They also vary in size, from wading-pool sized vernal pools to thousands of acres along coastlines or rivers.

Wetlands are found all over North America, along coastlines, far inland, in rural areas, and even in the middle of well-populated urban areas. There are generally five kinds of areas where we find wetlands:

1. rivers;
2. near coasts and inland lakes;
3. in depressions where land is low compared to surrounding landscapes;
4. areas where groundwater seeps out of the ground, and;
5. in broad, flat areas that receive significant rainfall (such as the Everglades).

3. 6 Arctic Tundra

The arctic tundra is circumpolar, meaning that it is an ecosystem surrounding the polar region, above roughly 60 degrees north latitude. The Arctic circle occurs at 66 degrees north latitude.

In the tundra, short days for much of the year and a harsh cold climate result in a brief growing season of 50-60 days. By contrast, the growing season in temperate forests is about six months long and in tropical forests lasts the entire year.

Strong winter winds challenge the stability of any plants that grow more than an inch or two above ground surface. Below a thin layer of soil that thaws every summer is ground that remains frozen year-round, called permafrost. The permafrost may be very deep, reaching more than 1000 feet thick in some locations. Although the tundra receives less than ten inches of precipitation each year (which is why it is sometimes referred to as an arctic desert), there can be plenty of standing water when the upper layer of soil thaws each summer.

Due to its high latitude and the tilt of the earth, the arctic experiences light and temperature extremes throughout the calendar year. The plants and animals of the tundra must be adapted to face these challenges, including not only extremes of day length and temperatures, but also harsh winter winds, long periods of below-freezing temperatures, and permanently frozen ground.

3.7 Habitat selected by some animals

- African Elephant: Found in forests, grasslands, marshes, scrub, and semi-desert areas. Elephants live in a highly organized social structure referred to as a matriarchal herd. The herd is typically composed of up to ten females and their young. All of the females in the herd are directly related to the matriarch, who is typically the oldest and largest female. Males beyond the age of maturity are with the herd only during mating.

- Penguin: Tend to inhabit islands and remote landmasses that are relatively free from land predators. Some species spend nearly 75% of their life at sea. All penguins live south of the equator, from the icy waters of Antarctica to the tropical Galapagos Islands off the coast of Ecuador, almost astride the equator. Penguins are specialized marine birds adapted to living at sea. Some species spend as much as 75% of their lives in the sea - only coming ashore for breeding and molting. Penguin wings are paddle-like flippers used for swimming, not flying.
- Sea Stars: they are found from the bearing sea, usually resting on broken or solid rocks. They are usually found on gravel, rocks and sand in the low intertidal zone

4.0 CONCLUSION

In this unit you learnt:

I. Different habitats with their peculiarities like Wetlands , Deserts etc.

II. Habitat selected by different animals like Sea stars, Penguin and an Elephant

5.0 SUMMARY

Habitats are place where animals live therefore various types of habitats have been discussed. This will help us to know where animal live to perform their various activities like reproduction, feeding etc.

6.0 TUTOR-MARKED ASSIGNMENT

1. Explain the following Habitats: Coral reef, Deserts and wetland.
2. Explain habitat selected by the following animals: Hippo, Manatee, Ostrich and Giant panda

7.0 REFERENCES

•Miller, S.A. and Harley, J.B. (1999): Zoology (Fourth Edition). WCB McGraw-Hill, Boston

UNIT 2 Homing and Navigation

CONTENTS

5.0 Summary

6.0 Tutor-Marked Assignment

7.0 References/Further Readings

1.0 INTRODUCTION

Homing is the ability of certain animals to return to a given place when displaced from it, often over great distances. This may occur in any compass direction and at any season. Navigation clues used by homing animals are the sun angle, star patterns etc. very strong homing ability are found among birds seabirds and swallows eg. A Manx Shearwater (*Puffinus puffinus*) transported in a closed contain to a point about 5,500km (3,400miles) from its nest and returned to the nest in 12 ½ days.

Navigation means migration which is the movements of animals in large numbers from one place to another. In modern usage the term is usually restricted to regular, periodic movements of populations away from and back to their place of origin. A single round trip may take the entire lifetime of an individual, as with the Pacific salmon salmon , member of the Salmonidae, a family of marine fish that spawn in freshwater, including the salmons, the trouts, and the chars. Many authorities place the whitefish and the grayling among the Salmonidae, so similar are they in structure and habits. An individual may make the same trip repeatedly, as with many of the migratory birds and mammals. The animals may travel in groups along well-defined routes; or individuals may travel separately, congregating for breeding and then spreading out over a wide feeding area.

2.0 OBJECTIVES:

By the end of this unit, you should be able to;

1. Define homing, and navigation.
2. Explain navigation tools for studying navigation in animals.
3. Explain navigation mechanisms in animals.

3.0 MAIN CONTENT

3.1 Initiation of navigation/migration

Various factors determine the initiation of migration. In some cases external pressures—temperature, drought, food shortage—alone may cause the animals to seek better conditions. For example, most of the mule deer of Yellowstone Park, Wyo., migrate between summer and winter pastures, but those living near hot springs, where grazing is available all year, do not. In many species migration is initiated by a combination of physiological and external stimuli. In birds the migratory instinct is related to the cycle of enlargement of the reproductive organs in spring and their reduction in fall. Experiments have shown that variation in day length is the chief external stimulus for this cycle: light received by the eye affects production of a hormone by the anterior pituitary gland, which stimulates growth of the reproductive organs.

3.3 Orientation and navigation: Much work has been done on orientation and navigation in migrating animals, although the subject is still not well understood. Studies of salmon indicate that they depend on the olfactory sense to locate and return to their stream of origin. Herbivorous mammals often follow well-established trails and probably also use their sense of smell. Bats, whales, and seals use echolocation to navigate in the dark or underwater; in addition, some whales appear to take visual bearings on objects on the shore in their migrations.

Migratory birds are believed to use the stars, sun, and geographic features as guides. The probability that stellar navigation is used has been strengthened by experiments in planetariums indicating that birds navigate at least in part by the stars. Night-migrating birds are sometimes disoriented in prolonged heavy fog. Day-flying birds navigate by the sun and also make some use of geographic features, particularly of shorelines. It has long been proposed that birds perceive the direction of the earth's magnetic field and use it for navigation, but experimental evidence for that hypothesis is inconclusive. Most migratory birds travel within broad north-south air routes known as flyways. There are four major flyways in North America, called the Pacific, central, Mississippi, and Atlantic flyways. The space within the flyway used by a particular group of birds is called a corridor. Bird migration is not always in a north-south direction. Many European birds migrate in an east-west direction, wintering in the more temperate British Isles, and many mountain-dwelling birds descend to lower altitudes in winter. The breeding grounds of a bird species are regarded as its home territory. Some migratory birds winter only a few hundred miles from their breeding grounds, while others migrate between the cold or temperate zones of the two hemispheres. The longest journey is made by the arctic tern, common name for a sea bird of the Old and New Worlds, smaller than the related gull. Because of their graceful flight and their long pointed wings and forked tails, some terns are called sea swallows. They plunge headlong into the water to catch small fish.

The monarch butterfly has a north-south migration pattern that resembles that of many birds. One monarch population that inhabits northeastern and midwestern North America averages c.12 mph (19 kph) as it heads for the winter to Mexico's Sierra Madre mountains. Monarchs start the return trip in the spring, but they breed along the way and then die; the new generation completes the journey.

3.4 Tools form studying migration: The movements of migrating animals are often studied by tagging individuals. Bird banding has been carried on extensively since the 1920s; more recently there has been tagging of fishes, butterflies, and marine mammals. Use is now made of radar, sonar, and radio for following migrations, particularly those of marine animals. Radio transmitters attached to whales or seals emit signals that can be picked up by weather satellites at regular intervals.

3.5 Navigation Methods in animals

- The sun : starlings and ants navigate this way. Some birds can travel at night using the sun – theories suggested that they take a 'reading' from where the sun sets and use that to est their course.
- Landmarks: fly towards those mountains . head to the left a little when you see the ocean, nest in the first nice, looking tree you can find. E.g Whales traveling in the pacific ocean near the North American West.
- Moon and stars: Planetarium experiments' have proved that many birds rely on stars cues to figure out which way to migrate e.g indigo.
- Scent: scent can pin point specific location. E.g Salmon find their exact spawning ground through scent.
- Weather: wind condition are often used as supplementary navigation aids by birds.AW
- Magnetic field: the earth has a magnetic field that is usually undetectable to human who are not holding a compass. Bat and sea turtles use magnetic information to find their way. Bacteria even rely on the magnetic field to orient them.

4.0 CONCLUSION

In this unit you learnt:

I. About homing and navigation.
II. Navigation mechanisms in animals.
III. Tools for studying navigation .
IV. Orientation and navigation.

5.0 Summary

In animal behavior homing and navigation/migration are important issues that cannot be overemphasis. This topic had being dealt with but more information are still needed in the area of orientation and navigation.

6.0 Tutor-Marked Assignment

1. Explain seasonal migration/navigation in animals.
2. What are the initiation of navigation in animals.
3. Explain navigation methods in animals.

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UNIT 3: Behavioral and Neural Mechanisms of Homing and Migration/navigation in Birds

CONTENTS

1.0 INTRODUCTION

The extraordinary navigational ability of animals, which enables some species to carry out remarkably precise long-distance migrations and homing behavior, has fascinated natural historians for as long as animal behavior has been of interest. The observation of an arctic tern (Sterna paradisaea) carrying out a yearly migration between the arctic regions of the northern and southern hemisphere, a gray whale (Eschrichtius robustus) migrating between cold water feeding areas near Alaska and birthing sites around the Baja peninsula, a loggerhead sea turtle (Caretta caretta) migrating from feeding areas in the north Atlantic to egg deposition sites on the coastal beaches in tropical and sub-tropical North America, and a monarch butterfly (Danaus plexippus) making a one-way flight from temperate North America to their winter congregation site in central Mexico can seem mystifying (Figure 1). In fact, the seemingly routine ability of animals in general to accurately navigate space nurtures the speculation that the evolution of spatial cognitive abilities may have also served as pre-adaptation for other forms of cognition and associated brain mechanisms (e.g., O'Keefe, 1996). But how do animals navigate? The goal of this chapter is to review the behavioral mechanisms that are exploited by animals as they navigate large-scale, environmental space, as well present some findings related to brain mechanisms that support this ability. Because of their dramatic spatial behavior and extensive use as experimental subjects, we will concentrate our review on birds.

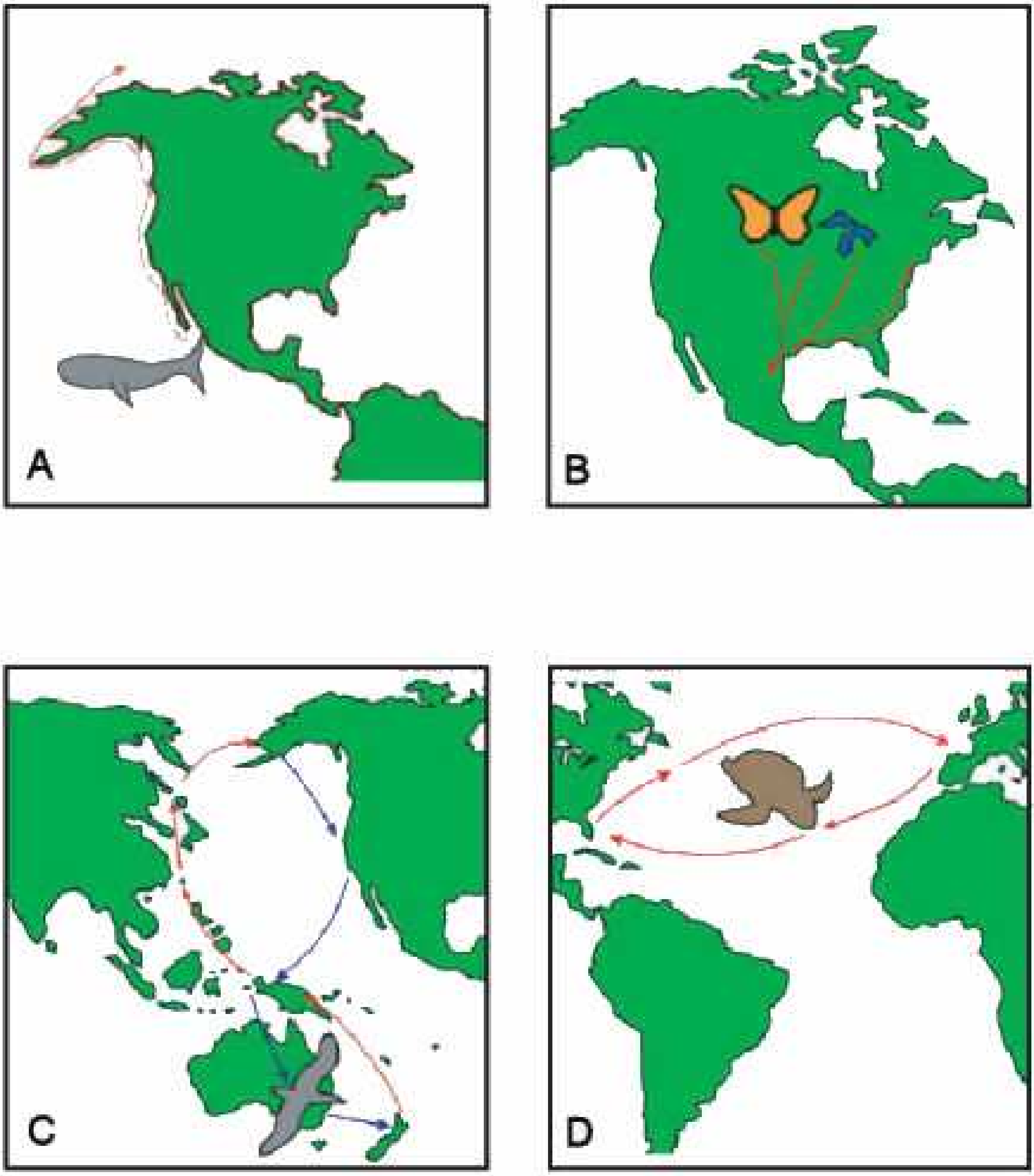
A
B
C
D

Figure 1. Global migratory paths of four exceptional navigators: A) gray whale (*Eschrichtius robustus*); B) monarch butterfly (*Danaus plexippus*); C) arctic tern (*Sterna paradisaea*); D) loggerhead sea turtle (*Caretta caretta*).

2.0 OBJECTIVES.

Students should be able to explain

1 Compass mechanisms in navigation using different cue like sun compass, star compass, geomagnetic compass etc.

2 Explain the phenomenon of getting there without knowing where and getting there and knowing where.

3 Navigation in avian space using laterized HF.

3.0 MAIN CONTENT

3.1 Compass Mechanisms

The ability to polarize space within some directional framework is essential if animals are to maintain movement in a constant direction with respect to the environment. Metaphorically, the challenge is similar to a human navigator needing to use a compass to identify directions in space and maintain a constant directional bearing while moving. Animal navigators possess biological compasses based on their sensitivity to the position of the sun projected on the horizon, or azimuth, stars and the earth's magnetic field. These compass mechanisms, although providing only directional information, form the basis from which richer, map-like representations of space can emerge.

Sun compass.

For diurnal animals with sensory access to the sky, the sun undoubtedly offers the richest source of information to define compass directions and orient movements in space whether it is a short-distance flight of a bee navigating between its hive and a food source or a diurnally migrating swallow making a journey of several thousand kms. The discovery and properties of the sun compass in birds were thoroughly investigated by numerous German researchers in the 1950s and ‘60s (Hoffmann, 1954; Kramer, 1952, 1959; Schmidt-Koenig 1958, 1961). Conceptually, the challenge the sun presents an animal that wants to maintain, for example, a southerly bearing is that the position of the sun in the sky changes during the course of the day. To continue moving south, a bird in the northern hemisphere would need to keep the easterly sun to its left in the morning, fly toward the southerly sun at midday and keep the westerly sun to its right in the evening. The changing azimuth of the sun across the day needs to be calibrated with respect to stable compass directions in space. Birds seem to carry out this conceptually challenging computation effortlessly. They do so by relying on their internal sense of time, which manifests itself in the form of endogenous circadian rhythms. Endogenous, biological circadian rhythms oscillate with a period of about 24 hours and are entrained or calibrated against the light-dark cycle of the environment. A point in time would correspond with a point in the cycle of the circadian rhythm. As such, reading off the circadian rhythm can be used to define time of day and therefore be used to read off a compass bearing from the sun's azimuth.

How do we know that the temporal calibration of the sun compass recruits endogenous circadian rhythms as the time giver? This was elegantly demonstrated in birds (homing pigeons and starlings) by placing experimental subjects in an environment where the light-dark cycle was shifted; for example, the lights in the room would come on at midnight and go off at noon basically advancing the day of the birds six hours relative to the light-dark cycle of the natural environment. Birds kept in these conditions for a week or so would experience a shift in their circadian rhythms; a rhythm would recalibrate to the changed light-dark cycle such that the circadian rhythm's morning would correspond or entrain to lights coming on, which would be midnight with respect to the natural environment. Imagine now a migratory bird or homing pigeon that would typically orient south held in the shifted light-dark cycle for a week. The bird would then be tested for its orientation, either by letting it fly (see Figure 3) or in a cage, during the natural morning when the sun is in the east. However, for our experimental bird the reading of its circadian rhythm would indicate that it is noon (remember its circadian rhythm has been shifted), and you would actually observe the bird orient not in the desired southerly direction but east (Figure 3)! Why? The midday sun is in the south, and according to the bird's internal rhythm, it is noon and it should fly toward the sun. But the sun is really in the east during the environmental morning; therefore movement toward the sun is actually an easterly movement and the wrong direction. It is this type of clock- or phase-shift experiment that has demonstrated that birds, and other animal groups including monarch butterflies (Mouritsen & Frost, 2002), use their internal sense of time to calibrate the movement of the sun in the sky. This enables them to use the sun as a stable reference to define compass directions in space.

