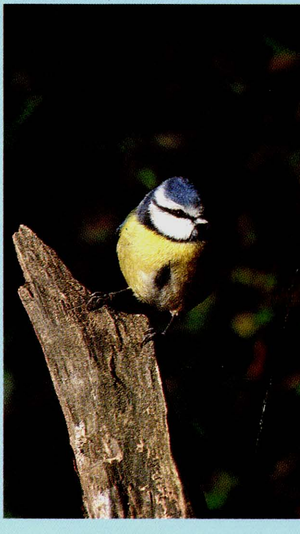

Animal Behaviour

Practical work and data response exercises at GCSE

by
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Association for the Study of Animal Behaviour

ANIMAL BEHAVIOUR

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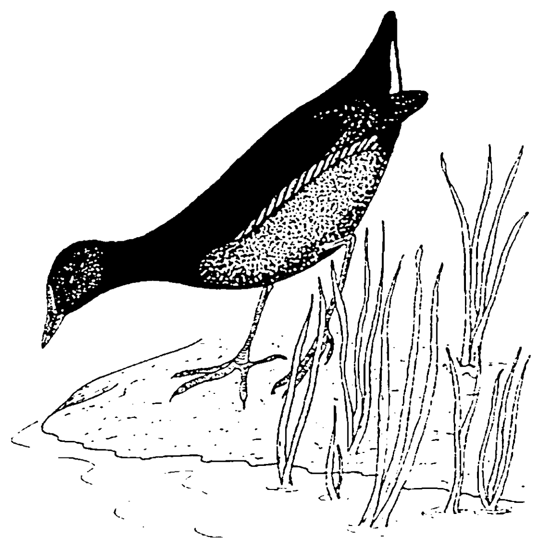
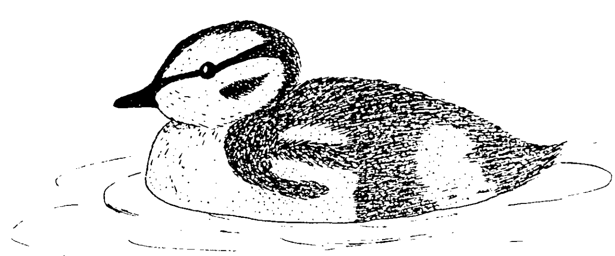
1997





Association for the Study of Animal Behaviour

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INTRODUCTION

We hope that this book will fulfil three aims. First, to encourage the use of more practical work on animal and human behaviour at GCSE level. Secondly, to enable pupils to develop an understanding of some basic principles of animal behaviour, relevant to biology and psychology. Thirdly, to help pupils studying GCSE Biology, Psychology or Science to develop their study skills by tackling data response exercises (structured questions). Most of the book consists of suggested practical work and data response exercises. In addition, we have included sections on describing and measuring behaviour, on the practicalities of using animals in schools, on safety and legislation and on ethical issues surrounding the use of live animals in schools.

Practicals

Some of the practicals use pupils - generally available in most schools - as subjects; others require access to certain non-human animals. Details of where to obtain these and other animals are contained in the section on 'Practicalities'. Our hope is that the sections on 'Practicals', 'Practicalities' and 'Describing and measuring behaviour' will, between them, allow a wider range of interesting and challenging practical work to be carried out on live animals than is often the case. We have written these sections to allow a range of practical work from very structured activities through less formal investigations to more open-ended (project) work.

At GCSE, all Biology and Science syllabuses now have virtually identical schemes for the assessment of coursework. Animal and human behaviour studies can provide a wealth of suitable material for investigations allowing candidates to demonstrate skills of planning, obtaining evidence, analysing evidence, drawing conclusions and evaluating evidence. Indeed, behaviour studies have a number of significant points in their favour:

- Behaviour investigations can often be carried out over a shorter period of time than many other biology investigations. This is especially true of those which use laboratory animals and humans.
- Candidates generally find behaviour studies interesting and motivating, helping them to perform to the best of their ability.
- Candidates from a very wide range of abilities can often start with a single investigation (for example, the feeding behaviour of snails) and take it in different directions, displaying skills of planning and obtaining evidence, according to their interests and abilities.
- Behaviour studies, unlike studies in some of the other sciences, need not require the use of expensive or complex equipment.
- Behaviour studies often produce a wealth of quantitative data allowing candidates to display their prowess at analysing evidence, drawing conclusions and evaluating evidence.