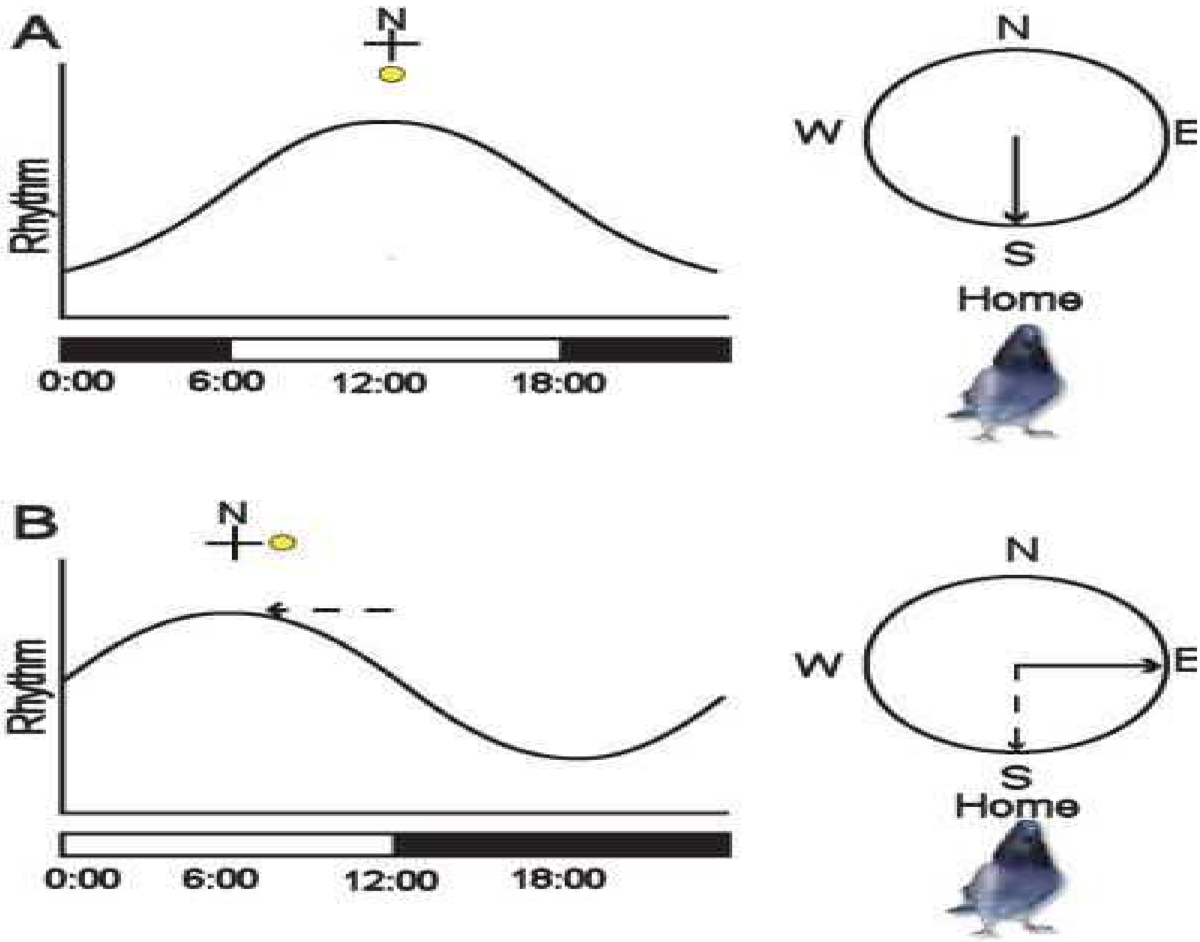

Figure 3. Effect of a phase-shift in the light-dark cycle on the sun compass orientation of homing pigeons. A.) Under natural conditions, the properties of a circadian rhythm would peak durin g midday and be associated with the sun in the south. A pigeon needing to fly south would then orient toward the sun at midday. B.) After being held for one week in a room where the light-dark cycle has been advanced by six hours, the peak in the circadian rhythm associated with midday would now occur during the natural morning. When released now during the natural morning, the pigeon's subjective noon, the same bird needing to fly south would again fly toward the sun, which would be east! Because of the change in the circadian rhythm, the peak in the circadian rhythm previously associated with midday and the sun in the south

would now actually correspond to environmental morning and the sun in the east.

To end our discussion of the sun compass, it should be mentioned that in addition to the disc of the sun, birds can also orient to patterns of skylight polarization derived from the sun. They can do so because the properties of skylight polarization change predictably with the changing position of the sun (e.g., Able, 1982). Bird visual sensitivity to ultraviolet light, like that of bees, may be important in detecting skylight polarization

Star compass.

The sun is not the only celestial body that can be exploited to define directions in space. Although nocturnal migrant birds can and do use the position of the setting sun to orient their nighttime migrations (Moore, 1987), they can also rely on the stars. But it is not just any star or cluster of stars that can be used to guide migration. It is the stars around the axis point of the night's sky apparent rotation that are preferentially relied on (Emlen, 1967). In the Northern Hemisphere, these would be circumpolar stars like those found in the constellations of the Big Dipper and Cassiopeia. However, this star compass has properties different from the sun compass. For example, orientation to the stars is not time compensated; phase shifting migrant birds do not alter their migratory orientation to the stars as they would sun compass orientation. It is also notable that whereas birds can be trained to use the sun compass to orient to a food source or other goal unrelated to migration or homing, orientation by the stars has only been demonstrated in the context of migration.

Geomagnetic compass.

The sensitivity of birds to visual orientation stimuli is not surprising given that they have well developed visual systems, and the idea of a sun and star compass was quickly embraced by researchers. This was not the case for the now well established behavioral ability of birds to orient by the earth's magnetic field. The problem with celestial cues is that there are times, in some places frequently, when the sky is obscured by clouds. Lengthy periods of time without access to celestial orientation cues could substantially compromise survival and reproduction if birds could not rely on some alternative compass mechanism. In areas familiar to a bird, known landmarks could serve as orientation cues. But what about a migrant flying high over completely unfamiliar terrain? A sensitivity to the earth's magnetic field, the central nervous representation of which still remains poorly understood, is the solution that natural selection has provided birds for the challenge of compass orientation without access to celestial cues. The experimental demonstration of geomagnetic orientation is apparent when either migrant birds or homing pigeons experience a shift in the ambient magnetic field lines under conditions when they would rely on non-visual cues for orientation. Simply, the birds shift their orientation in parallel with the altered magnetic field. One curious property of their magnetic compass is that it is not the kind of compass that people use while hiking; a so-called polarity compass. Rather, the bird geomagnetic compass is a so-called inclination compass by which north and south are defined by the angle the ambient magnetic field lines make with some vertical reference like gravity (Wiltschko & Wiltschko, 1972).

Ontogeny: The importance of experience.

This book is about spatial cognition, and the compass mechanisms described above would not usually be considered in discussions of animal cognition. At first glance they have an innate, reflexive quality that might be of more interest to an ethologist than a traditional comparative psychologist; however, as we will present below, spatial behaviors readily identified as relying on "cognitive" representations are grounded in these compass mechanisms under field conditions. But labeling these compass mechanisms as innate, even if they played no role in higher order spatial cognition, would be an oversimplification. Young birds must experience the sun's arc across the sky if they are to use it as a compass cue (Wiltschko & Wiltschko, 1981). Even seeing the movement of the sun during only one part of the day, for example the afternoon, enables young birds to make meaningful inferences about the sun's position at unfamiliar times of day, in this case the morning (Budzynski, Dyer, & Bingman, 2000). Birds must continually adjust to the changing solar ephemeris due to the shortening and lengthening of the day, a challenge compounded in migrants because of their geographical displacements.

For nocturnal migrants that use the stars to orient, similar experience is required. Failure to see the night sky during their first summer renders young birds unable to use the stars to guide their first migration. However, even experience with a night sky rotating around a false axis, like a planetarium sky rotating around Betelgeuse in Orion, or a completely artificial rotating night sky is sufficient to enable young birds to adopt the point of rotation as a migratory reference. In the northern hemisphere, young experimental birds during their first migration will orient away from the point of rotation, or "south," thus displaying meaningful migratory behavior (Emlen, 1970).

The type of deprivation experiment that easily identifies a crucial role for experience in shaping how birds use the sun and stars as a compass has not been carried out with respect to the earth's magnetic field. However, geomagnetic orientation is responsive to experience, and this is most apparent when conflicting information about the direction of migration is provided by the different compass mechanisms.

Compass mechanisms: Interactions among the different cues.

Some have described the orientation mechanisms of birds as "redundant." However, the term redundant, suggesting that the different sources of compass information provide identical information, is clearly inappropriate. There is nothing redundant about the earth's magnetic field when the sun or stars are obscured by clouds. Similarly, there is nothing redundant about the sun or stars for birds near the magnetic equator where the inclination of the earth's magnetic field would render geomagnetic orientation ambiguous. Multiple sources of compass information are clearly adaptive. But multiple sources also raise the question of whether orientation mechanisms are organized hierarchically; is one source of information preferentially used over the others, and might orientation to one cue be calibrated against another?

The answer to this question is not straightforward. For young birds learning about environmental orientation cues during their first summer, both North American and European species seem to preferentially rely on celestial cues, in particular the sun and patterns of skylight polarization, as a geographic reference to define north. Young birds will in fact use celestial cues to determine their migratory orientation with respect to the ambient magnetic field (Bingman, 1983). The use of celestial cues to calibrate orientation to the earth's magnetic field is adaptive because whereas the point of celestial rotation provides a temporally and spatially stable reference to define geographic compass directions, variation in the earth's magnetic field in space and time render it less reliable.

In experienced adult migrants, the relationship between geomagnetic and celestial orientation mechanisms depends on geographic location. In Europe, magnetic field information is preferentially used to calibrate orientation to celestial cues indicating an ontogenetic shift in the hierarchy among the orientation mechanisms (Wiltschko & Wiltschko, 1975). By contrast, in North America, at least at more northern latitudes, celestial information continues to be preferentially used to calibrate orientation to the ambient magnetic field (Able & Able, 1990; Cochran, Mouritsen, & Wikelski, 2004). These findings raise the question of why North American and European experienced migrants should behave differently? A likely answer is related to the relative stability of sun and geomagnetic information as birds migrate in time and space (Bingman, Budzynski, & Voggenhuber, 2003). As a bird migrates south in North America, changes in the angular distance between geomagnetic north and geographic north (declination) and changes in the compass direction of the setting sun are similar. There would be no advantage to shift away from the developmental pattern of preferentially relying on celestial cues. By contrast, as a bird migrates south in Europe, the angular distance between geomagnetic north and geographic north remains essentially constant while the direction of the setting sun changes as the migratory season progresses. Therefore, for European migrants, it would be adaptive to adopt the earth's magnetic as the preferential orientation cue once migration begins because of its stability as a directional reference

3.2 Map-like or Navigational Mechanisms

Compass mechanisms enable birds to define directions in space to guide oriented movement. However, a compass does not inform an organism of *where* it is in space. That birds have a map sense of where, in addition to a sense of direction, is readily attested to by their remarkable ability to return to the same breeding and wintering sites year after year, and their ability to do so even after dramatic experimental displacements; the most notable example of which is the homing ability of pigeons. However, not all goal navigation necessarily requires a map sense of where.

Getting there without knowing where.

Many typically diurnal songbirds will carry out their first migration at night alone in the absence of any stable social network. Yet the vast majority of these birds will reach their species typical over-wintering area often thousands of kms away. It is difficult to imagine that such birds have acquired map-like knowledge of their migratory route in the absence of any previous experience, so how do they succeed? The answer is a remarkable example of genetic programming (Berthold, 2003). Although the development of celestial sun and star compass mechanisms requires experience, the initial orientation angle a bird makes with respect to those cues seems to be innate. Once a bird is able to define directional space using the sun, stars or earth's magnetic field, how they orient on their first migration, although amenable to change, is innately represented in the nervous system. This innate directional preference can start a naïve migrant moving at least in the direction of its population specific over-wintering site. In fact, the genetic programming can be so sophisticated as to include appropriate changes in direction, for example, when some European species shift their orientation from southwest to south as they approach Africa (Wiltschko & Gwinner, 1974).

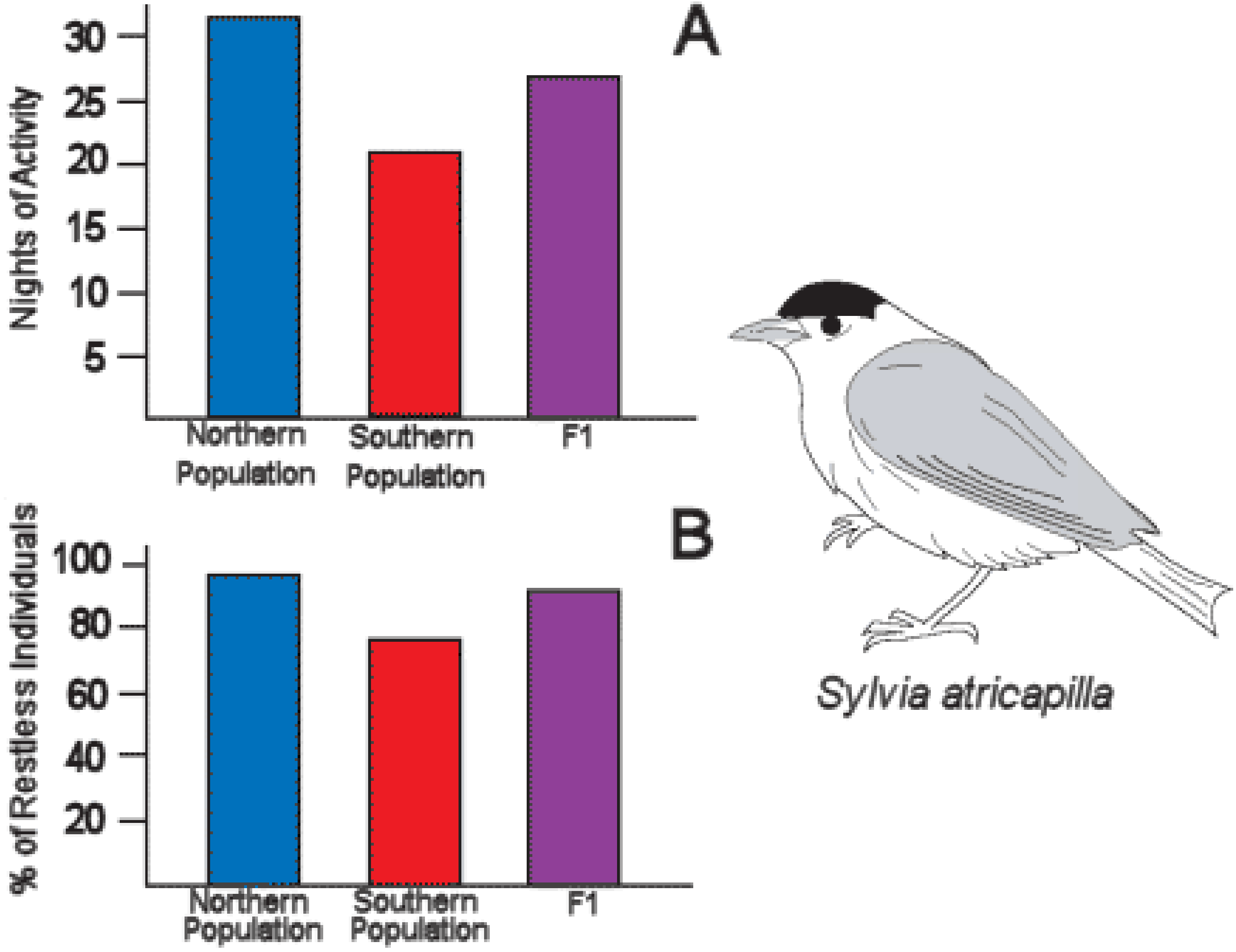

Figure 4. Hand-raised black caps from a northern population that naturally migrate farther (blue) display more nights with nocturnal migratory activity (A) and a greater percentage of migratory active individuals (B) than black caps from a more southern population (red). Crosses between northern and southern population individuals produce F1 birds (purple) that display intermediate levels of migratory behavior.

But what about distance, how does a naïve migrant know how far it should fly? The solution to this challenge seems to be time (Figure 4). The genetic program that appears to guide a young bird's first migration includes how long it should be active migrating (Berthold & Querner, 1981). This was elegantly demonstrated by studying different populations of European black caps (*Sylvia atricapilla*). Identically hand raised young black caps from a long-distance migratory northern population and a short-distance southerly population were tested in cages for the amount of nocturnal activity displayed during their first fall migration. Young birds from the northern population displayed substantially more migratory activity for a longer period of time during the fall compared to the southern population. Interesting from a genetic perspective, crosses of the northern and southern populations produced young that displayed intermediate levels of migratory activity. The genetic program that guides a young bird's first migration seems to control distance by controlling the amount of time a bird engages in migration.

In summary, a young bird on its first migration succeeds in navigating to its population specific over-wintering site without a map sense of where. A genetic program that defines which direction and how long to fly seems sufficient to get them close, and in the literature this type of navigation is often referred to as "vector navigation."

Getting there and knowing where.

As programmed as a young bird's first migration may be, experience provides them with opportunities for a far richer representation of space that enables a map-like sense of almost global proportions. This map sense can be used by birds to navigate to specific goal locations following displacements to unfamiliar places sometimes thousands of kms away. Layson albatrosses (*Phoebastria immutabilis*), white-crowned sparrows (*Zonotrichia leucophrys*), European starlings (*Sturnus vulgaris*) and routinely homing pigeons (*Columba livia*) are examples of species that have been used in displacement experiments, successfully demonstrating the ability to goal navigate over unfamiliar terrain.

For a bird to have a map-like representation of space, it needs to take advantage of some spatial variation in the quality of environmental stimuli. For a map of a familiar (experienced) environment, this variation may be the spatial relationship among landmarks; such landmarks would typically be visual (Biro, Meade, & Guilford, 2005; Gagliardo, Odetti, & Ioalé, 2001; Lipp et al., 2004) but potentially of other sensory modalities as well. In fact, the spatial relationship among the familiar landmarks and goal locations is likely represented in a directional framework defined by the sun or some other compass mechanism described above (Bingman & Jones, 1994). An important point is that a bird would not be able to extrapolate a map of familiar landmarks beyond the range of sensory contact with the landmarks. But the map sense of birds extends well beyond the boundaries of the sensory range of their experienced space.

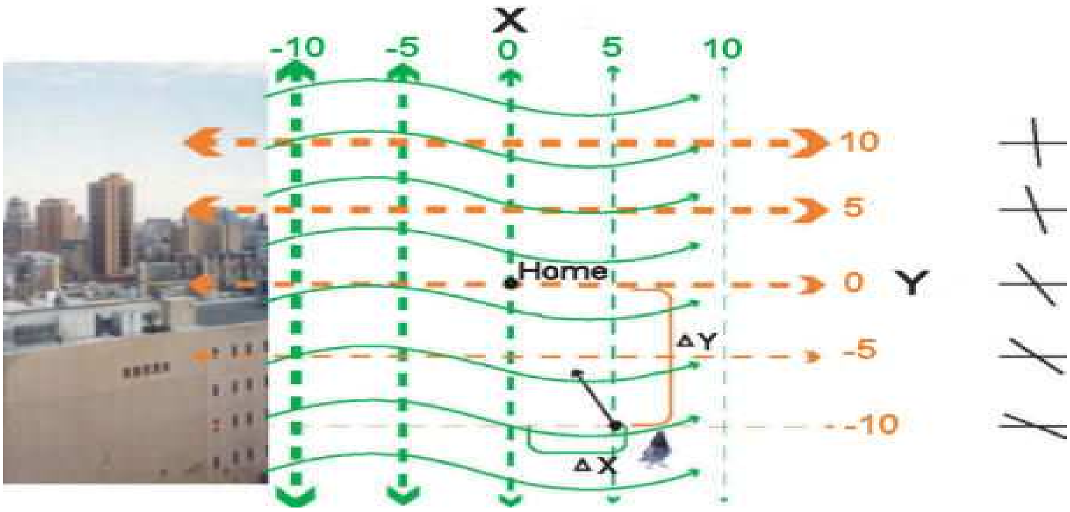

Figure 5. Conceptualization of Wallraff's gradient model of a navigational map. In this hypothetical example, variation in geomagnetic field inclination (far right black lines) increases to the north (Y axis, orange dashes of increasing thickness bracketed by arrows). By contrast, a source of atmospheric odors (city to the left) creates an odor gradient that decreases to the east (X axis, green dashes of decreasing thickness bracketed by arrows). A homing pigeon transported to a location southeast of home would measure

its relative displacement by determining the difference between the local atmospheric odor intensity and geomagnetic field inclination with the home values (relative values ranging from +10 to -10). Once the direction of displacement is determined, a homeward vector, or at least direction, can be computed.

The challenge of a map that extends beyond the range of experienced space is that when a bird is displaced beyond the boundaries of familiarity it must infer its location relative to a goal location. As conceptualized by Wallraff (1974), a bird's map of unfamiliar space could be based on the qualities of two environmental stimuli that vary *predictably* in space in a gradient like fashion (Figure 5). The gradient axes of the two stimuli must also intersect, not necessarily orthogonally, to create a bi-coordinate grid-like system. Using the homing pigeon as an example, let's assume that with respect to the home loft the quality of stimulus x increases to the north and decreases to the south, the quality of stimulus y decreases to the east and increases to the west. A pigeon learns the predictable properties of this variation during flights over familiar areas. More importantly, what a pigeon learns has the properties of an algorithm such that it can infer how the qualities of the stimuli change *beyond* its area of familiarity. When a pigeon is now displaced to the southeast beyond the range of familiarity, it will detect a decrease, compared to the home loft, in the quality of stimulus x and infer its relative displacement northward. It will also detect a decrease in the quality of stimulus y and infer its relative displacement westward. The pigeon could then essentially locate its position on the gradient map to compute a vector or at least direction home to be read off one of its compasses.

Wallraff's elegant model can explain goal navigation from unfamiliar locations, but is it right? The first challenge is to identify environmental stimuli that have the requisite qualities of predictably varying in space. It is not surprising that properties of the earth's magnetic field other than those used to define compass directions have been popular candidate stimuli. On a coarse global scale, a number of geomagnetic parameters, e.g., geomagnetic inclination, vary predictably in space. Therefore, assuming a sensory system capable of detecting often very small differences, two of these geomagnetic parameters with intersecting gradient axes could be used to construct a map. Unfortunately, for homing in pigeons on a scale of tens to a few hundred kms geomagnetic variation can be very noisy and only poorly predicts relative location. Also, there is practically no experimental evidence that favors the presence of a geomagnetic map in homing pigeons (Wallraff, 1999). However, recent work with migrant birds in Australia (Fischer, Munro, & Phillips, 2003), and theoretical considerations (Bingman & Cheng, 2005), are consistent with the possibility of coarse scaled, geomagnetic map information operational at much larger distances from a goal.

If not the earth's magnetic field, then what? Surprisingly, the answer seems, at least in part, related to spatial variation in the distribution of atmospheric odors (Wallraff, 2001). Numerous experiments carried out in homing pigeons have demonstrated that olfactory deprivation sabotages homing ability from distant, unfamiliar locations while sparing homing from sites where familiar landmarks can be used as an alternate source of navigational information. More impressive, false olfactory information, in other words releasing pigeons from one unfamiliar location while being exposed to odors from another location, leads to predictable changes in the direction flown by pigeons upon release. The orientation of the "fooled" pigeons is consistent with them being released from the site recognized by the odors and *not* their actual location.

Could variation in the spatial distribution of atmospheric odors make up one or both of the gradients in Wallraff's model? Developmental studies have demonstrated that even homing pigeons held in an outdoor aviary without the opportunity to fly can learn an olfactory navigational map. Under these conditions, it is difficult to imagine how a gradient map can be learned without a bird experiencing quantitative differences in stimulus quality while actively moving through space. Birds held in an outdoor aviary learn an olfactory navigational map by associating different odor qualities with winds from different directions. Rather than learn a gradient map, they learn what has been described as a "mosaic map," in which patches of different atmospheric odor qualities are associated with different compass directions (Papi, Fiore, Fiaschi, Benvenuti, & Baldaccini, 1972). Note again that a compass mechanism, like the sun compass, would be used to represent how odors vary in space. When subsequently released from a distant, unfamiliar location, a pigeon would sample the odor profile at the release site, recall the wind direction associated with that odor profile experienced at the loft and then, using its sun or magnetic compass, fly off in a direction opposite from the associated wind direction. Interestingly, such a mechanism would render what are ostensibly unfamiliar locations "familiar." The odor profile of unfamiliar sites would be "familiar" to the pigeons because of the odor profile having been transported to the loft by winds. Odor profile would take on the quality of a landmark that could be experienced remotely because of wind.

So does such a mosaic map of atmospheric odors completely solve the problem of navigation after displacement to a distant, unfamiliar location? Probably not. The primary obstacle is that successful navigation can occur over hundreds of kilometers beyond a range conceivable for wind borne odors to be reliably brought to one site like a pigeon loft. How would a pigeon discriminate between an odor profile from the north 50 kms away compared to one from the north 500 kms away? It may well be that a mosaic map is operational over relatively short distances (50-100 kms) and a gradient-like map is operational over longer distances. But is there any evidence that pigeons can learn two types of dissociable navigational maps? We will discuss the role of the hippocampal formation in avian spatial behavior in more detail below, but it is noteworthy that young homing pigeons with hippocampal lesions are unable to learn an olfactory navigational map when held in an outdoor aviary; a presumptive mosaic map (Bingman, Ioalé, Casini, & Bagnoli, 1990). By contrast, young homing pigeons with hippocampal lesions can learn an olfactory navigational map if given the opportunity to fly freely from the loft under conditions when the gradient quality in odor profile could be sampled as the birds move through space (Ioalé, Gagliardo, & Bingman, 2000). The different effects of hippocampal lesions on navigational map learning under conditions of varying experience are consistent with the two map idea. One would be a hippocampal dependent mosaic map operational over relatively short distances, the other a hippocampal independent gradient map operational over much larger distances.

It must be admitted that the proposal of an olfactory navigational map has not been unanimously embraced by researchers in the field. A frequent criticism has been the intuitive difficulty in accepting that the spatial variation in atmospheric odors is stable and predictable enough in space and time to support a gradient or mosaic map of the types described above. This criticism has now been successfully answered by research actually measuring spatial variation in trace atmospheric substances over distances homing pigeons routinely return from. If one looks not at one substance but the relationship among the concentrations of numerous substances, the spatial variation of that *relational* quality is stable and predictable enough to support a gradient map and explain how homing pigeons can identify the direction home from hundreds of kms away (Wallraff, 2004).

We are comfortable with the idea that homing pigeons can rely on atmospheric odors to construct a navigational map, and that they do so in different global regions with substantial differences in climate. There is evidence that other species of birds can use a similar navigational mechanism over relatively short distances (50-100 kms). But it seems impossible to explain migrations of thousands of kms based on a map of atmospheric odors. What type of environmental stimulus could serve as an element in a gradient map of this scale? Although not necessarily satisfying given the general lack of empirical support, and despite Wallraff's admonishment (Wallraff, 1999), there is a persistent temptation to think that at some point the answer will be related to some variation(s) in the earth's magnetic field (Bingman & Cheng, 2005). However, one should be open to any theoretically possible solution as the sensory and cognitive abilities of birds continue to offer surprises.

3.3 The Neural Representation of Space in Birds: The Avian Hippocampus

Under natural conditions, birds display an enormous range of spatial behavior mechanisms including different compass mechanisms, vector navigation,

navigation by familiar landmarks, and mosaic and gradient maps of atmospheric odors. But there is no reason to think we have fully uncovered all the ways birds represent space or their sensory basis. The different behavioral mechanisms would be supported by different neural representational mechanisms, which would to a lesser or greater extent be supported by different brain regions. To date, it is the hippocampal formation (HF) that has been most extensively studied in the context of avian spatial behavior, and not surprisingly, its importance appears restricted to only a subset of the behavioral mechanisms described above. Although playing some role in navigational map learning under conditions of confinement in homing pigeons, the available data indicate that the prevailing role of HF in the spatial behavior of birds is in the map-like representation of familiar landmarks used to guide goal navigation over familiar terrain.

Lesion and immediate early gene studies.

The very first study examining the effects of HF lesions on the homing behavior of experienced pigeons was accompanied by the disappointment of beautiful homeward orientation from a distant, unfamiliar location and the mystery that the lesioned birds never showed up at the loft (Bingman, Bagnoli, Ioalé, & Casini, 1984). How could one explain an intact navigational map but failed homing? The hypothesis put forth was that as a pigeon approaches its home loft it becomes increasingly reliant on familiar landmarks to guide the final phases of the homing flight, and it is navigation by familiar landmarks that engages HF. The importance of HF for familiar landmark navigation has subsequently been demonstrated in numerous field and laboratory studies, but we will only highlight two to illustrate the complexity of this relationship.

Intact and HF lesioned homing pigeons were trained from two familiar locations and then tested to reveal the kind of landmark-based strategy they learned to return from the familiar sites (Gagliardo, Ioalé, & Bingman, 1999). When tested, the pigeons were rendered anosmic. Blocking the ability to smell would eliminate the ability of the birds to rely on their olfactory navigational map to return home, thus forcing them to rely exclusively on their representation of familiar landmarks. They also had their internal clocks phase-shifted. Conceptually, homing pigeons could use familiar landmarks as an independent map and guidance system, using the landmarks to guide their flight home by serially locating their position in space and noting their movement with respect to the landmarks. Alternatively, they could simply use the landmarks at the familiar release site to recall the compass direction flown from that site during training, and then use their sun compass to take up the homeward bearing. Phase-shifting would dissociate these two strategies. Navigating home by gauging movement with respect to the familiar landmarks alone would not be influenced by the phase-shift manipulation. By contrast, recalling the compass direction home and then orienting by the sun would result in a shift in orientation away from the homeward direction.

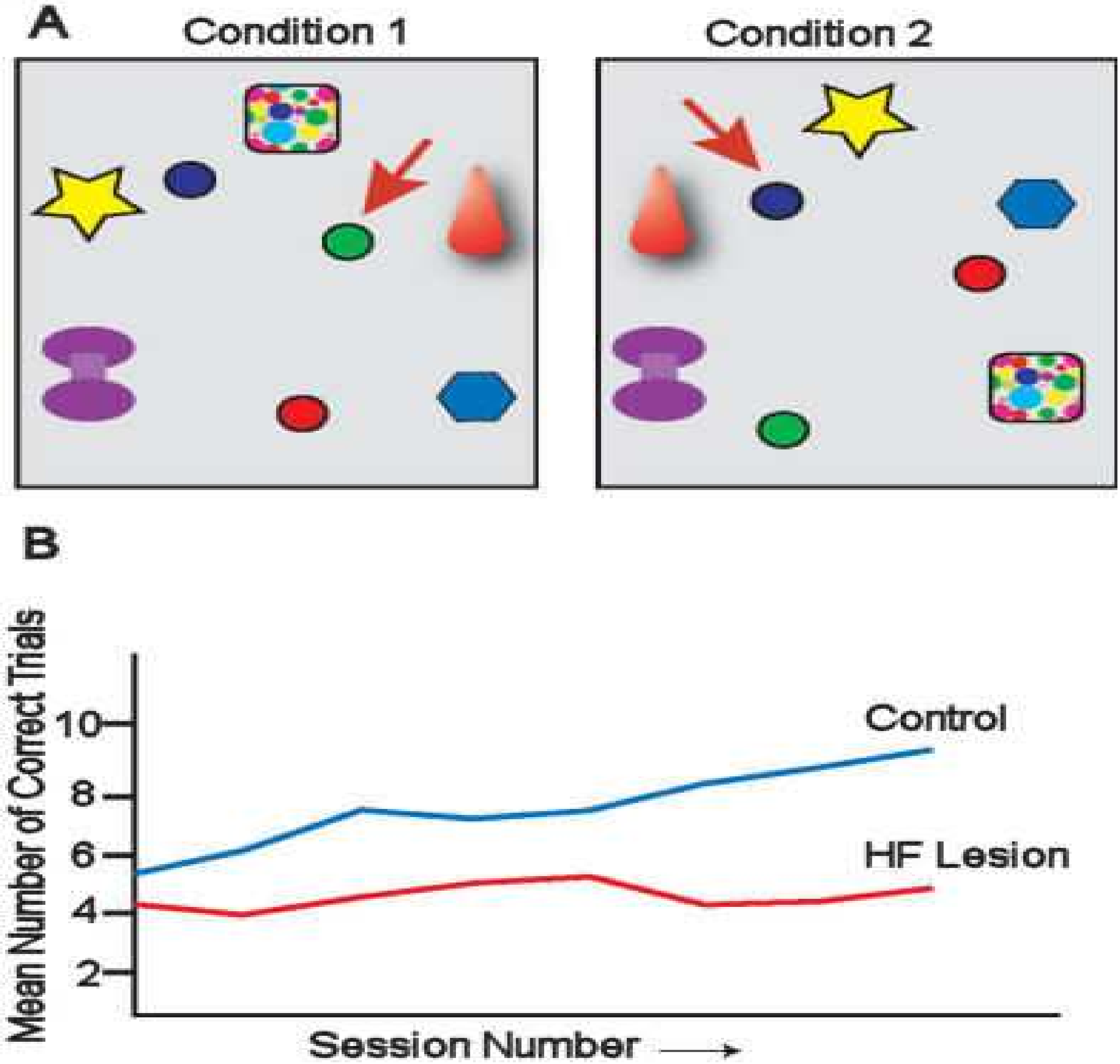
A
Condition 1
Condition 2
B
Mean Number of Correct Trials
10
8
6
4
2
Control
HF Lesion
Session Number

Figure 6. A.) Two five-landmark array environments that differed in the spatial (topological) relationship of the landmarks (e.g., the purple spool was counter-clockwise of the star in one environment and counter-clockwise of the red pyramid in the other). The green bowl contained food in one environment (arrow); the blue bowl in the other (arrow). The red bowl never contained food. B.) Control pigeons (blue line) successfully learned to discriminate the two landmark arrays to choose the correct food bowl. At the end of training they were getting close to 90% of all trials correct. Although the HF lesioned birds (red line) learned to preferentially choose the green and blue food bowls and not the red, they never learned to associate the green and blue bowls with the correct landmark array.

The results of this study demonstrate how subtle the differences can be in the navigational strategies used by control and HF lesioned pigeons. Control pigeons oriented in a direction approximating the true direction home, and therefore, were for the most part uninfluenced by the phase-shift manipulation. They used the unspecified array of familiar landmarks in a map and guidance-like fashion. By contrast, the HF lesioned pigeons displayed a shift in orientation away from the home direction indicating that they relied on their sun compass once determining their location relative to home, presumably by recognizing landmarks at the training site and then recalling the compass direction home flown during training. It is clear that the map-like spatial memory representation learned by the control pigeons was much richer in terms of spatial information available and the potential for inferring route corrections in the event of displacement. This ability requires recruitment of the HF. Simply learning to associate a compass direction with a cluster of familiar landmarks, instructed by the olfactory navigational map available during the training phase of the study, does not require an intact HF.

It is appealing to label the spatial learning of the control pigeons in the previous study as reflecting map-like or spatial relational learning; what has been called a cognitive map (O'Keefe & Nadel, 1978). However, under field conditions it is prohibitively difficult to determine if landmarks are actually being used and how they are represented (but see Guilford, Roberts, Biro, & Rezek, 2004; Lipp et al, 2004); the landmarks can't be manipulated. In a companion study (Figure 6), control and HF lesioned pigeons were trained to discriminate between two landmark arrays, which varied with respect to the spatial relationship among the landmarks, to determine which one of three possible goal locations contained food (White, Strasser, & Bingman, 2002). The landmarks used in the two arrays were identical, just their spatial relationship with respect to each other varied between the two conditions. Control pigeons were successful in discriminating between the landmark arrays. In striking contrast, the HF lesioned pigeons gave no indication of learning that the spatial relationship among the landmarks was different in the two conditions. This laboratory study, together with the previously described field study, offer compelling evidence that the avian HF is crucial for successfully representing landmarks in a map-like, relational manner; a map that can then be used to guide to navigation among goal locations.

The usefulness of lesion techniques for the study of brain-behavior relations is indisputable. However, it is desirable that conclusions drawn from lesion studies be supported by less invasive experimental procedures. One such procedure relies on the activation of so-called immediate early genes that are thought to be often recruited when some type of neuronal re-organization in support of learning occurs. For both homing pigeons learning to navigate by familiar landmarks (Shimizu, Bowers, Budzynski, Kahn, & Bingman, 2004) and a species of songbird remembering the locations of cached seeds to be recovered later (Smulders & DeVoogd, 2000), increased activation of an immediate early gene has been observed in HF. Both the lesion and immediate early gene data converge on the conclusion that the avian HF is critical for landmark-based, map-like representations of space.

Unit recording studies.

The realization that the avian HF is crucial when map-like representations are recruited to navigate and recognize salient locations in space raises the challenging question of how space may be represented at the level of the response properties of HF neurons (units). As background to this question are the well described "place cells" found in the rodent hippocampus (O'Keefe & Nadel, 1978). Place cells are neurons that routinely display large increases in activity when a laboratory rat is at a restricted location in an experimental environment. The place cell has shaped discussion of hippocampal function since its discovery more than 30 years ago and necessarily looms as a standard by which HF unit response properties in other species are measured. However, given the substantial differences in spatial ecology and evolutionary history between rats and birds like homing pigeons, it is likely that the spatial response properties of HF neurons would differ between the two groups in some adaptive fashion.

In fact, recordings of HF neurons carried out in freely moving homing pigeons navigating a laboratory environment have yet to reveal place cells so easily encountered in rats. Rather, what have been found are neurons of two types that are relevant to the challenges of navigating and recognizing locations in space (Hough & Bingman, 2004; Siegel, Nitz, & Bingman, 2005, 2006). One type of neuron is characterized by a tendency to display increased levels of activity (action potential firing rate) when a pigeon is at or near a goal location—a type of neuron we have referred to as a "location" cell. Although perhaps superficially resembling place cells, these pigeon HF location cells differ from rat place cells with respect to a number of response property characteristics. The second type of neuron is characterized by a tendency to display increased levels of activity when a pigeon is moving through corridors that leads to and from goal location—what we have referred to as a "*path*" cell. The types of response properties described are consistent with the speculation that homing pigeon HF neurons participate in relating the position of goal locations with the computation of navigational trajectories that lead to those locations. But perhaps the biggest surprise is that neurons with different response properties tend to lateralize to the HF on different sides of the brain.