- It is often easier for candidates to undertake original work on behaviour than in many other branches of science.

For all these reasons candidates can score well if doing behaviour investigations as part of their GCSE coursework. In addition, the practicals suggested in this volume can be used to teach and back up a number of areas of GCSE biology theory - for example adaptations to the environment ('Choice of egg-laying site by female seed beetles') and feeding ('Where to feed? - decision making in pigeons').

The subject content of GCSE Psychology syllabuses focuses on human behaviour, though studies of animals are included, for example, the use of rats in research on operant conditioning. The coursework, however, can focus on either human or animal behaviour. The practicals suggested in this book certainly allow candidates the scope to show that they can plan, carry out, acquire and then analyse the information and data they obtain, draw conclusions on the basis of the evidence and demonstrate their ability to present a cogent and considered report of their investigation.

Many of the practicals in this volume can be used to exemplify topics on the *'individual processes'* section of all GCSE syllabuses. For example, emotion ('How fearful are humans of various animals?' and 'Stress in social situations'), perception ('The interpretation of a visual stimulus - the power of an illusion' and 'Navigation in the absence of visual cues') and learning ('The influence of feedback in learning a skill'). The collection of practicals here could also help to teach aspects of *'interpersonal processes'*, for example, gender identity ('The development of behaviour - removing a sweater'). The data response questions concerning 'Obedience of drivers at traffic lights' and 'Human preferences for dogs' might also be the stimulus for an investigation. Some of the other practicals in the book could be carried out simply because the students are fascinated by the behaviour of the particular animals. For example, the 'Flexibility in the choice of a cat's sleeping site' and 'Where to feed? - decision making in pigeons'. (The latter study is unlikely to disturb the birds unduly or affect their long-term survival or breeding success, thus adhering to the ethical guidelines concerning animal studies that are outlined in the Psychology syllabuses.)

In all practical work on animal behaviour it is essential that due consideration is given to safety issues and to the ethics and legalities of using live animals in schools. The sections on 'Safety and legislation' and 'Ethics of using live animals in schools' are intended to cover these issues.

Data response exercises

The data response exercises (structured questions) start with one or more pieces of stimulus material, such as a piece of text, a photograph, some numerical data or a drawing. Following the stimulus items there are questions that relate to them. Few of these questions require factual knowledge about animal behaviour; most can be answered entirely from the stimulus material. The intention is that practice at these will help pupils develop skills of analysis, comprehension and data handling, such as are required in GCSE Biology, Psychology and Science examinations. Each data response exercise is provided at two levels - Intermediate and Higher. The number of marks for each question is indicated by the number in brackets at the end of the question. 'Suggested' answers are provided towards the back of the book.

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DESCRIBING AND MEASURING BEHAVIOUR

Describing behaviours

Scientists describe behaviours so that they can record data, often in the form of numbers, and then analyse them. In everyday conversation, behaviours are given names and may be described by their *consequences*. We talk, for example, about lambs 'playing' when we see them prancing around a field or jumping onto and off a fallen tree and may assume that the consequence of this is that their muscles become stronger. In scientific studies of behaviour, though, it is generally better to describe a behaviour by its *structure* (in other words, what the animal is actually doing), rather than by its consequences (in other words, what we think the purpose of the behaviour may be). The reason for this is that it stops us assuming that we know what the behaviour is for. After all, what we think of as two lambs playing might actually be a dominance interaction in which one of the lambs - the dominant one - forces the other - the subordinate - to give way. So in this case, describing the behaviour as 'one lamb chases another' would probably be better than describing it as 'two lambs playing'.