A lateralized HF: Adaptation for navigating avian space?

The functional lateralization of the vertebrate forebrain was once thought to be a uniquely human characteristic. However, it has now been clearly demonstrated that the avian forebrain is similarly lateralized with the different hemispheres preferentially recruited in the control and expression of different behavior (Güntürkün, 1997). This has been convincingly shown in the domain of spatial behavior in a number of bird species such as chicks, homing pigeons and songbirds. More recently, the asymmetrical contribution of the HFs of the two forebrain hemispheres in guiding spatial behavior has been revealed. In one lesion study carried out in homing pigeons (Kahn & Bingman, 2004), birds were trained to locate a food goal by relying on landmark cues locally distributed in the

experimental environment, which the birds could move through (Figure 8). They could also rely on distal cues such as light fixtures and markings on the walls and ceiling in the room where the experimental environment was located. Pigeons with left and right HF lesions both learned the task without difficulty. However, the spatial representation that guided their behavior, as revealed by probe trials that set information from the local landmarks in conflict with the distal room cues, was notably different. Pigeons with left HF lesions overwhelmingly relied on the distal room cues to locate the goal and behaved as if the local landmarks did not exist. By contrast, pigeons with right HF lesions used the distal room cues less and were more reliant on the local landmarks to locate the goal. The results suggest that the right HF may be more important for the representation of goal locations reliant on global/distal properties of an environment. It is interesting to note that pigeons with right HF lesions can also use the sun compass to learn the location of a goal or an olfactory navigational map; both of these spatial abilities are impaired in pigeons with left HF
lesions.

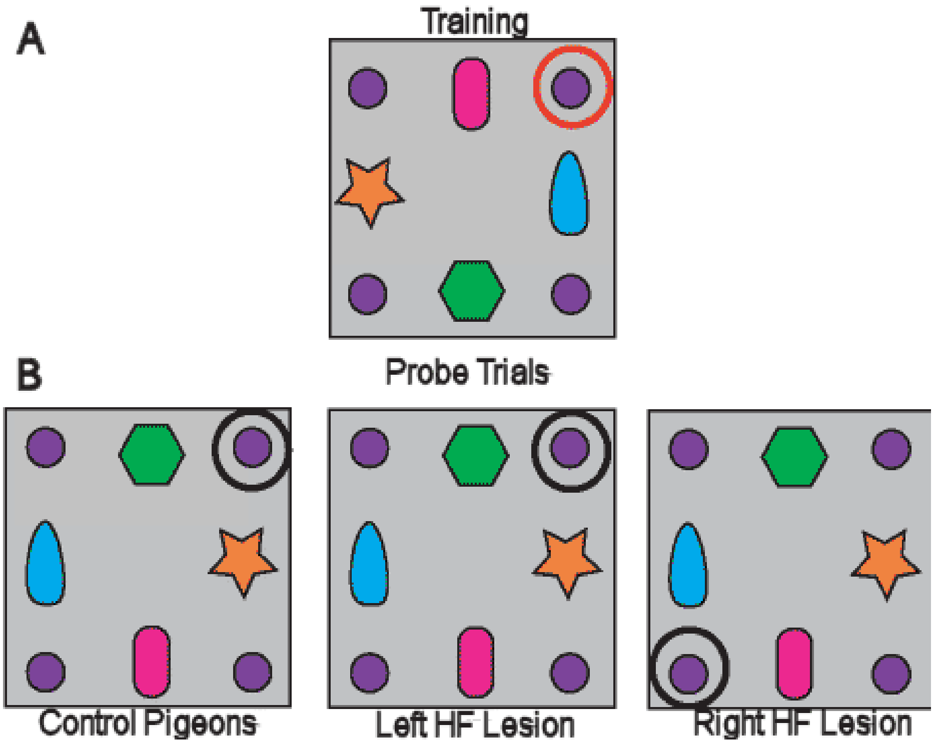

Figure 8. In a lesion study carried out in homing pigeons (Kahn & Bingman, 2004), birds were trained to locate a

food goal by relying on landmark cues locally distributed in the experimental environment the birds could move through. Figure A shows the goal location in training while figure B shows the birds selection of the goal location in probe trials.

The different sensitivity of the right and left HF to different aspects of space as revealed by the lesion studies is paralleled by unit recording data (Siegel et al., 2006). The occurrence of location and path cells described above do not distribute symmetrically in the HFs of the two hemispheres. Location cells are more likely to be found in the right HF while path cells are almost exclusively found in the left HF. The spatial response profile of neurons in the left and right HF also differ in other respects, the most notable of which is the greater temporal stability or reliability in the spatial variation in the firing rate of left HF cells. Neurons in the left HF likely participate more in representing aspects of space that are stable in time.

Reconciling the lesion and unit recording data.

Surveying the lesion and unit recording data reveals a complex picture of HF function and its apparent defining characteristic of lateralization. This lateralized quality is interesting because the human HF is also lateralized while there is little indication of it in the rat. When the dust settles, lateralization, and particularly HF lateralization in the context of spatial behavior, may be a defining adaptive feature of the avian HF organization that explains in part the extraordinary ability of birds to navigate space (Bingman, Hough, Kahn, & Siegel, 2003). But what is really lateralized? As a working model, we view the right HF as preferentially participating in the representation of goal or "event" locations (location cells) defined by global spatial features of the environment (lesion data). By contrast, the left HF preferentially participates in navigating the environment and computing trajectories among goal locations (path cells) relying on map-like representations of landmarks learned with the aid of directional cues like the sun compass. However, it must be emphasized that the proposed functional asymmetry is in some sense an experimental artifact. In intact pigeons, the two HFs work cooperatively and collectively in supporting behavior; goal navigation requires an ability to determine a path trajectory or route as well as recognize the location of a goal once close. A very large hippocampal commissure offers testimony that the two HFs function as an integrated unit in the control of spatial behavior. Indeed, navigating by familiar landmarks in the field as described previously is disrupted by either left or right HF lesions (Gagliardo et al., 2002). Neurons in the left and right HF may be preferentially sensitive to different aspects of space, but both are required to support the challenge of navigating by a map-like representation of familiar landmarks.

4.0 CONCLUSION

Traditionally, the study of comparative psychology has relied on controlled experimental settings in an intellectual environment setting shaped by learning theory. Although undeniably successful as a science, this research may have necessarily diminished the detection of species differences as subjects were tested in laboratory environments that often failed to promote the expression of species typical behavior and the cognitive mechanisms that support them. The research described in this chapter is inspired by a complementary approach to comparative psychology that draws on the lessons of ethnology. It can be taken as axiomatic that during the course of evolution a species' ecology and natural history have substantially shaped the relationship among brain organization, behavior and the underlying cognitive processes that support behavior. The unique suite of spatial behavior mechanisms that birds rely on to navigate space, from a magnetic compass and vector navigation that require little experience to become operational, to open-ended, HF mediated familiar landmark navigation, can all be viewed as adaptive responses to the challenges of their spatial ecology. From this perspective it is easy to understand why the homologous HF of rats and homing pigeons can differ in the qualities of space represented. More subtle HF differences can be expected even among different species of birds or any taxonomic group. In our view, a growth area in comparative psychology is a revitalized interest in an experimental philosophy that encourages the expression of species typical behavior accompanied by research into supporting neural mechanisms. The comparative study of spatial cognition is an example of how successful this approach can be.

5.0 SUMMARY

The extraordinary navigational ability of birds has fascinated natural historians for as long as animal behavior has been of interest. Successful navigation in birds is based first on an ability to determine directions in space (compass sense), relying on the sun, stars and earth's magnetic field. This compass sense promotes the development of an ability to determine relative location in space (map sense), which, depending on distance to a goal, exploits predictable variation in the spatial properties of visual landmarks, atmospheric odors and perhaps the earth's magnetic field. The hippocampus of birds is a brain region particularly well suited for implementing navigation based on the map-like representation of familiar landmarks. The experimental study of spatial cognition nurtures a revitalized comparative psychology that encourages the expression of species typical behavior accompanied by research into supporting neural mechanisms.

6.0 TUTOR-MARKED ASSIGNMENT

1. Explain compass mechanism under the following methods: sun and star.
2. What do you understand by getting there without knowing where?
3. Give examples of animals that can be used to explain phenomenon of getting there and knowing where.
4. Explain HF avian space with examples.

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MODULE 11: COURTSHIP AND PARENTHOOD

Unit 1: Animals Displaying Homosexual Behavior

CONTENT

1.0 Introduction

2.0 Objectives

3.0 Main Contents

3.1 Mammals

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3.1.3 Raccoon

3.2 Birds

3.2 .1 Chicken

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3.3.2 Wood Turtles

4.0 Conclusion

5.0 Summary

6.0 Tutor-Marked Assignment

7.0 References/Further Readings

1.0 INTRODUCTION

This list includes animals (birds, mammals, insects, fish etc.) for which there is documented evidence of homosexual or transgender behavior of one or more of the following kinds: sex, courtship, affection, pair bonding, or parenting, as noted in researcher and author Bruce Bagemihl's 1999 book *Biological Exuberance: Animal Homosexuality and Natural Diversity*.

Bagemihl writes that the presence of same-sex sexual behavior was not 'officially' observed on a large scale until the 1990s due to possible observer bias caused by social attitudes towards LGBT people making the homosexual theme taboo. Bagemihl devotes three chapters; *Two Hundred Years at Looking at Homosexual Wildlife*, *Explaining (Away) Animal Homosexuality* and *Not For Breeding Only* in his 1999 book *Biological Exuberance* to the "documentation of systematic prejudices" where he notes "the *present ignorance* of biology lies precisely in its single-minded attempt to find reproductive (or other) "explanations" for homosexuality, transgender, and non-procreative and alternative heterosexualities.[4] Petter Bøckman, academic adviser for the *Against Nature?* exhibit stated "[M]any researchers have described homosexuality as something altogether different from sex. They must realise that animals can have sex with who they will, when they will and without consideration to a researcher's ethical principles". Homosexual behavior is found amongst social birds and mammals, particularly the sea mammals and the primates. Animal sexual behavior takes many different forms, even within the same species and the motivations for and implications of their behaviors have yet to be fully understood. Bagemihl's research shows that homosexual behavior, not necessarily sex, has been observed in close to 1500 species, ranging from primates to gut worms, and is well documented for 500 of them. Homosexuality in animals is seen as controversial by social conservatives because it asserts the naturalness of homosexuality in humans, while others counter that it has no implications and is nonsensical to equate animal behavior to morality. Animal preference and motivation is always inferred from behavior. Thus homosexual behavior has been given a number of terms over the years. The correct usage of the term *homosexual* is that an animal *exhibits homosexual behavior*, however this article conforms to the usage by modern research applying the term *homosexuality* to all sexual behavior (copulation, genital stimulation, mating games and sexual display behavior) between animals of the same sex.

2.0 OBJECTIVES

By the end of this unit, you should be able to;

1. Explain homosexual behavior in general
2. Mammals with examples.
3. Reptiles with examples

3.0 MAIN CONTENT

3.1 Mammals

3.1.1 Humans

Human sexuality, besides ensuring biological reproduction, has important social functions: it creates physical intimacy, bonds, and hierarchies among individuals; and in a hedonistic sense to the enjoyment of activity involving sexual gratification. Sexual desire, or libido, is experienced as a bodily urge, often accompanied by strong emotions such as love, ecstasy and jealousy. The extreme importance of sexuality in the human species can be seen in a number of physical features, among them hidden ovulation, the evolution of external scrotum and penis suggesting sperm competition, the absence of an os penis, permanent secondary sexual characteristics, the forming of pair bonds based on sexual attraction as a common social structure and sexual ability in females outside of ovulation. These adaptations indicate that the importance of sexuality in humans is on a par with that found in the Bonobo, and that the complex human sexual behaviour has a long evolutionary history.

Human choices in acting on sexuality are commonly influenced by cultural norms, which vary widely. Restrictions are often determined by religious beliefs or social customs. The pioneering researcher Sigmund Freud believed that humans are born polymorphously perverse, which means that any number of objects could be a source of pleasure. According to Freud, humans then pass through five stages of psychosexual development (and can fixate on any stage because of various traumas during the process). For Alfred Kinsey, another influential sex researcher, people can fall anywhere along a continuous scale of sexual orientation (with only small minorities fully heterosexual or homosexual). Recent studies of neurology and genetics suggest people may be born predisposed to various sexual tendencies.

3.1.2 Dog

In domestic dogs, sexual maturity begins to happen around age six to twelve months for both males and females, although this can be delayed until up to two years old for some large breeds. This is the time at which female dogs will have their first estrous cycle. They will experience subsequent estrous cycles biannually, during which the body prepares for pregnancy. At the peak of the cycle, females will come into estrus, being mentally and physically receptive to copulation. Because the ova survive and are capable of being fertilized for a week after ovulation, it is possible for a female to mate with more than one male.

Dogs bear their litters roughly 56 to 72 days after fertilization, with an average of 63 days, although the length of gestation can vary. An average litter consists of about six puppies, though this number may vary widely based on the breed of dog. Toy dogs generally produce from one to four puppies in each litter, while much larger breeds may average as many as twelve.

Some dog breeds have acquired traits through selective breeding that interfere with reproduction. Male French Bulldogs, for instance, are incapable of mounting the female. For many dogs of this breed, the female must be artificially inseminated in order to reproduce.

3.1.3 Raccoon

Raccoons usually mate in a period triggered by increasing daylight between late January and mid-March. However, there are large regional differences which are not completely explicable by solar conditions. For example, while raccoons in southern states typically mate later than average, the mating season in Manitoba also peaks later than usual in March and extends until June. During the mating season, males roam their home ranges in search of females in an attempt to court them during the three to four day period when conception is possible. These encounters will often occur at central meeting places. Copulation, including foreplay, can last over an hour and is repeated over several nights. The weaker members of a *male social group* also are assumed to get the opportunity to mate, since the stronger ones cannot mate with all available females.

3.2 Birds

3.2 .1 Chicken

To initiate courting, some roosters may dance in a circle around or near a hen ("a circle dance"), often lowering his wing which is closest to the hen. The dance triggers a response in the hen's brain, and when the hen responds to his "call", the rooster may mount the hen and proceed with the fertilization.

3.3 Reptiles

3.3.1 Desert Tortoise

Tortoises mate in the spring and in the fall. The female will lay a clutch of 3 - 5 hard-shelled-eggs (which are the size and shape of ping-pong balls), usually in June or July, and they hatch in August or September. Wild female tortoises can produce 2 or possibly 3 clutches a year.

3.3.2 Wood Turtles

The wood turtle takes a long time to reach sexual maturity, has a low fecundity (ability to reproduce), but has a high adult survival rate. However, the high survival rates are not true of juveniles or hatchlings. Although males establish hierarchies, they are not territorial. The wood turtle becomes sexually mature between 14 and 18 years of age. Mating activity among wood turtles peaks in the spring and again in the fall, although it is known to mate throughout the portion of the year they are active. However, it has been observed mating in December. In one rare instance, a female wood turtle hybridized with a male Blanding's turtle.

The courtship ritual consists of several hours of 'dancing,' which usually occurs on the edge of a small stream. Males often initiate this behavior: starting by nudging the females shell, head, tail, and legs. Because of this behavior, the female may flee from the area, in which case the male will follow. After the chase (if it occurs), the male and female approach and back away from each other as they continually raise and extend their heads. After some time, they lower their heads and swing them from left to right. Once it is certain that the two individuals will mate, the male will gently bite the female's head and mount her. Intercourse lasts between 22 and 33 minutes. Actual copulation takes place in the water, between depths between 0.1 and 1.2 meters (0 and 4 ft). Although unusual, copulation does occur on land. During the two prominent times of mating (spring and fall), females are mounted anywhere from one to eight times, with several of these causing impregnation. For this reason, a number of wood turtle clutches have been found to have hatchlings from more than one male.[16]

Nesting occurs from May until July. Nesting areas receive ample sunlight, contain soft soil, are free from flooding, and are devoid of rocks and disruptively large vegetation. These sites however, can be limited among wood turtle colonies, forcing females to travel long distances in search of a suitable site, sometimes a 250 meters (820 ft) trip. Before laying her eggs, the female may prepare several false nests. After a proper area is found, she will dig out a small cavity, lay about seven eggs (but anywhere from three to 20 is common), and fill in the area with earth. Oval and white, the eggs average 3.7 centimeters (1.5 in) in length and 2.36 centimeters (0.93 in) in width, and weigh about 12.7 grams (0.45 oz). The nests themselves are 5 to 10 centimeters (2.0 to 3.9 in) deep, and digging and filling it may take a total of four hours. Hatchlings emerge from the nest between August and October with overwintering being rare although entirely possible. An average length of 3.65 centimeters (1.44 in), the hatchlings lack the vibrant coloration of the adults. Female wood turtles in general lay one clutch per year and tend to congregate around optimum nesting areas.

The wood turtle, throughout the first years of its life, is a rapid grower. Five years after hatching, it already measures 11.5 centimeters (4.5 in), at age 16, it is a full 16.5 to 17 centimeters (6.5 to 6.7 in), depending on gender. The wood turtle can be expected to live for 40 years in the wild, with captives living up to 58 years.[18]

4.0 Conclusion

In this unit you learnt:

1. Homosexual behavior in different animals.

2. Homosexual behavior in mammals, reptiles etc.

5.1 Summary

Homosexuality in animals is seen as controversial by social conservatives because it asserts the naturalness of homosexuality in humans, while others counter that it has no implications and is nonsensical to equate animal behavior to morality. Animal preference and motivation is always inferred from behavior. Thus homosexual behavior has been given a number of terms over the years. The correct usage of the term homosexual is that an animal exhibits homosexual behavior, however this article conforms to the usage by modern research applying the term homosexuality to all sexual behavior (copulation, genital stimulation, mating games and sexual display behavior) between animals of the same sex.

6.0 Tutor-Marked Assignment

1 Explain homosexual behavior in the following animals:

I. Human
II. Dog
III. Wood Turtles

2 Explain copulation Raccoon.

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Unit 2 Sexual Selection for Cultural Displays

Contents

1.0 INTRODUCTION

Friedrich Nietzsche, male, aged 27, published his first book *The birth of tragedy* in January 1872, barely a year after Charles Darwin published *The descent of man, and Selection in relation to sex.* Both books viewed human culture as a natural outcome of human sexuality and animal instinct. Although both were widely read and discussed, their views on the origins of human culture were widely forgotten. The assumption they were attacking, that culture is an autonomous sphere of human activity and belief above the biology of behaviour and instinct, persists as the dominant framework for thinking about the evolution of culture. That framework has provoked much writing about cultural transmission, memes, and gene-culture co-evolution. However, it has signally failed to deliver a good theory about what evolutionary selection pressures actually shaped the human capacity for producing and understanding concrete instances of 'culture'. This chapter suggests that, a century and a quarter after Nietzsche and Darwin, cultural theory and sexual selection theory have advanced enough that we should once more consider their subversive idea: cultural behaviour is very much more instinctive in nature and sexual in function than most cultured people would care to admit.

Nietzsche (1872) distinguished two modes of culture: the Apollonian (individual, rational, technical, cognitive, useful, hierarchical) and the Dionysian (collective, emotional, sexual, mystic, fertile, revolutionary). Most Darwinian theories have tried to explain the evolution of human culture through a strange combination of Apollonian technology, utility, and hierarchy, and Dionysian collectivity and ritual. Typically, this entails trying to find survival benefits for group cultural traditions. By contrast, this chapter emphasises Apollonian individuality and Dionysian sexuality, seeing whether culture may have evolved mostly through reproductive benefits for individual displays of 'cultural' behaviours.

Culture, rather than a system for transmitting useful technical knowledge and group-benefiting traditions down through the generations, can be considered an arena for various courtship displays in which individuals try to attract and retain sexual partners (Miller, 1993, 1997a, b). When a young male rock star stands up in front of a crowd and produces some pieces of human 'culture' known as songs, he is not improving his survival prospects. Nor is he engaging in some bizarre maladaptive behaviour that requires some new process of 'cultural evolution' to explain. Rather, he is doing something that fulfils exactly the same function as a male nightingale singing or a male peacock showing off his tail. He is attracting sexual partners. As we will see later, the fact that most publicly generated 'cultural' behaviour is produced by young males points towards its courtship function.

This cultural courtship model proposes that sexual selection through mate choice by both our male and female ancestors was a major evolutionary force in shaping human culture, i.e. the genetically inherited capacities for behaviours such as language, art, and music (Miller, 1993, 1997; in press, a; in press, b). These behaviours, according to this model, function mainly as courtship displays to attract sexual partners, and show many of the same design features shared by other courtship displays in other species. In short, human culture is mainly a set of adaptations for courtship. This hypothesis doesn't really come from Nietzsche, of course, or from Freud. Rather, it is a relatively simple application of standard Darwinian sexual selection theory to a somewhat puzzling set of behavioural phenomena in one rather pretentious species of primate.

This chapter examines what kind of data would be most relevant to testing competing evolutionary hypotheses about culture, and reviews sexual selection theory as a possible explanatory framework. It then introduces my cultural courtship model where cultural displays function as sexually-selected indicators of phenotypic and genetic quality, and presents some data on the demographics of cultural production that seem better explained by a sexual selection model than by standard survival selection models.

2.0 OBJECTIVES

Students should be able to discuss fully the following:

1. The sexual selection theory.
2. Courtship cultural model.
3. Darwinian demographics of cultural display.

3.0 MAIN CONTENT

3.1 Why cultural anthropology won't tell evolutionists what we need to know about culture

Explaining the 'evolution of culture' is shorthand for explaining the genetic evolution, through natural selection and sexual selection, of the human mental adaptations that generate, learn, modify, and produce those behaviours that sustain 'cultural' phenomena (Tooby & Cosmides, 1992). At first glance, it would seem obvious that this explanatory project should take seriously everything that anthropologists have learned about cultural phenomena. Shouldn't the evolutionary psychology of culture take cultural anthropology as its starting point?

Unfortunately, cultural anthropology can't tell evolutionists the most important things we need to know, because its concerns have pulled in different directions. Evolutionists need thorough functional descriptions of the mental adaptations underlying culture, their specialised features, their survival and reproductive benefits and costs, their phylogeny, their phenotypic variability between humans, their genetic heritability, their lifespan development, and their strategic flexibility in response to various ecological, demographic, social, and sexual contexts. These are the basic kinds of data that biologists would routinely collect as a first step to determining why something evolved in any other species. These are the kinds of data that evolutionary psychologists are starting to collect for other human mental adaptations.

But cultural anthropologists have not usually collected that sort of data on human culture. Most cultural anthropology relies on qualitative description of cultural patterns. Where anthropologists have collected quantitative data on culture, it has generally been at the level of aggregate group data, measuring things like divisions of labour, rates of polygyny, and durations of initiation rituals. These sort of group averages do not reveal who is producing or receiving particular exemplars of culture, ideological or material.

Crucially, group aggregate data cannot reveal how individual heritable variation in the capacity for various cultural behaviours co-varies with various components of biological fitness. Thus, group average data permits only very weak and indirect tests of competing hypotheses about cultural evolution. Stronger tests would require knowing exactly what fitness payoffs accrued to individuals who generated particular kinds of behaviours that sustained various kinds of cultural phenomena, not merely knowing what those phenomena are. For example, ornithologists test hypotheses about the functions of bird song mostly by looking at how individual variation in song production co-varies with individual variation in survival and reproduction (Catchpole & Slater, 1995), not by derived predictions about emergent group-level song patterns from their hypotheses and comparing these predictions to group aggregate data.

It may be more productive to shift our attention from cultural anthropology to sexual selection theory itself, to see how far it can take us in explaining what we do know about human culture. Some useful tests of the cultural courtship model may then be found right under our noses, not in hunter-gatherer ethnographies, but in evidence about cultural production in our own post-industrial societies.

3.2 Sexual selection theory

If the courtship model is right, the best tools for understanding human culture can be found in sexual selection theory, as first developed by Darwin (1859, 1871) and revived in the last twenty years (Andersson, 1994; Cronin, 1991; Miller, in press, a; Miller & Todd, in press). Darwin recognised that evolution is fundamentally reproductive competition, not just Spencer's "survival of the fittest". Natural selection for survival ability is certainly important, but sexual selection for attracting mates is often more important. Darwin understood that in most sexually-reproducing species, there would be strong incentives for choosing one's sexual mate carefully, because one's offspring would inherit their traits, good or bad, along with one's own traits. Bad mate preferences would find themselves in poor-quality offspring, and would eventually die out. Equally, poor courtship displays that attracted few mates would also die out over generations. Thus, a process of sexual selection will tend to arise in many sexually-reproducing animals, whereby individuals display their attractiveness, health, status, fertility, genetic quality, and other reproductively important traits, and individuals select their mates based on such displays. As Darwin (1871) noted, female animals are often choosier about their mates than males, and males often display more intensely than females. However, sexual selection does not necessarily produce or depend on sex differences; it could equally apply to hermaphrodites.

Victorian biologists generally rejected the idea that mate choice by females could be a major force in evolution, so the core idea in Darwin's sexual selection theory fell into disrepute for many decades. Sexual selection has been revived only in the last two decades because evolutionary theorists finally figured out how to use analytical proofs and computer simulations to show some of the counter-intuitive ways that sexual selection can work, and animal behaviour researchers figured out how to demonstrate mate preferences experimentally in the lab and the field (Andersson, 1994). Especially in the last decade, sexual selection theory and animal mate choice research have dominated the best journals in biology and evolutionary psychology (see Miller & Todd, in press).

The strange history of sexual selection theory is important to appreciate because virtually all of 20th century anthropology, psychology, and cultural theory developed when the theory was in scientific exile. Lacking an appreciation of how mate choice shapes behavioural evolution, evolution-minded social scientists searched for survival functions for the more puzzling human cultural behaviours, largely without success.

3.2.1 Sexual selection for indicators of phenotypic and genotypic quality

So, how does mate choice shape courtship displays? Biologists such as Alfred Russell Wallace, George Williams, and William Hamilton have long argued that mate choice should often favor cues that indicate a prospect's phenotypic quality, including health, fertility, parasite resistance, parenting abilities, and genotypic quality or heritable fitness (Cronin, 1991; Andersson, 1994). However, this idea that mate choice favors "indicators" rather than arbitrary, aesthetic traits was not widely considered until 1975, when Amotz Zahavi stirred intense controversy with his "Handicap Principle" (Zahavi and Zahavi, 1997). Zahavi proposed that the only way to reliably demonstrate one's quality during courtship is to display a high-cost signal such as a heavy peacock's tail, an exhausting bird-song concert, or an expensive sports car. Only these costly "handicap" signals are evolutionarily stable indicators of their producer's quality, because cheap signals are too easy for low-quality imitators to fake (Zahavi and Zahavi, 1997).

Many sexual cues in many species have now been shown to function as indicators: they have high growth and maintenance costs, their size and condition correlates with their owner's overall fitness and genetic quality, and they influence mating decisions (Andersson, 1994). Sexual selection theorists now believe that many sexual cues, both bodily ornaments and courtship behaviors, function as reliable indicators of an individual's quality. Such indicators, while improving reproductive prospects, actually impair survival chances, so are fairly easy to distinguish from naturally-selected traits shaped for survival. Many empirical methods have been developed to test whether a particular trait is a sexually-selected indicator, but these methods have almost never been applied in studies of human culture.

A key question is whether sexually-selected indicators reveal just environment-influenced phenotypic quality, or heritable genotypic quality as well. Until recently, many biologists and evolutionary psychologists believed that fitness must not be heritable in most species most of the time, because natural selection should tend to eliminate any genetic variation in traits that influence survival or reproduction ability (Tooby and Cosmides, 1990). However, theorists realized that mutation pressure, spatial and temporal variations in selection, and migration tend to maintain heritable fitness (see Andersson, 1994; Rowe and Houle, 1996; Pomiankowski and Moller, 1995). Also, every human mental trait ever studied by behavior geneticists shows significant heritability, even traits that must have been strongly fitness-related such as general intelligence and other capacities fundamental to cultural behaviour (Jensen, 1997; Plomin et al., 1997).

Many biologists now agree that fitness often remains substantially heritable, in most species most of the time (Moller and Swaddle, 1997; Rowe & Houle, 1996; for review see Miller & Todd, in press). Thus, our mate choice strategies probably evolved to focus on sexual cues that advertise heritable fitness. From a selfish gene's point of view, mate choice is supremely important because mate choice determines whose genes it will have to collaborate with in all succeeding generations.

The most dramatic examples of human culture, such as ritual, music, art, ideology, and language-play, seem like energetically expensive wastes of time, to someone thinking in terms of the survival of the fittest. From the viewpoint of indicator theory, that sort of wasteful display is exactly what we would expect from traits shaped for reproductive competition.

3.2.3 Sexual selection for other features of courtship displays

Courtship displays can reveal quality in an almost limitless number of ways, because all they need do is to have high marginal fitness costs in all domains other than courtship. Thus, the indicator function vastly under-determines the details of courtship displays, and other sexual selection processes can become important. For example, the peacock's tail needs to be large, heavy, and expensive to grow to function as an indicator, but its indicator function doesn't determine its exact colours, patterns, and movements.

R. A. Fisher (1930) proposed a "runaway" model of sexual selection that could favor courtship features that are not indicators. In the runaway process, a heritable mate preference (e.g. a preference for a longer-than-average peacock tail) becomes genetically correlated with the heritable trait it favours (e.g. a longer-than-average tail), because offspring tend to inherit both the preference and the trait as a package. The result is an evolutionary positive-feedback loop that drives both the preference and the trait to an extreme. Because the runaway process is extremely sensitive to initial conditions, its evolutionary outcome is hard to predict. Given two similar species living in similar econiches, runaway might lead them to evolve very different courtship displays (Miller & Todd, 1995; Todd & Miller, 1997).

Recent theorists have also suggested that perceptual biases (e.g. greater responsiveness to large, bright, high-contrast, loud, rhythmic, or novel stimuli) can influence the direction of sexual selection and the details of courtship displays (e.g. Endler, 1992; Ryan & Keddy-Hector, 1992; for review see Miller, in press, a). Small differences between species in these perceptual biases may lead to large differences in the courtship displays they evolve.

3.3 The cultural courtship model

In my cultural courtship model, “culture” subsumes a variety of specific human behaviours such as telling stories, wearing clothes, dancing, making music, decorating artefacts, expressing belief in certain ideas, and so forth. The human capacity for culture, then, is not a single adaptation, but a set of interrelated adaptations that may have evolved under different selection pressures to fulfil different biological (Tooby & Cosmides, 1992). Our unique human capacities for language, art, music, and ideology may be distinct mental modules that evolved at different times, develop according to different life histories, operate according to different psychological principles, and contribute in different ways to biological fitness. In this rather modular view of mental evolution, culture does not come for free as a side-effect of having a large brain, general-purpose learning and imitation abilities, or general intelligence (Pinker, 1997).

However, there may be a common theme running through these cultural capacities. They are self-expressive. They cost time and energy. Most of them have no clear survival benefits. They are unique to our species. They show strong individual differences, with some people much better at them than others. They require intelligence, creativity, and health. They play upon the perceptual and cognitive preferences of spectators. These all the hallmarks of adaptations that have been shaped as courtship ornaments by Darwin’s process of sexual selection through mate choice.

3.3.1 Cultural displays as sexually-selected indicators

Cultural displays such as productions of language, art, music, and ideology may function in courtship as sexually-selected indicators of phenotypic and genotypic quality. This idea may explain not only behavioural differences between humans and other primates, but also the easily observed differences between individual humans in their capacity for producing impressive, attractive cultural behaviour. The whole point of indicators is to amplify perceivable differences between individuals, to make heritable differences in health, intelligence, creativity, and other traits more apparent and easier to judge during mate choice (see Andersson, 1994; Pomiankowsi & Moller, 1995; Rowe & Houle, 1996; Zahavi & Zahavi, 1997). Almost all other evolutionary theories of culture (e.g. Dissanayake, 1992; Knight, Power, & Watts, 1995) would be expected to produce very small differences between modern humans in their cultural capacities, because they assume survival selection for culture, and survival selection tends to eliminate genetic variation much faster than sexual selection.

If cultural displays evolved as sexually-selected indicators of intelligence and creativity, this may also explain why many building-blocks of cultural displays are so highly ritualised, while many higher-order structures are so variable. Comparison between courtship displays is easier if the displays share many elements in common, so deviations indicating inferior production ability can be easily noticed. For example, ritualization of vocabulary, pronunciation, and grammar makes it easy to tell who is good at language and who is not. Ritualization of timbre, rhythm, and tonality makes it easy to tell who is good at music (Miller, in press, b). This is why most people dislike abstract art, atonal music, and modernist architecture: these styles avoid just those recognisable, ritualised elements that indicate whether their creators are any good at the basics of their craft.

But individuals can display their creativity in addition to their virtuosity, by recombining these basic cultural elements in novel patterns (Catchpole & Slater, 1995; Miller, 1997: Werner & Todd, 1997). Such new patterns can yield new emergent meanings that capture attention, excite the imagination, and remain memorable. This is why people during courtship tell new stories using old words, rather than expecting a sexual prospect to be impressed by a string of newly invented words. Standardised cultural elements allow easy comparisons of behavioural virtuosity, while protean cultural patterns allow easy assessment of behavioural creativity (Miller, 1997).

3.3.2 Sexual functions versus sexual motives

Culture as a set of adaptations for courtship does not mean that the production of cultural behaviour stems from some kind of Freudian sublimated sex drive. Sexually-selected adaptations do not need to feel very sexy to their users. A trait shaped by sexual selection does not have to include a little copy of its function inside, in the form of a conscious or subconscious sexual motivation (see Tooby & Cosmides, 1992). The male human beard, although almost certainly an outcome of sexual selection through female mate choice, is not a jungle of hidden, illicit motives. It simply grows, and displays that its possessor is a sexually mature male, without having any idea why it's doing that. Even psychological adaptations like music production may work similarly, firing off at the appropriate age and under the right social circumstances, without their possessor having any idea why they suddenly feel "inspired" to learn the guitar and play it where single people of the opposite sex happen to congregate. The cultural courtship models does not reduce culture to a crude sex drive any more than natural selection models of cultural evolution reduce culture to a crude survival drive.

3.3.3. Why sexual selection doesn't care whether myths are true

Anthropology textbooks (e.g. Haviland, 1996) present many functions for art, music, myth, ritual, and other cultural phenomena, such as "imposing order on the cosmos", "coping with the unpredictability of life", "appeasing ancestral spirits", and "maintaining tribal identity". To an evolutionary biologist, none of these even come close to qualifying as reasonable adaptive functions for costly, complex, evolved behaviours. In a strictly Darwinian framework, behaviours only evolve when their fitness benefits exceed their fitness costs. Fitness almost always relates directly to individual survival and reproduction in the real, objective econiche that a species faces, not in an imagined world of spirits and cultural meanings. The single thing we must demand of any theory concerning the evolution of human culture is: show me the fitness!

Showing the fitness benefits for many cultural behaviours is hard because they create and transmit fictional mindscapes that are not accurate models of biological reality (Knight, Power, & Watts, 1995). The almost unbeatable advantage the courtship model has in this regard is that cultural displays must be honest only as reliable indicators of their producer's fitness, not as accurate mental models of the world. Mate choice doesn't care whether a story told during courtship is literally true; it only cares whether the story is good enough to prove the intelligence and creativity of its narrator. Indeed, the more fantastic, baroque, outlandish, and counter-factual the tale, the better an indicator of heritable mental capacity it may be. Without sexual selection, it seems impossible to explain why so much human culture represents the world so inaccurately, and why fiction out-sells non-fiction by such a large margin.

Language did not evolve just so we could tell each other amusing fictions. It clearly shows some design features for communicating useful, true information to others very quickly and efficiently when necessary (Pinker, 1994). The survival and social benefits of complex information-transfer from one mind to another would have been substantial. However, the courtship benefits of being able to activate complex mental representations inside the minds of sexual prospects must have also been substantial, a revolutionary advance over tickling their eyes or ears with meaningless colours and sounds, as all other species are limited to doing.

Both the survival and courtship models for language evolution face the same difficult problem of explaining why language evolved only once, in our species, if it was so useful for either function. Here the courtship model has the advantage that sexual selection is a highly stochastic process, extremely sensitive to initial conditions and unpredictable in outcome, whereas natural selection is a relatively more predictable hill-climbing process that often produces convergent evolution on the same adaptation in many lineages (Miller & Todd, 1995).

3.3.4 Why sexual selection is as smart as we are

Sexual selection is a very powerful process, not just evolutionarily (see Miller & Todd, 1995; Todd & Miller, 1997), but epistemologically. Sexual selection through mate choice can potentially explain anything you can ever notice about evolved human behaviour as something that needs explaining. This is because anything you can notice about other people, your ancestors could have noticed too, and perhaps favoured in picking their sexual mates. While natural selection is so often blind and dumb, sexual selection is as smart as the individuals making the mate choices. Our ancestors were very smart indeed, according to the dominant social intelligence theory of human brain evolution. So, if we are even capable of noticing that someone else is wonderfully creative in their cultural efforts, that perceptual capacity itself is good evidence that mate choice could have shaped the very phenomenon we are admiring. Sexual selection through mate choice can reach as far into the minds of others as our own social intelligence can reach, and can potentially explain whatever we find admirable there.