Having decided to describe behaviours by their structures rather than their consequences, the next thing to do is to list the various behaviours shown by the animal in which you are interested. The behaviours you list should be clearly *defined*. For example, when studying dogs it is no good having a behaviour called 'sleeps' unless you are sure you can distinguish 'sleeps' from 'lies inactive'. After all, just because a dog is lying still with its eyes closed, doesn't mean it must be asleep.

Not only should the behaviours you list be unambiguous, they should be *non-overlapping* because when we *score* events, we do not want any *double-counting*. If describing the movements of horses, for example, it may be unwise to list the behaviour 'prances' unless you are sure that it doesn't overlap with any of 'walks', 'trots', 'canters' and 'gallops'. The best way to ensure that the behaviours you list are unambiguous and non-overlapping is to provide a clear description of each. This description may be written or drawn. Ideally, get someone else to check your descriptions. It is also a good idea to carry out a pilot study before deciding on your list of behaviours so that the first numbers you subsequently collect give reliable data.

Finally, keep in mind what effect your presence has on the animals you are studying. Unless you are interested in studying the way animals relate to humans, you will probably want to minimise the effect you have on the behaviour of your animals. Think carefully about how you can achieve this aim.

Measuring behaviours

Behaviours can be measured in a number of ways. The most frequently used measures are: *interval* (technically known as latency), *frequency* and *duration.*

Interval

An interval is a measure of how long it takes till the behaviour in which you are interested occurs. Intervals may be measured in seconds, minutes or hours.

Suppose, for example, you are interested in the response of adult female locusts to the songs produced by different male locusts. You might try tape recording the songs of different males and then playing them, one by one, to isolated females. You could then measure the interval between starting to playback a male song and the time at which the female starts to move towards the loudspeaker.

Frequency

The frequency with which a behaviour occurs is the number of times the behaviour takes place during an observation period. Frequencies are usually measured in units of per minute, per hour or per day.

Suppose, for instance, you are recording the hunting behaviour of cats of different ages. You might watch cats of known ages in their owners' gardens for a total of four hours per cat and record the number of times during the four hours that the cat chases any potential prey.

Duration

The duration of a behaviour is a measure of how long it lasts for. Durations may be measured in seconds, minutes or hours.

For example, the sucking behaviour of lambs can be measured by timing the length of suckling bouts to the nearest second.

Sampling rules

Unless you are observing an isolated animal, you need to decide how you are going to sample from the group of animals. Sampling is needed because it is almost never realistic to try and provide a complete description of the behaviour of a whole group of animals. Three sampling rules are widely used.

Focal sampling

Here you concentrate (focus) on just a single individual for a predetermined time - e.g. 30 minutes. Once this period is up, you either stop recording or switch to another individual. Focal sampling is only possible if you can tell individuals apart from one another. For example, you may be able to identify the individuals in a herd of cows by a combination of their coat patterns and ear tags.

Scan sampling

Here you look round (scan) the group of animals and, in some way, record what they are doing. For example, you might scan a group of horses and record how many are feeding, how many standing inactive, how many lying down, etc.. Scan sampling is useful for scoring several animals but is not appropriate for scoring very brief events such as pecking.

Behaviour sampling

Here you focus not on individuals but on a particular behaviour. You scan the group of animals and then concentrate on the first individual you see that is showing the behaviour in which you are interested. For example, suppose you are studying pollination by honey bees. You might concentrate only on those bees either collecting pollen or feeding on nectar.

Recording rules

You need to decide how often you are going to record your results. Three main approaches are used. All three approaches work best if you have someone to help you.

Continuous recording

Here you try to record all the behaviours, and their durations, shown by an animal. This is only normally possible if:

- you select just one individual (focal sampling)
- there are only a small number of behaviour categories and you can remember these without having to take you eyes off the animal
- the animal changes behaviour only infrequently
- you have someone to help you keep a note of the time.