3.3.5 Why sexual selection pre-empts natural selection

A second immodestly powerful feature of sexual selection is that it tends to hijack whatever natural selection pressures are already shaping a species (Miller & Todd, 1995; Todd & Miller, 1993). This is because there are such large incentives to avoid mating with individuals whose offspring would stand little hope given whatever natural selection is happening. For example, suppose the capacity for social imitation happened to confer some survival advantage on our ancestors. If social imitation abilities remained subject to natural selection over many generations, it seems likely that mate preferences would evolve to favour individuals who displayed above-average social imitation abilities. Those mate preferences in turn would favour the evolution under sexual selection of courtship displays that reliably indicated one's social imitation abilities. The result would be a set of costly, exaggerated displays of one's social-imitation ability, such as a talent for humorous impersonations of sexual competitors. These displays might look vaguely related to traits useful for survival, but their principal function would be courtship. This same argument applies to any other behavioural capacity: if it was really useful for survival, mate preferences would have evolved to “realise” that, and favoured elaborate advertisements of the capacity that do not, in themselves, contribute to survival. Theories of culture evolution that stress pure survival advantages need to explain why cultural behaviours would be uniquely immune to this sort of hijacking, amplification, subversion, and complexification by sexual selection.

3.4 Darwinian demographics of cultural display

The courtship hypothesis makes a simple prediction that amount of cultural production in many domains should depend heavily on the age and sex of the producer. Specifically, cultural production should increase rapidly after puberty, peak at young adulthood when sexual competition is greatest, and gradually decline over adult life as parenting eclipses courtship. Males should also show much higher rates of cultural production than females, because they are competing more intensely for mates (see Andersson, 1994; Cronin, 1991; Ridley, 1993). Daly and Wilson (1986) found that homicide follows exactly this pattern, across many different cultures and historical epochs, suggesting that violent competition is largely sexual competition. I was curious whether quantifiable types of cultural production would show the same demographic profile, suggesting similar evolutionary origins in sexual selection.

An initial sample of over 16,000 items of culture from diverse media showed the demographic profile predicted by the courtship hypothesis (Miller, submitted). The method relied on finding reference works such as music discographies, museum catalogues of paintings, and writer’s directories that include very large samples of cultural works for which the age and sex of their producer can be identified. From these references, large random samples were obtained, and the number of cultural works produced by individuals of a particular age and sex were counted and plotted. The method works best for discrete, easily counted cultural productions such as paintings, books, music albums, and plays. Reference works were chosen that aimed to exhaustively list all works that fit some well-defined objective criteria, rather than small samples based on some author’s quality judgements. For this short chapter, only a few example studies can be reviewed, analysing the production demographics for jazz albums, modern paintings, and modern books.

Figure 1 plots 1,892 jazz albums by age and sex of their principal musician/composer, reflecting a random sample of about 20% of the albums documented in Carr, Fairweather, and Priestly (1988), an exhaustive reference that includes every commonly recognised jazz musician and album. The data points represent how many jazz albums (as an absolute frequency) were released by musicians of a particular age (displayed along the x-axis from age 0 to age 90), and sex (distinguished by rhomboid symbols for men and circles for women). Two striking features are apparent from the figure. First, there is an enormous sexual dimorphism in cultural production, with 1800 albums by 685 men, and 92 albums by 34 women. Males produced about 20 times as many total jazz albums as females, and produced them at a much higher rate for every age. Second, male productivity peaks very sharply at 30 years of age, rising steeply from age 20 upwards, and falling off steeply until age 50, and then more slowly until age 70. While homicide rate typically peaks in the early 20s (Daly & Wilson, 1986), the later peak for jazz album production suggests that it takes longer to learn to play good music than to kill someone, and longer between composing music and releasing the album than between pulling a trigger and committing a murder.

Figure 2 plots 3,374 modern paintings from *The Tate Gallery Collections* (1984), an exhaustive sample of every painting owned by one of Britain's major national museums. The sample includes all datable works in the collection done by every artist with a last name beginning A through K. The sample yielded 2979 paintings by 644 men and 395 paintings by 95 women, showing an eight-fold sexual dimorphism. Here, cultural productivity for both sexes peaks in their mid to late 30s, following a gradual rise from age 20, with a slower decline from 40 into the 80s.

Figure 3 plots 2,837 English-language books published in the 20th century, a random sample of about 2% of all books listed in *The writers directory* (1992). This includes 2,213 books by 180 men and 624 books by 49 women, with males still producing over three times as many books as females. The age peaks are later for books, around 43 for males and 50 for females, with the first hint of a sex difference in age profiles.

Similar results were obtained in other studies of over 2500 rock albums from Strong (1991), 3,800 major works of classical music from Sadie (1993), 850 old paintings from the *National Gallery: Illustrated general catalogue* (1986), 250 plays from Crystal (1993), and 150 major philosophical tracts from Collinson (1987) -- Nietzsche, male, aged 27, was a typical culture-producer (see Miller, submitted, for details). In every case, cultural production was much greater for males than for females, and showed the same general age profile, though with somewhat different age peaks depending on the medium.

A single pattern seems to pervade the age-sex profiles of cultural production across quite different media from different cultures and historical epochs. Human males and females show a virtually identical age-profile for cultural production: a rapid rise following late adolescence, a peak around age 30 (plus or minus a few years), and a roughly exponential decline throughout the remainder of life, with the most rapid productivity loss between ages 40 and 60, followed by a more gradual decline until death. This age pattern for cultural production resembles that found for many other domains of display behaviour (Simonton, 1988). Though this age profile looks positively skewed if chronological age is plotted on a linear axis, it looks like an almost perfect normal distribution if age is plotted on a logarithmic axis, with the production peak midway between puberty and death.

The second major result is the persistent sexual dimorphism in cultural production rates, with males producing about 10 times more cultural output, across all media, than females. This male domination of public culture has been widely recognised by both evolutionary psychologists (e.g. Ellis, 1934) and feminist scholars (e.g. Battersby, 1989; Russ, 1983), but is almost entirely ignored in theories of cultural evolution (e.g. Dissanayake, 1992). Given observations by Darwin (1871) and hundreds of other researchers (see Andersson, 1994) that male courtship displays are almost always more frequent, more energetic, brighter, louder, and more strongly motivated than female displays, the most parsimonious biological interpretation of the cultural dimorphism is this: human cultural production functions largely as a courtship display, and the persistent sex difference in public cultural production rates reflects an evolved sex difference in courtship strategies.

There are also strong incentives for females to display cultural creativity during courtship to attract high-quality male mates. But the costs of male sexual harassment probably favoured a female display strategy of targeting desired prospects rather than broad-casting one’s fertility and attractiveness to all males indiscriminately. Also, we would expect much of female “courtship” to occur after a sexual relationship forms and even after children are produced, with the cultural displays directed specifically at one’s partner, and designed to solicit his continued attention and investment. These arguments suggest a sexually dimorphic motivational system, with equal capacities for cultural production in both sexes, but with males much more prone to publicly broadcast their cultural production and thereby to leave their mark on historical records of culture.

3.4.1 Do these age-sex demographics describe production of other kinds of human culture?

The three figures shown, plotting cultural production as a function of age and sex of producer, could be termed "display profiles". Though they show some variation, there is a general pattern of much more public display by males than by females, and display rates that increase markedly after puberty, peak in young adulthood, and decline slowly with decreasing fertility. There may be a universal display profile that shows these features across many different domains and styles of cultural production. A strong version of my cultural courtship model would make the following prediction: this universal profile will be found for every quantifiable human behaviour that is public (i.e. perceivable by many potential mates) and costly (i.e. not affordable by all sexual competitors). This universal profile may even apply to evolutionarily novel behaviours such as sky-diving, playing one's car stereo at high volume, and constructing an elaborate "home page" on one's Internet web site. If the universal profile is replicated for other genres, other media, other cultures, and other historical epochs, it could be interpreted as an evolved, species-typical, sexually dimorphic, life-history adaptation, shaped by sexual selection, and fundamental to understanding the distribution of cultural behaviour in our species.

A different version of the cultural courtship model could emphasise sex differences not in display rates, but in display channels that show off particular components of phenotypic quality desired by the opposite sex. For example, one could take the standard evolutionary psychology view that males pay relatively more attention to youth and physical attractiveness in mate choice than females do (Buss, 1989), to predict that body ornamentation (e.g. cosmetics, jewellery, costly clothes) will show a display profile with a similar age peak, but with more ornamentation worn by females than by males. However, the definition of body ornamentation depends on where one draws the border around an individual's "extended phenotype" (Dawkins, 1982). If women wear more red ochre or lipstick, but high-status men "wear" more sports cars, body guards, country estates, and corner offices with skyline views, how do we quantify their relative amounts of phenotypic ornamentation? Developing better methods for measuring cultural production and reception will be necessary for testing more sophisticated models of cultural evolution.

This courtship hypothesis is bound to stir some scepticism, but we must be clear about whether such scepticism concerns the validity of the production data, or their interpretation as serving a courtship function. If culture theorists do not believe that the universal display profile proposed here will apply to their favourite type of public cultural behaviour, I would invite them to measure production of that behaviour, using objective, replicable, quantitative methods, in a large random sample of people from their favourite culture, and see if the profile holds. The universal display profile may not be truly universal, but trying to see whether it is may be useful in distinguishing between different hypotheses about cultural evolution. At least, standard survival-benefit or group-benefit models of cultural evolution have no reason to predict sex differences in display profiles, whereas sexual selection models do.

On the other hand, some may claim that this display profile, though a possibly valid description of public cultural behaviour, is a self-perpetuating artefact of patriarchy rather than an evolved aspect of human nature (e.g. Battersby, 1989; Russ, 1983). In that case, one would have to explain why it is sensible to explain similar profiles in bird song production (e.g. Catchpole & Slater, 1995) and other courtship behaviour in other species using a different theory than one invokes for human cultural behaviour. Parsimony demands that if we see the same age and sex profiles for animal courtship behaviour and for human public cultural production, and if these behaviours show many of the same design features (e.g. high cost, aesthetic appeal, heritable variation in production ability, importance in mate choice), we should admit that the same theory, sexual selection through mate choice, might explain both phenomena.

4.0 **CONCLUSION**

Human culture does not make much sense as a set of survival adaptations shaped by natural selection. Too much of cultural behaviour, such as art, music, ritual, ideology, myth, humour, and story-telling, seems so expensive in terms of time, energy, and practice costs, and so useless for survival. Anthropologists have struggled for a century to find plausible survival functions for such cultural behaviours, and have not succeeded to their general satisfaction. Indeed, the difficulty of finding survival functions for much of human culture has led many cultural anthropologists to abandon evolutionary explanation altogether as irrelevant and distracting.

This pessimism is misplaced, because it ignores the astonishing revival of Darwin's sexual selection theory in biology over the last two decades. That revival has not been taken seriously by cultural theorists, but it seems to offer their best hope for a fruitful connection with human evolutionary psychology. Human culture makes a great deal of sense as a set of courtship adaptations shaped by sexual selection through mate choice. The costs and aesthetics of cultural behaviour that make it so inexplicable in survival terms make it perfect as a set of reliable fitness indicators that help advertise one's superiority over sexual competitors. This hypothesis offers a natural way of explaining the distinctive age and sex patterns of human cultural production.

This chapter is just a first attempt at tracing the implications of sexual selection for understanding human culture, and a plea for grounding any evolutionary discussion of culture in an up-to-date knowledge of evolutionary theory, combined with rigorous quantitative measurements of the cultural behaviours to be explained.

5.0 SUMMARY

The evolutionary significance of culture lies not in its subjective meaning, but in its objective fitness costs and benefits. Subjective meaning is simply what our would-be mates use to excite and entertain us during courtship.

6.0 TUTOR-MARKED ASSIGNMENT

1. Explain the sexual selection theory.
2. Discuss with examples Courtship cultural model.
3. Explain Darwinian demographics of cultural display.

7.0 REFERENCES/ FURTHER READING

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Unit 3: Animals Displaying Homosexual Behavior

CONTENT

1.0 INTRODUCTION

Courtship is the period in a couple's relationship which precedes their engagement and marriages or establishment of an agreed relation of a more enduring kind. A courtship may be an informal and private matter between two people or may be a public affair or a formal arrangement with family approval. The average duration of courtship varies considerably throughout the world, this depends on individual.

Parenthood means parentage i.e. the state of being a parents. Parenthood in habits the intersection of two distinct relationships, that between parents and child, and that between the parents (or family) and the larges society or other collective. This is called relationship.

Parenting is the processs of promoting and supporting the physical , emotional, social and intellectual development of a child from infancy to adulthood.3

2.0 Objectives:

By the end of this unit, you should be able to;

1. Define courtship and parenthood.
2. Define Self Gene Model of courtship.
3. Give examples of courtship behavior in some animals.
4. Explain modern models of parenting.
5. Explain sexual selection as form of courtship displays
6. Darwinian demographics of cultural display.

3.0 MAIN CONTENT

3.1 Courtship in the Animals Kingdom

Many non-human animal species have mate-selection rituals also referred to as 'courtship' in an anthropomorphic (misleading) manner. Animal courtship may involve complicated dances, or touching, vocalization, displays of beauty or fighting prowess.

From the scientific point of view, courtship in the animal kingdom is the process in which the different species select their partners for reproduction purpose. Generally speaking, the male initiates the courtship and the female chooses to either mate or reject the male based on performance. for example, the Selfish Gene model was proposed by Richard Dawkins which state that an individual of a particular species will mate with individuals from the same species that display good genes.

In this case, courtship is a display of "genes" carried by a particular organism looking forward to mix with the genes of another organism in generation, thereby, ensuring the survival of the genes themselves.

3.2 Examples of courtship behavior in animal kingdom

- Insects: female uses odorous substances called pheromones to attract males from a distance eg. Gypsy moth (lymantria dispar).
- Birds: boobies perform ritualized dances with many components, including whistling and an elaborate gesture known to Ornithologists as sky-pointing. The male peacock displays his glouries plumage the female.
- Amphibians: Courtship of songs in frogs (Rana species).

3.6 Models of Parenting /parenthood

Developmental psychologist Diana Baumrind identified three main parenting styles in early child development: authoritative, authoritatrian and permissive.

Most conventional and modern models of parenting fall somewhere in between.

- Attachment parenting: seeks to create strong emotional bond, avoiding physical punishment and accomplishing discipline through interactions.
- Slow parenting: encourages parents to plan and organize less for their children, instead allowing them to enjoy their childhood and explore the world at their own pace.
- Strict father model: an authoritarian approach, places a strong value on discipline as a means of survive and thrive in a harsh world.
- Nurturant parent model: a family model where children are exoected to explore their surrounding with protection from their parents.
- Single parent model
- Historical development

6.0 Tutor-Marked Assignment

1. Explain courtship in animal behavior with examples in animal kingdom. E.g Sea turtle
2. Explain sexual selection theory in animal.
3. Explain cultural courtship model.
4. State Darwinian demographics of cultural display.
5. Explain mode of parenthood in the following animals: Monkey, kangaroo, Penguin and duck fowl.

7.0 References/Further Readings

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MODULE 12 BIOLOGICAL CLOCKS

Unit 1 Biological Clock

CONTENT

1.0 Introduction

2.0 Objective

3.0 Main Content

3.1 Circadian clock

3.1.1. Why the Recent Fascination With Circadian Clocks?

3.2.1Over view of circadian Timing System

i. What Need for a Circadian Clock?

ii. Human Health Issues

1. Effects imposed by external conditions on otherwise healthy individuals.

3.1.4.2 Issues related to diagnosis and treatment.

1. Disorders or disease states that appear to be causally linked to malfunctions in the circadian timing system.

ii. The Fly and Mammalian Circadian Clocks

3.1.5.1. Drosophila.

1.0 Introduction.

Biological clocks are mechanisms internal to the animal, that has rhythmic influence upon its physiology and behavior, synchronizing them to cyclic changes in the environment. Biological clocks are internal timing mechanisms which can have a period of several hours, a day, or a year. The circadian clock runs with a period of *about* 24 hours. Circadian clocks have two functional characteristics: 1) they will persist (=free-run) with a period of about a 24 hours in the absence of environmental cues; and 2) they will synchronize (=entrain) to a 24 hour environmental cue, such as the light-dark cycle. Entrainment is important because it permits animals to synchronize to a changes in the seasonal photocycle. How they synchronize to the cue is determined by the phase response curve (PRC).

Types of Biological Clocks

1 Exogenous: this is a direct response to various changes in external (exogenous) geophysical stimuli

2 Endogenous: this is an internal (endogenous) rhythm that programs the animals' behavior in synchrony with the exogenous temporal period, particularly a 24-hours or 365-days period.

3 The synchronization mechanism that involve the combination of (1) and (2) above.

An animal may use many features of the external environment to gain information about the passage of time. The most important of these is the apparent movement of celestial bodies e.g sun, moon and stars, such influences have been much studies in birds and in bees (Apidae). In addition, it is possible that animals can obtain time cues from changes in environmental temperature, barometric pressure and magnetic phenomena.

Endogenous daily rhythms are termed "circadian" and usually fall short of a 24-hour periodicity.

Endogenous annual rhythms are termed "circannual" and usually less than 365 days.

Our biological clocks measure the day length and change our behavior according to the seasons circadian rhythms and circannual rhythms are internal calendars built into an animals' nervous system, especially in the brain.

2.0 OBJECTIVES

By the end of this unit, you should be able to;

1. Define biological clocks.
2. Differentiate between exogenous and endogenous rhythm
3. Differentiate between circadian and circannual rhythm

3.0MAIN CONTENTS

3.1 CIRCADIAN CLOCKS

Circadian clocks are important in photoperiod time measurement. There are two models for how clocks might be important in measurement of photoperiod: 1) External coincidence model (external light occurs at a critical phase in the circadian oscillation) and 2) Internal coincidence model (internal phase of multiple circadian oscillators is set by dusk and dawn). Circadian clocks are also important in animal orientation. Many species of bird and fish use the sun for orientation. To be successful, however, adjustment to the sun's daily movement is necessary. A circadian clock makes this adjustment.

3.1.1. WHY THE RECENT FASCINATION WITH CIRCADIAN CLOCKS?

The concept of time has always perplexed and fascinated people. What is the nature of

this mysterious thing that influences our lives so much? Although the ancient Greek philosophers believed that time was infinite, they perceived it as following endless cycles where the universe is born and dies, with an exact recurrence of everything in each cycle. The Newtonian view held that time is an immutable entity flowing on an infinite linear scale operating independent of nature’s forces. Einstein’s theory of relativity radically changed this conventional wisdom by revealing that time is actually embedded in the very fabric of the physical universe giving rise to a reality that is more accurately expressed as a four-dimensional space-time continuum. It follows from the big bang theory that time and our physical universe were jointly created at a singular event that, according to current estimates, occurred ~12–15 billion years ago, at least from our frame of reference. Interestingly, Kabbalists had intimate knowledge of old oral traditions that discussed the deep relationship between time, corporeal entities, and their creation. For example, almost 800 years ago a famous rabbi known as Nachmanidies, in his commentary to *Genesis*, wrote, "with this primeval creation, which was like a very small point having no substance, everything in the heavens and the earth was formed, and when the heavens and the earth came forth from nothing into existence, time came into being and from the moment some substance came into existence time was already part of it".