Instantaneous sampling

This is best done if you have someone to work with you who has a watch with a second-hand. Every 15 or 30 or 60 seconds, precisely, he or she says 'now' and you write down the behaviour(s) shown. Instantaneous sampling can be done either with focal sampling or scan sampling but doesn't work well at recording very brief behaviours.

One-zero sampling

Again, this is best done if you have someone to work with you who has a watch with a second-hand. Every 15 or 30 or 60 seconds, precisely, he or she says 'now' and you then record whether or not the behaviour in which you are interested has occurred *since the last beep*. If it has, you record a '1'. If it hasn't, you record a '0'. One-zero sampling is most often used with focal sampling for recording behaviours which don't last long, such as grooming or drinking.

Recording medium

Finally, you need to decide how to make a record of your results. The basic principle to keep in mind is the need to find a method which gives you a good quantitative record of the behaviours you are interested in. Several approaches are used.

Check sheet

A check sheet is a recording medium you need to design yourself. An example of one is given in Figure 1. This shows a check sheet used to record the behaviour of an adult female Syrian hamster for 5 minutes after she had been placed in a new home. The new home was provided with bedding, food and water and the animal had been woken up and placed in her new home at time zero - i.e. 15 seconds before the first observation which was at Time 00 15. Instantaneous sampling was used.

Date 15 Oct 1996	**Animal** Adult female Syrian hamster, 'Gemima', born May 1995, Mass = 31g	**Aim** To see how behaviour changes on being put in new cage at 14.25 hours
TIME	**BEHAVIOUR**	**NOTES**
00 15	Runs	Looks startled
00 30	Runs	
00 45	Stands on hind legs	
01 00	Runs	
01 15	Stands on hind legs	
01 30	Runs	
01 45	Stands still on all four legs	
02 00	Runs	Not running as fast
02 15	Stands on hind legs	
02 30	Drinks	Not sure she took any water
02 45	Grooms	
03 00	Runs	
03 15	Burrows in bedding	
03 30	Grooms	
03 45	Runs	
04 00	Burrows in bedding	
04 15	Burrows in bedding	Beginning to make a nest?
04 30	Grooms	
04 45	Stands on hind legs	
05 00	Burrows in bedding	

Figure 1
An example to show the use of a check sheet.

It should be clear how the use of a check sheet such as this allows quite a lot of data to be collected easily and objectively.

Tape recorder

A tape recorder can be very useful because it means you don't have to take your eye off the animal whilst recording data. However, be sure that your voice doesn't disturb the animal (how could you check this?), use fresh batteries and transfer your tape recording to paper the same day.

Video

Video can be very useful for recording rapid behaviours, for example, dominance interactions at a bird table. They can be played back repeatedly in slow motion, helping you to sort out precisely what was going on.

PRACTICALITIES OF KEEPING ANIMALS IN SCHOOLS

A great deal of valuable work on animal behaviour can be carried out without keeping any animals in schools. Animals can either be observed outside of the classroom (e.g. birds) or can temporarily be removed from their natural environments and brought into a laboratory for a short period before being returned unharmed to the wild (e.g. soil invertebrates).

Keeping live animals within a school, however, allows a far greater variety of activities to be carried out. This section considers the practicalities of keeping animals in schools. It should be read in conjunction with 'Safety and legislation' (pp. 21-24) and 'Ethics of using live animals in schools' (pp. 25-28).

A great range of animals can be kept in schools. In deciding which ones - if any - should be kept, the following questions may be useful:

- What experience does your school already have of keeping animals?
- What expertise is available among science department technicians or teaching staff?
- What functioning equipment is already available, e.g. aquaria? Note that aquaria which are no longer suitable for fish may provide perfectly adequate homes for terrestrial invertebrates.
- How easy will it be to look after the animals during weekends and holidays? Nowadays it is generally considered inappropriate to entrust animals to the care of pupils over weekends and holidays.
- What educational benefit will pupils obtain from working with the animals?
- How often will the animals be used during a year? If only rarely, it may make more sense not to keep the animals permanently in the school. As an alternative to keeping animals in school, consider using a reputable Visiting Animal Scheme. These are run by a number of organisations including private individuals, charities and some Local Education Authorities. For information about what makes a good Visiting Animal Scheme see Coggan, D. F. (1988). *Visiting Animal Schemes: A Guide to Good Practice for Schools, Local Education Authorities and VAS Operators*, RSPCA, Causeway, Horsham RH12 1HG, Tel: 01403 264181; Fax: 01403 241048.

The number of different animals that can profitably be kept in schools is very considerable. What follows are brief notes on a few of these, together with sources of further information.

Giant African land snails

Giant African land snails (*Achatina fulicata*) (Figure 1) are terrestrial snails, native to East Africa. They grow to an impressive size - the largest recorded measured 39.3 cm from head to tail with a shell length of 27.3 cm. Giant African land snails can conveniently be housed in aquaria or vivaria provided a weighted cover is used. No more than four adults should be kept in a tank measuring 100 x 30 x 30 cm and a warm, humid atmosphere is needed. Detailed instructions are available from CLEAPSS (1992) *Giant African Land Snails, L197,* School Science Service, Brunel University, Uxbridge, UB8 3PH, Tel: 01895 251496.

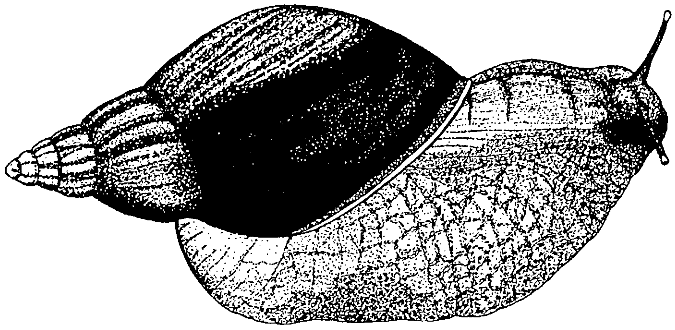

Figure 1
Giant African land snail.

The snails are available from most of the major biological suppliers. It is important that stocks should always be obtained from reputable sources as there is a risk of imported individuals carrying a parasitic lungworm which can infect humans.

A range of studies can be carried out, for example:

- locomotion - how fast do the snails move? Is this affected by the surface over which they are travelling?
- feeding - are certain foods preferred to others?
- learning - is habituation shown?

Brine shrimps

Brine shrimps (*Artemia salina*) (Figure 2) are easily kept in aquaria or plastic bottles containing salt water and a starter culture which has the algae on which they feed. A starter culture, together with a supply of egg-cysts and further information, is available for £5.00 including p & p from Shrimp World Watchers, Homerton College, Cambridge CB2 2PH, Tel: 01223 507111; Fax: 01223 507130. (Cheques should be made payable to 'Homerton College'.)

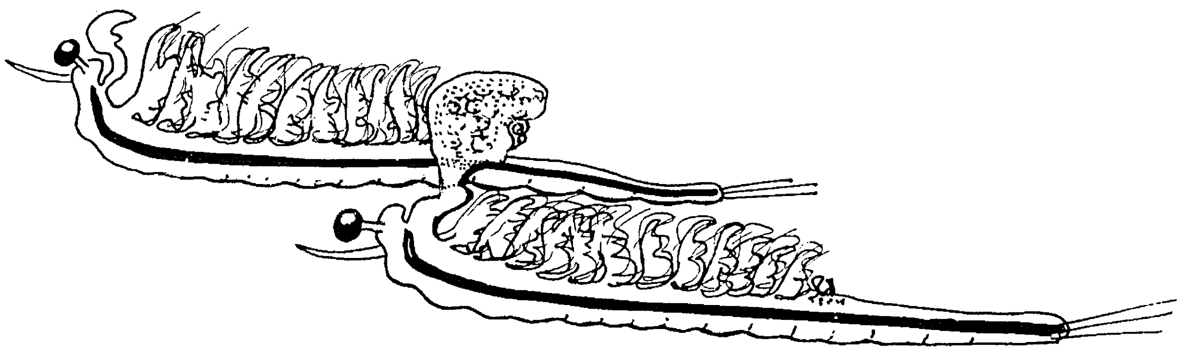

Figure 2
Pair of adult brine shrimps – female on left.