Despite our changing understanding of the nature of time, one thing has remained constant, the human obsession with harnessing this elusive entity. From sundials to calendars to cesium clocks, the quest to capture the essence of time and measure its passage has significantly influenced human history.

But on what basis do we rationalize the units we use to measure time? Essentially, this is a tale of spheres and cycles. The passage of time has been recorded (at least historically) by observing the rhythms of "heavenly bodies", most notably the daily rotation of the Earth on its axis, the monthly cycle of the moon around the Earth, and the yearly journey of our planet around the Sun. Considering the average human lifespan and spatial distribution on our tilted planet, the broad frequencies encompassed by these reliable celestial rhythms (day, month, and year) provide quite relevant and useful units for recording time. These predictably recurring physical events inspired humans to design timing devices that could measure the passage of a known amount of time (e.g., sand-filled hourglasses), identify a specific phase in a cycle (e.g., sundials, Stonehenge?), or both (e.g., modern clocks).

The most influential physical oscillation that reminds us of our inescapable rhythmic relationship with time is the day-night cycle. Although we intuitively know that time proceeds in a unidirectional flight into the future, our lives are largely organized into a 24-h schedule dominated by periods of wakefulness and sleep. Thus we perceive time as being spiral in its geometry; there is ever forward progression into the future (e.g., counting years) coupled with time coordinates that are revisited in a cyclical manner (e.g., measuring time of day).

But is our cyclical concept of daily time and its technological expression in the design of clocks just a convenient invention of the human intellect that allow us to better cope with the waxing and waning of day and night?

In 1729, a French astronomer named Jean Jacques d'Ortous de Marian took plants that displayed daily leaf movements and put them in the dark for several days. He noted that the leaves of the plants continued to open during the day and close at night despite the absence of sunlight. Based on this seminal experiment, he concluded that the observed rhythm was not passively driven by a cyclic environment but was an innate property of the plant. From these humble beginnings, the formal study of circadian (endogenously driven biological rhythms with periods of ≅24 h) biology can be traced. It is now quite clear that living organisms have been tracking the passage of daily time long before we ever invented clocks.

However, the contention that life forms have internal timekeeping devices was only widely accepted about 60 years ago. For some it seemed too incredulous that organic material had properties similar to clocks fashioned by human hands . After all, it was claimed that although daily pacemakers keep on ticking with a reasonably constant period in the absence of environmental cues (zeitgebers), in natural conditions they are accurately synchronized to local time. Adding to the dismay was a peculiar attribute of circadian rhythms; the length of the period is invariant over a wide range of temperatures. This still mysterious property, known as temperature compensation, was viewed largely enigmatic from a chemical or biochemical perspective because most chemical reactions speed up about two- to threefold for every 10°C increase in temperature (or Q_{10}). Moreover, the prevailing thought at the turn of the previous century was that physiology is governed by the principles of homeostasis, effectively dismissing any observed oscillatory behavior as nothing more than random fluctuations of little or no significance.

With the eventual realization that endogenously driven daily rhythms are "real" and widespread, occurring in virtually all organisms, much interest was placed on elucidating the nature of the underlying pacemaker or clock. What are the molecular equivalents of the gears and springs in a watch? Unfortunately, trying to unmask the circadian clock was more like probing a black hole than a black box. While the tools of genetics and molecular biology were reaping great benefits in many areas, as recently as 1994 only two "clock" genes, *period* (*per*) in *Drosophila* and *frequency* (*frq*) in *Neurospora.* molecularly characterized.

Then, almost overnight, there are now a bunch of clock genes identified in humans, rodents, fish, frogs, insects, plants, and even cyanobateria. This gold mine led to important paradigm shifts in how the organization of the circadian timing system is viewed. From a molecular perspective, the basic message from these recent studies is that circadian clocks use the same design principles; namely, the period, amplitude, and phase of a circadian clock are determined by a specialized set of interconnected proteins, many of which undergo daily rhythms in one or more character traits, most notably abundance. From a theoretical point of view, this framework for understanding the molecular underpinnings governing circadian rhythms is very satisfying, because regular change is the basis for timekeeping devices. However, although the RNA and protein products from many genes display cyclical behavior, those that define the clock operate within molecular loops that by virtue of their intrinsic design principles generate their own rhythms. The emerging picture is that at least two interconnected transcriptional and translational feedback loops, one mainly functioning in a positive manner and the other in a negative capacity, provide synchronized pulls and pushes that generate an oscillator with a stable period of around 24 h. Indeed, cells displaying a synthetic oscillatory network were engineered based on the introduction of a simplified negative transcriptional-translational feedback loop. Synchronization of circadian oscillators with the outside world is achieved because light (or other external temporal cues) has acute effects on the levels of one or more of a clock's components, the consequences of which have ripple effects that are experienced throughout the interconnected molecular loops, leading to a stable phase realignment of the endogenous rhythm generator and the external entraining conditions. Yet, despite striking similarities, there are interesting differences that reveal incredible flexibility in how molecules can assemble to build circadian timekeeping devices.

With this preamble, we can begin to appreciate why research on circadian rhythms has generated so much interest lately, being recognized in 1998 by the American Association for the Advancement of Science (AAAS) as the first runner-up in their list of breakthrough of the year. Clocks were also on the AAAS "top 10 list" in 1997. Given the enormous recent progress in our understanding of the molecular bases of circadian clocks, many excellent reviews have been written just in the last 2 years detailing these discoveries). This review is mostly structured as an overview of research on circadian rhythms, from human health issues to mechanisms. More detailed discussions on any particular aspect can be found in the cited references. As far as mechanisms are concerned, focus is placed on the circadian clocks of *Drosophila* and mice; the best-studied animal model systems.

3.1.2. Overview of the Circadian Timing System

Circadian rhythms are operationally defined as biorhythms that exhibit the following three properties: *1*) persist (or free-run) with a period of ≅24 h in the absence of external time cues (or zeitgebers); *2*) reset by changes in environmental conditions, most notably the daily light-dark and temperature cycles; and *3*) have an invariant period length over a wide range of physiologically relevant temperatures (temperature compensation, see above).

It is not clear why circadian clocks are designed with the capacity to keep on ticking for long periods of time in the absence of a cyclical environment (first property), a situation not normally faced in nature. A free-running oscillator might enable animals to maintain synchrony even during days when adverse weather conditions or other unfavorable settings force them to seek shelter in places that receive little or no light. Alternatively, this self-sustaining property might reflect some peculiarity of the design principles required to build these oscillators and not an adaptation with a particular advantage. The ability to reset a circadian clock (second property) allows it to maintain temporal alignment with local time. The last property (i.e., temperature compensation) makes biological sense, because regardless of whether it is a cold day or a warm day, it still lasts 24 h. A mechanism that can offset the effects of temperature on the periodicity of an oscillator is likely to be absolutely necessary in non-homeotherms, if they are to maintain accurate timekeeping. Indeed, early versions of man-made clocks were not very accurate, because increases in temperature lengthened the pendulum causing the clock to slow down.

The circadian timing system is usually depicted as being composed of three interconnected parts: *1*) input pathways that can receive and transmit environmental cues, such as light and temperature, to a *2*) clock or pacemaker, connected to *3*) downstream effector pathways that manifest overt rhythms. Although the input to clock to output paradigm is usually depicted as moving from left to right, there are examples where the flow of information occurs in the opposite direction. These findings support a recent model whereby photic input and circadian clock are viewed in a more fluid relationship being composed of overlapping molecular loops. The demonstration that even in metazoans isolated cells can manifest bona fide circadian rhythms indicates that an intracellular network can describe the molecular events beginning with input and ending with rhythmic output .

3.1.3 What Need for a Circadian Clock?

Why do we have internal clocks that can record the passage of a day? Knowing how long circadian rhythms have been around could suggest a primordial role(s). Although we can only speculate, some 15 years ago it was shown that cyanobacteria manifest bona fide circadian rhythms, dispelling a long-held view that only nucleated creatures danced to the rhythm of endogenous daily pacemakers (59 and references therein). Thus circadian clocks might have been present in the earliest life forms. Early clocks could have endowed organisms lacking spatial barriers with the means to separate incompatible biochemical reactions (e.g., reduction/oxidation or photosynthesis and nitrogen fixation) in time. Another possibility that has been suggested is that because the first appearance of life might have occurred while the earth lacked an extensive ozone layer, having a synchronizable clock could enable an organism to, for example, synthesize DNA at night when the ionization radiation from the Sun is minimal. how did clock mechanisms arise? Again we can only speculate. A hint may be offered by the conserved molecular logic underlying circadian oscillators. As noted above, compelling evidence strongly suggests that all circadian clocks are based on periodic oscillations in contrast to a more hourglass-type of mechanism that has to be turned over every day. It is possible that primitive cells exhibited "spontaneous" oscillations in the levels of macromolecules, perhaps driven by changing rates of synthesis and destruction. These oscillations with widely differing periods could have enhanced the adaptive capabilities of cells by providing them with the means to routinely sample large concentration gradients. It has been speculated that one or more "random" biochemical oscillations with an intrinsic period close to 24 h and likely containing a photosensitive entity was widely adopted by cells because of the selective advantage conferred in tracking daily time. Relevant to this discussion is the observation that PAS or PAS-like domains (named after the three founding members of this superfamily: *Drosophila* PER, mammalian ARNT, and *Drosophila* SIM) are protein motifs commonly found in several eukaryotic clock-relevant proteins. Although the PAS domain was originally shown to mediate protein-protein interactions, in some cases it functions as an interface for ligand or cofactor binding. It is possible that the more canonical PAS domain found in clock proteins from animals evolved from the PAS-like LOV domain (light, oxygen, voltage) that plays a role in a growing number of diverse signaling pathways. Incorporating a motif that can sense environmental conditions into an oscillatory feedback loop with an endogenous period of about a day could have been the start of entrainable circadian clocks.

Whatever the early driving force(s), from our present vantage point it appears that the most critical property of circadian clocks under natural conditions is that they can be reset by external time cues. This property was not merely selected so that we could avoid perpetual jet lag following transmeridian flight. Rather, the ability to anticipate environmental changes enables

organisms to organize their physiology and behavior such that they occur at biologically advantageous times during the day. In addition, a second function that is widely regarded as important is that these endogenous timekeeping devices also serve to impose internal alignments between different biochemical and physiological oscillations.

With this in mind we can appreciate why circadian rhythms are observed at all levels of cellular organization. There are daily oscillations in the levels of enzymes and hormones that affect the timing of cell function, division, and growth. Physiological parameters such as body temperature, immune responses, digestion, susceptibility to anesthesia, and dental pain threshold. all undergo cyclic changes peaking at fixed times during the day. Our visual and mental acuity fluctuate during the day, affecting complex behaviors.

In addition to circadian rhythms that are manifested by and within individuals, there are also group or population rhythms. Some of these rhythms occur multiple times during the lifetime of the organism. For example, in many Diptera, males and females have the same peak time for activity during a daily cycle, increasing the chances of productive encounters between the sexes. In this regard it is interesting to note that because related species of insects have varying daily distributions of activity , the circadian clock might have contributed to insect speciation by establishing temporal barriers limiting the mating opportunities of individuals sharing the same spatial constraints. Other population rhythms involve events that occur once in a lifetime. A well-studied example is the eclosion (emergence from pupal cases) rhythm in *Drosophila*, which is only apparent in a group of individuals comprising mixed developmental stages. The circadian clock gates the timing of eclosion such that it happens in the early morning when the relative humidity in the air is highz.his is important because upon emerging from its pupal case the fruit fly is susceptible to desiccation, and its wings do not readily expand at low humidities. An interesting example of a population rhythm that is composed of many synchronized once-in-a-lifetime events is the daily oscillation in luminescence displayed by the cyanobacterium *Synechocystis sp*. It is interesting to note that this rhythm is somehow transmitted from mother to daughter in mid-stride without missing a beat, as the replication cycle is shorter than 24 h. Stable population rhythms are not restricted to individuals of the same species. The classic tango between bees and plants is a case in point. Different flowering plants have characteristic times during the day when they open and close their petals, making nectar available only at restricted times. The presence of an endogenous and synchronizable clock maximizes the feeding success of bees by enabling them to return to the same plants at times in the day when their nectar is available.

These rhythms also highlight the fact that the "adaptive value" of a circadian rhythm might only be understood within the framework of the dynamic interactions occurring in particular habitats. On a more global perspective, it is important to consider that organisms do not adapt to a static environment but one that undergoes daily changes. Oscillations in physical parameters (e.g., intensity of visible light, water and air temperature, relative humidity) will pervade natural habitats and their occupants, adding a strong daily component to the intricate relationships that govern ecosystems. Whether physical or biotic factors play primary or secondary roles in influencing the daily activity patterns of animals is likely to be largely dependent on the species in question. It has been suggested that the high rate of water loss in dry air might be the main driving force for the nocturnal activities of some small animals. On the other hand, biotic factors such as predation are relatively more significant in determining the daily activity patterns of larger animals. In any case, it is almost certain that many behaviors involved in mating, reproduction, seeking shelter, hunting for food, and avoiding predators evolved to take advantage of temporal niches. A recent study showed that the ability of *Drosophila* to smell odors is under circadian regulation (90), suggesting that many cyclical behaviors are ultimately "hardwired" into clocks that regulate physiological changes in the ability to sense, interpret, and respond to various cues in the environment.

Two points of caution should be made at this stage. First, given the "chicken-and-egg" problem (which came first?) inherent in the complex and highly interdependent interactions between life forms and their physical environments, it is not possible to determine with a high degree of certainty the cause and effect in the dynamic relationships between individuals. Second, although light is the primary synchronizer of circadian clocks in nature, other physical or biotic factors might be the primary force(s) governing the adaptive function of a circadian rhythm.

Circadian clocks are not limited to timing daily events, but also play a role in adapting to seasonal changes in day length (photoperiod). By distinguishing between the long days (or short nights) of summer/spring and the short days (or long nights) of autumn/winter, organisms that live in temperate latitudes can anticipate and respond to seasonal changes in external conditions by controlling appropriate developmental, physiological, and behavioral switches. For example, certain species of insects enter diapause, a period of growth arrestment that is induced by short photoperiods or cold temperatures.The Siberian hamster typically breeds only in the spring and summer months, a seasonal adaptation that is partly regulated by regression of the gonads induced by the expanded nocturnal release of melatonin. Photoperiodism has been extensively studied in plants, where floral initiation can be experimentally controlled by altering day length. Recent genetic evidence in the flowering plant *Arabidopsis* clearly indicates that common elements participate in circadian clock function and in eliciting photoperiodic responses.

In addition to day length, circadian rhythms are modulated by seasonal changes in average daily temperatures. Diurnal animals typically respond to colder temperatures by displaying a greater proportion of their activity during daytime hours, whereas nighttime activity predominates at warmer temperatures. This directional response has a clear adaptive value, ensuring that the activity of an organism is maximal at a time of day when the temperature would be expected to be optimal for activity. Direct evidence for circadian clock function in temperature-induced alterations in the timing of the daily distribution of activity has been shown in *Drosophila melanogaster*, where a thermosensitive splicing event in *per* RNA contributes to preferential daytime activity on cold days.

A less classic example in which circadian clocks are used is during long distance navigation of birds, insects, and other animals to predetermined target areas using the azimuth of the sun as a compass. By artificially resetting the circadian clock, the animal misrepresents the position of the sun leading to a predictable change in the direction of navigation .

Despite the widespread manifestation of circadian rhythms by living forms, ablating central pacemaker tissues or abolishing the activities of key clock components does not appear to affect viability. An exception is the *D. melanogaster* "double-time" (DBT) protein, a kinase that regulates the phosphorylation and stability of PER. A presumptive null or strong hypomorphic allele called dbt^{P} is associated with pupal lethality. However, it is almost certain that this lethal phenotype is unrelated to clock-specific roles for DBT and is a consequence of developmental defects. Despite the (presumably) nonessential nature of circadian oscillators, there are examples where longevity, ability to avoid predators, and reproductive fitness can be reduced in mutant strains that are either arrhythmic or manifest behavioral rhythms with significantly abnormal periods. Part of the problem in trying to address the presumed selective advantage of circadian oscillators is that, for the most part, organisms that lack or have altered clocks have been assessed under mlaboratory conditions in which individuals are housed under favorable environmental conditions in the absence of predators or competition from their wild-type counterparts for food acquisition or partners to mate.

3.1.4 Human Health Issues

The medical implications of circadian rhythms are immense and can be broadly classified into the following three groups

3.1.4.1. Effects imposed by external conditions on otherwise healthy individuals.

This group can be further divided into symptoms that arise from acute changes in external time cues, such as transmeridian flight (jet lag), and those that result from continual changes in light-dark cycles, most notably arising from shift work. Technological advances, from the invention of the light bulb to dramatic increases in the speed of air travel to highly integrated world wide communication systems, have permitted individuals and societies to escape the temporal constraints otherwise imposed by the natural environment. However, this "escapement" has a price tag, because human physiology has not undergone comparable changes and remains firmly interconnected with the internal pacemakers we all carry. Performing tasks during times in the day when psychomotor capabilities are suboptimal is associated with many serious consequences. For example, nurses on a repetitive shift work schedule are two- to threefold more likely to misdiagnose and wrongly treat patients than their daytime counterparts. More extreme examples of accidents related to the ill effects of "unnatural" work schedules include the Chernobyl nuclear plant in 1986, the chemical explosion of the Union Carbide plant in Bhopal, India, in 1984 and the grounding of the oil tanker Exxon *Valdez* in 1989.

The effects of transmeridian flight and shift work on the human circadian timing system likely occur at two levels. For many years it was believed that the primary circadian pacemaker in mammals is located in the suprachiasmatic nucleus (SCN) in the brain. Although this idea remains relatively intact, more recent studies have shown that similar to *Drosophila*, independent circadian pacemakers are present in many tissues in vertebrates such as zebrafish and mammals. The emerging picture is that in intact mammals, much of the photic input to the circadian timing system is transduced via the retinohypothalamic tract (RHT) to the SCN (reviewed in Refs. 44 and 104), which in turn conveys time-of-day information to peripheral clocks that have tissue-specific regulatory features Desynchronization not only occurs between the external environment and the SCN rhythm generator but also affects phase alignments between the different peripheral clocks. Different rates of resynchronization amongst the cellular clocks in the SCN and those found in the various tissues likely contribute to the dysfunction associated with jet lag and other abrupt changes in light-dark cycles .

Melatonin, a naturally produced hormone that is under circadian regulation, has been used to alleviate disorders associated with jet lag and shift work. Numerous lines of evidence suggest that the administration of melatonin can elicit phase shifts, although other roles for this "wonder drug", such as beneficial effects on longevity, combating cancer, and mounting immune responses remain controversial. Another successful approach for treating jet lag and shift work has been the use of phototherapy. The rationale for this noninvasive treatment is based on earlier work in model organisms showing that depending on when during the night a short pulse of light is administered, it can evoke either a delay or advance in the phase of the clock. Ideally, by correctly timing the phototherapeutic treatment, the rate of resynchronization to local time can be accelerated.

It is estimated that more than 20% of the U.S. work force is subjected to shifting work schedules . This includes a wide variety of occupations where suboptimal psychomotor capabilities could have disastrous consequences for many people, such as medical personnel, pilots , air traffic controllers and other systems administrator, security and military personnel , and commercial truck drivers . More attention needs to be placed on the physiological, behavioral, social, and economic consequences of maintaining societies that are active round the clock. Indeed, a growing number of private and public entities have emerged that use circadian principles to recommend ways of minimizing the malaise associated with abrupt changes in light-dark schedules.

3.1.4.2.Issues related to diagnosis and treatment.

Many physiological and behavioral variables change in a rhythmic manner over the course of a day. Whether the lack of accounting for circadian variations in medically relevant variables has had a significant negative impact on diagnosis and treatment plans is not clear. Sampling at different times of day and knowing the natural rhythm of the variable in question would enable physicians a more precise account of the status of the patient. However, in addition to the inherent problem of feasibility in round-the-clock sampling, other factors such as exposure to "unnatural" light conditions or patients with malfunctions in their circadian timing system might lead to rhythms that are altered, rendering the variable unreliable as a diagnostic indicator.

Effect of antihypertensive and hypoglycemic agents in management of hypertension and Diabetic mellitus has connected to timely of the day, blood pressure is lower around 6:00am while release of insulin is also lower around 4:00am- 5.30am (Somolgive Effect).

3.1.4.3. Disorders or disease states that appear to be causally linked to malfunctions in the circadian timing system.

Malfunctions in the circadian timing system are associated with several disorders such as chronic sleep disturbances, manic-depression and seasonal affective disorders (SAD, or winter depression) . This is a very active area of research. The extent to which circadian disturbances are causally linked to the manifestation of the disorder or are secondary downstream events of the diseased state are not clear. Nonetheless, many of the symptoms associated with certain chronic sleep problems and affective disorders can be alleviated by alterations in light-dark schedules . With recent advances in molecular genetics, it will be possible to determine whether polymorphisms in clock genes are causally linked to disorders that show a strong circadian component. Whether this line of investigation will also explain the basis for "night owls" and "early birds" remains to be seen . The recent demonstration that rest in *D. melanogaster* has physiological and behavioral correlates with sleep in mammals should provide interesting insights into understanding the role of circadian factors on regulating sleep and its substrates .

3.1.5. The Fly and Mammalian Circadian Clocks

Progress in understanding the molecular underpinnings governing circadian rhythms has been remarkable in the last 3 years. This has included the isolation, characterization, and manipulation of clock gene products and their interconnections in cyanobacteria, *Neurospora*, plants, *Drosophila*, zebrafish, amphibians and mammals. The discussion that follows is limited in scope to a bird’s-eye view of the clockworks operating in *Drosophila* and mice, the two best-studied animal model systems for understanding neural circadian pacemakers. Both organisms show remarkable similarities in clock components and overall molecular logic. Indeed, due to extensive similarities, much "cross-fertilization" has occurred in studies using these two model organisms, and the story of one is not complete without the other. Despite numerous apparent similarities, it is also clear that striking differences exist.

3.1.5.1.Drosophila.

At least seven circadian-relevant clock/light-input genes have been characterized in *D. melanogaster* (to avoid confusion with structural homologs in other species, all the genes and protein products corresponding to those from *D. melanogaster* will be preceded by the suffix "*dm*"). These are *dmclock* (*dmClk*) , *dmcycle* (*dmcyc*/*dmBmal1*) , *dmperiod* (*dmper*) , *dmtimeless* (*dmtim*) , *doubletime* (*dmdbt*) , *dmcryptochrome* (*dmcry*) and *dmvrille* (*dmvri*) . In addition, at least one rhythmically expressed factor that functions downstream of the clock in effector pathways has been identified, namely, pigment dispersing factor (*dmpdf*) . How do the RNA and protein products of these genes interact to assemble an entrainable self-sustaining oscillator that can control overt rhythms? Although the picture is not complete, it is clear that the core mechanism comprises at least two interconnected positive and negative transcriptional-translational feedback loops that take 24 h to complete a cycle . Entrainment of these molecular loops by light-dark cycles is achieved because photic cues stimulate the rapid degradation of *dm*TIM (71, 116, 208). Because most of the core clock proteins regulate clock gene expression, daily oscillations in their activities likely drive rhythmic expression of target genes involved in output effector pathways , although a direct molecular link has not been shown in *Drosophila*.

4.0Conclusions

Incredible progress has been made in understanding the molecular and cellular bases of circadian rhythms, and this is sure to continue at a rapid pace. The further we peer into the clockworks of a growing number of model organisms, the more we are struck by two seemingly opposing viewpoints; namely, within the apparent constraints of striking similarities are embedded radical differences. Whether this reflects divergent or convergent evolution (or something else) is a discussion for another time. However, understanding the molecular logic underlying the differences in these oscillatory networks will give us insights into how different species adapted to life on our rotating planet

5.0 Summary

Biological clocks are internal timing mechanisms which can have a period of several hours, a day, or a year. The circadian clock runs with a period of *about* 24 hours. Circadian clocks have two functional characteristics: 1) they will persist (=free-run) with a pm eriod of about a 24 hours in the absence of environmental cues; and 2) they will synchronize (=entrain) to a 24 hour environmental cue, such as the light-dark cycle. Entrainment is important because it permits animals to synchronize to a changes in the seasonal photocycle. How they synchronize to the cue is determined by the phase response curve (PRC).

6.0 Tutor-Marked Assignment

1. Explain circannual rhythm .

2. Explain circadian rhythms in mammals with examples.

3. How are biological rhythms involved in timing of seasonal events? In general, how would you experimentally confirm that a rhythm is involved?

4. What is the experimental evidence that a biological clock is involved in photoperiod time measurement (PTM)?

5. You have revealed a putative biological clock controlling lizard activity. What general experiments might you run to confirm that it is indeed a biological clock?

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Unit 2 Sleep

CONTENTS

5.0 Summary.

6.0 Tutor-Marked Assignment

7.0 References

INTRODUCTION

What is sleep? Sleep is a readily reversible state of reduced responsiveness/interaction with the environment.

We should certainly define the basic biological state that we have been discussing. Most of the characteristics that people invoke to define sleep- immobility, eye closure, snoring- can be readily simulated in the waking state. We should ask then, what is the most fundamental difference between a human being awake and a human being asleep?

Answer: The crucial event that occurs as we fall asleep is an abrupt shut down of the neural processes that allow us to perceive the world around us. At one moment we are awake, and can see and hear. A fraction of a second later we are asleep, and we are completely blind and completely deaf. Another way of saying this is that sleep is a behavioral state of complete perceptual disengagement from the environment. Sleep is an active process in which sensory stimulation is blocked or modified in some way such that we cease to be conscious of the world around us. In fact, research over the past couple of decades has decisively established that the sleeping brain is an active brain. Because so many people believe that sleep occurs when the brain is "turned off," I like to say, "If that is your image of sleep, then hear this, 'the brain never sleeps!'"

Of course, there is much more to say about what sleep is and what the sleeping brain does, but not here. That would make this document far too long.

2.0 OBJECTIVES.

At the end of this unit, students should be able to:

1. Define sleep and mention types of sleep.
2. Causes of sleep disorder.
3. Biological rhythms as a function of sleep.
4. Effects of sleep deprivation.
5. Differences between sleep and Drowsiness

3.0 MAIN CONTENT

3.1 TYPES OF SLEEP

The sleep-wake cycle is also under circadian control and free-runs under constant conditions. Sleep is divided into:

I. Slow Wave Sleep (SWS, or NREM)
II. Rapid Eye Movement (REM sleep).

REM sleep is less common and is characterized by a lack of movement, dreaming, and greater sleep depth. Sleep is regulated in part by the reticular activating system

(RAS). The neural circuits controlling REM and non-REM sleep probably involve an antagonism between Acetylcholine and Serotonin/Norepinephrine. All vertebrates sleep. Sleep is probably needed as part of a recovery process, although the precise reasons for sleep remain unknown.

3.2 What causes us to feel sleepy?

To repeat, the size of your sleep debt determines the strength of the tendency or ability to fall asleep. If your sleep debt is zero, sleep is impossible. If your sleep debt is very low, only a small amount of stimulation is required to keep you awake. If your sleep debt is very large, no amount of stimulation can keep you awake.

Think of your sleep debt as a very heavy load. You are carrying with the help of two companions. Together, the three of you can hold it up. One of your companions is pretty strong. This companion is your biological clock. The other companion is not quite so strong, and represents transient external stimulation, e.g. noise, light, excitement, anger, pain, and so on. If one of your companions drops out, you and the other may be able to manage. If both companions drop out and you are left alone, you absolutely cannot hold up the heavy sleep debt and you are crushed. In other words, you cannot stay awake no matter how hard you try. Even without external stimulation, it is usually easy to stay awake and alert if your stronger companion, the biological clock, is helping you.

With the above image in mind, it should be clear that the things we usually assume cause us to become drowsy or to fall asleep actually do not cause us to become drowsy or to fall asleep. Their true role is to unmask any tendency to fall asleep that is present already. If you believe that boredom, a warm room, or a heavy meal causes sleep, you are completely wrong! If boredom, a warm room, or anything else seems to cause you to feel drowsy, you have a sleep debt and you need to be stimulated in order to stay awake. If you frequently feel sleepy or drowsy in any dull or sedentary situation, you almost certainly have a very large sleep debt. A large sleep debt makes us vulnerable to apathy, inattention, and unintended sleep episodes. Errors, accidents, injuries, deaths, and catastrophes can be the result, not to mention poor grades.

3.3 How much sleep do we need?

Each of us has a specific daily sleep requirement. The average sleep requirement for college students is well over eight hours, and the majority of students would fall within the range of this value plus or minus one hour. If this amount is not obtained, a sleep debt is created. All lost sleep accumulates progressively as a larger and larger sleep indebtedness. Furthermore, your sleep debt does not go away or spontaneously decrease. The only way to reduce your individual sleep debt is by obtaining extra sleep over and above your daily requirement.

The powerful brain mechanism that regulates the daily amount of sleep is called the sleep hemostat. By increasing the tendency to fall asleep progressively in direct proportion to the increasing size of the sleep debt, this homeostatic process ensures that most people will get the amount of sleep they need, or close to it. The elevated sleep tendency together with the associated drowsiness and an intense desire for sleep would ordinarily prevent most people from becoming dangerously sleep deprived because they would go to bed early, or sleep late, when such excessive daytime sleepiness occurred.

However, in our society we are prone to ignore or resist nature's signal that we need more sleep, and we often resist far too long. At this point, we cannot resist falling asleep. Depending on when and where this happens, falling asleep can be tragic, or merely inconvenient, an individual's fundamental daily sleep requirement.

3.4 **What is the biological clock?**

The biological clock is a term applied to the brain process which causes us to have 24-hour fluctuations in body temperature, hormone secretion, and a host of other bodily activities. Its most important function is to foster the daily cycle of sleep and wakefulness. The major role of the biological clock in the regulation of sleep and wakefulness is to provide an internal and very powerful wake-up signal to the rest of the brain.

This powerful signal is called clock-dependent alerting, and when present, it powerfully opposes the tendency to fall asleep. In the absence of any other stimulation, the process of clock-dependent alerting alone can usually keep us wide awake throughout the entire day. This may not be true if we are carrying a fairly large sleep debt. In ordinary circumstances, clock-dependent alerting is always synchronized with the daytime hours. However, if we travel rapidly to other time zones, it may occur during the sleeping hours, and we experience "jet lag."

What is the biological clock and what does it have to do with jet lag? Like many other biological functions, sleep and waking follow a daily, biological cycle known as a **circadian rhythm.** The human biological clock is governed by a tiny cluster of neurons in the brain known as the **suprachiasmatic nucleus (SCN)** that regulates proteins related to metabolism and alertness.

Normally, the rhythms and chemistry of the body's cycles interact smoothly, but when we cross several time zones in one day, hormonal, temperature, and digestive cycles become desynchronized.

3.5 **Sleep disorders**

Sleep disorders are illnesses and disturbances of sleep and wakefulness that are caused by abnormalities existing only during sleep or abnormalities of specific sleep mechanisms. These abnormalities typically produce symptoms during wakefulness that are easily recognized if the person is aware of their significance, but the fundamental pathology exists during sleep. Though the symptoms that exist during wakefulness can be helpful in recognizing the possible existence of a sleep disorder, an absolute certainty generally requires an examination of the patient during sleep utilizing a procedure called polysomnography, also widely known as a "sleep test."

3.5.1 How common are sleep disorders?

Though some are rare, most sleep disorders appear to be highly prevalent. The national prevalence has been established scientifically for one specific disorder;

1) Obstructive sleep apnea: This disorder afflicts 24 percent of adult males and 9 percent of adult females which extrapolates to 30 million Americans. Of these,

about 20 million are in the early stages, and about 10 million have progressed to a level of severity that requires treatment. Of greater relevance to students is that we found the problem in about 8 percent of a fairly large sample.

2) The Restless Legs Syndrome has been estimated to afflict at least 12 million Americans. A recent Gallup Poll has established a national prevalence of 14 percent for chronic insomnia. The same poll reported that half of all adults have had difficulty sleeping at one time or another.

3) **Sleepwalking**, also known as **somnambulism**, is a sleep disorder belonging to the parasomnia family. Sleepwalkers arise from the slow wave sleep stage in a state of low consciousness and perform activities that are usually performed during a state of full consciousness. These activities can be as benign as sitting up in bed, walking to the bathroom, and cleaning, or as hazardous as cooking, driving, violent gestures, grabbing at hallucinated objects, or even homicide.

Although generally sleepwalking cases consist of simple, repeated behaviours, there are occasionally reports of people performing complex behaviours while asleep, although their legitimacy is often disputed. Sleepwalkers often have little or no memory of the incident, as they are not truly conscious. Although their eyes are open, their expression is dim and glazed over.[9] Sleepwalking may last as little as 30 seconds or as long as 30 minutes.

3.5.2 Effects of Sleep Deprivation:

During practically any time of the day, most college students are sleepy enough to fall asleep in less than five minutes! Many of us think it is normal to be sleepy during certain activities, but the truth is, if you are getting enough sleep, you should be able to stay alert all day no matter what you are doing, even if you are in CIV or Chem lecture. A person's daily need for sleep is determined by how much sleep a person needs in order to maintain the same level of alertness that he or she had the day before, and is usually from 8 to 10 hours a night. Sleep deprivation occurs when people do not get their daily need for sleep, and accumulates into what is called a sleep debt. This sleep debt can be one hour or hundreds of hours, and it keeps on building up as long as a person is not getting his or her daily sleep requirements. The harms of a large sleep debt include: impaired performance in daily activities and a really strong desire to sleep, even at the worst times (such as while driving or trying to write that term paper). Benefits of adequate sleep are feeling energetic and on top of things all day. The only thing that can reduce the sleep debt is getting more than your daily need for sleep.

Another factor that affects our sleep wake cycles is the function of the biological clock. Biological rhythms follow patterns during the day that are fairly standard for all people: a strong wake alerting in the morning, a dip in the early afternoon (making us want to snooze after lunch), and another strong alerting period at the beginning of the night (getting us geared for a big party night or a long night of studying!).

Exercise improved alertness, despite sleep indebt, alcohol increase length of sleep period and sleeping period varies according to age.

3.5.3 Good Sleep Hygiene:

There are many ways that we can improve our sleep. One of the simplest is to have good sleep hygiene. This is a good way to get better sleep, plus be healthier in general. The six components of good sleep hygiene are:

1) Having a good setting for sleep. Try to make bedtime a quiet time, and reserve your bed for just sleeping in.

2) Sleep regularity. Keeping regular hours will not only train your body to be more alert when you wake up, but will also help you to manage your time better.

3) Synchrony. This is knowing when your biological clock is alerting you or making you sleepy, and planning naps and scheduling certain events accordingly. This is also knowing if you are a morning or a night person and not fighting your natural tendencies.

4) Total amount of sleep. This is the most important factor for obvious reasons. If you get your optimal amount of sleep, you should be able to stay alert all day. What a concept.

5) Good health in general. Proper diet, exercise and sleep go hand in hand.

6) Avoid drugs that would affect the sleep wake-cycle. Common drugs that affect our sleep are alcohol (which may make us sleepy early in the night, then wake us up in the middle of the night), caffeine, and sleeping pills (unless you have a legitimate sleeping problem).

Another thing to keep in mind in respect to the biological clock is that it is more important to get up than go to sleep at the same time everyday. So if you have that big paper due, it's better for your clock if you stay up late and get up at the same time. Also, if you know you have a tough week coming up, plan to get more sleep the week before so that your body is better equipped to handle the shock it's going to get. Napping is a good way to cut down on your sleep debt, but remember that napping in the early evening may keep you up later at night, canceling the benefits of the nap.

3.6 **Drowsiness is red alert!**

I sincerely hope that sleep deprived students will take the following advice very seriously. Drowsiness is red alert! Drowsiness is the last step before falling asleep, not the first. Imagine what that could mean when you're behind the wheel of a car driving on the highway. Drowsiness may mean you are seconds from a disaster. If everyone responded as if it were an emergency when they became aware of feeling drowsy, an enormous amount of human suffering and catastrophic events would be avoided.

4.0 CONCLUSION

Thus, an amazing paradox exists in our educational system. We have learned that the consequences of pervasive sleep deprivation and undiagnosed sleep disorders are collectively one of our nation's biggest and most serious problems. Falling asleep at the wheel and in other hazardous situations is a leading cause of death and disability. A single sleep disorder, obstructive sleep apnea, is now known to afflict 30 million Americans.

The paradox is that our society remains a vast reservoir of ignorance about sleep deprivation and sleep disorders. The benefits of the hard earned knowledge about normal and pathological sleep have not been passed on to the general public and practicing physicians. Millions of people are suffering and thousands are dying each year without ever knowing the true cause of their problems.

In this topic, students have learnt about sleep and dreams, the nature and consequences of sleep deprivation, and common sleep disorder symptoms, drowsiness as a red alert.

5.0 SUMMARY

The single most important thing to remember from this document is that drowsiness means you are seconds away from sleep. Seconds away from sleep may mean seconds away from death. If you are behind the wheel, just a few seconds of sleep can lead to a catastrophic disaster. Many freshmen may not do very much driving, but if you are a passenger, pay attention to the person who is driving. Recently, my limousine driver fell asleep at the wheel. If I had not been paying attention, I would not be here today. All this can be avoided with one simple rule, immediately stop any potentially dangerous activity when you feel drowsy. Encourage others to do likewise.

Drowsiness is red alert! Learn to be sensitive to your level of drowsiness. Being sensitive to your sleep tendency and responding appropriately may save your life.

6.0 Tutor-Marked Assignment

1. What is sleep?
2. Discuss the two types of sleep.
3. Discuss relationship between biological rhythms sleep.
4. Mention six sleep hygiene.
5. Effect of drowsiness on sleep

6. Explain the term sleep disorder with examples

7.0 References

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