Brine shrimps can be used for observations and studies on:

- reproductive behaviour
- locomotion
- feeding.

For examples of studies on behavioural ecology that can be carried out on brine shrimps see Ward-Booth, K. & Reiss, M. J. (1988). *Artemia salina*: an easily cultured invertebrate ideally suited for ecological studies, *Journal of Biological Education*, **22**, 247-251.

Spiders

Most spiders can easily be kept in any large lidded container. A book specifically written to enable KS3 and GCSE students to carry out behavioural work on spiders is Sigurjónsdóttir, H. & Hardardóttir, S. (1996). *Spiders: Behavioural Studies for Schools*, Association for the Study of Animal Behaviour. It is available for £5 incl. p & p from Michael Dockery (ASAB Education Officer), Department of Biological Sciences, John Dalton Building, Manchester Metropolitan University, Chester Street, Manchester M1 5GD, Tel: 0161 247 1149; Fax: 0161 247 6365. (Cheques should be made payable to 'ASAB'.) A good general book on spiders is Preston-Mafham, R. & Preston-Mafham, K. (1984). *Spiders of the World*, Blandford Press, Dorset.

Spiders can be used to investigate:

- feeding - including web construction and the capture of prey
- moulting
- arachnophobia (in people, not spiders!).

Stick insects

A valuable guide to keeping stick insects (Figure 3) is Floyd, D. (1987). *Keeping Stick Insects*, Floyd Publishing, Unit 2, Normanton Lane Industrial Estate, Bottesford NG13 0EL, Tel: 01949 842446. ISBN 0 9512466 0 7. The author, Dorothy Floyd, also sells stick insects and cages from the same address.

Possible studies on stick insects include:

- locomotion - best recorded as the insect moves horizontally over glass or aluminium which has been blackened with soot from a candle flame
- diet - how is the amount of food eaten per day related to the size of an individual and to the temperature of the environment?
- growth.

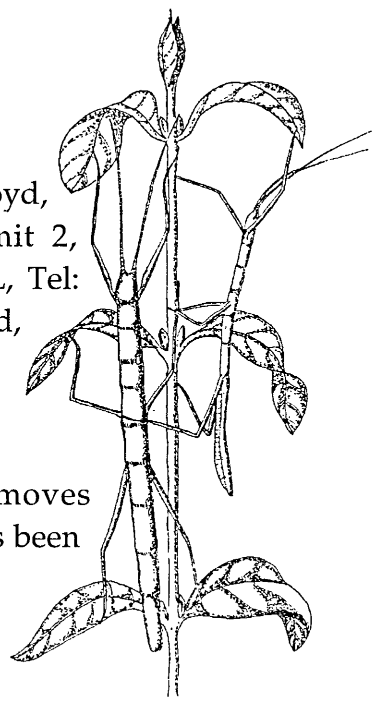

Figure 3
Stick insects.

Seed beetles

Seed beetles (*Callosobruchus maculatus*) (Figure 4) are easily kept in a large glass beaker or jar with a piece of muslin over the top (to prevent them escaping). A culture of the beetles can be obtained for £5 incl. p & p from Michael Dockery (ASAB Education Officer), Department of Biological Sciences, John Dalton Building, Manchester Metropolitan University, Chester Street, Manchester M1 5GD, Tel: 0161 247 1149; Fax: 0161 247 6365. (Cheques should be made payable to 'ASAB'.) This includes instructions about how to keep the beetles.

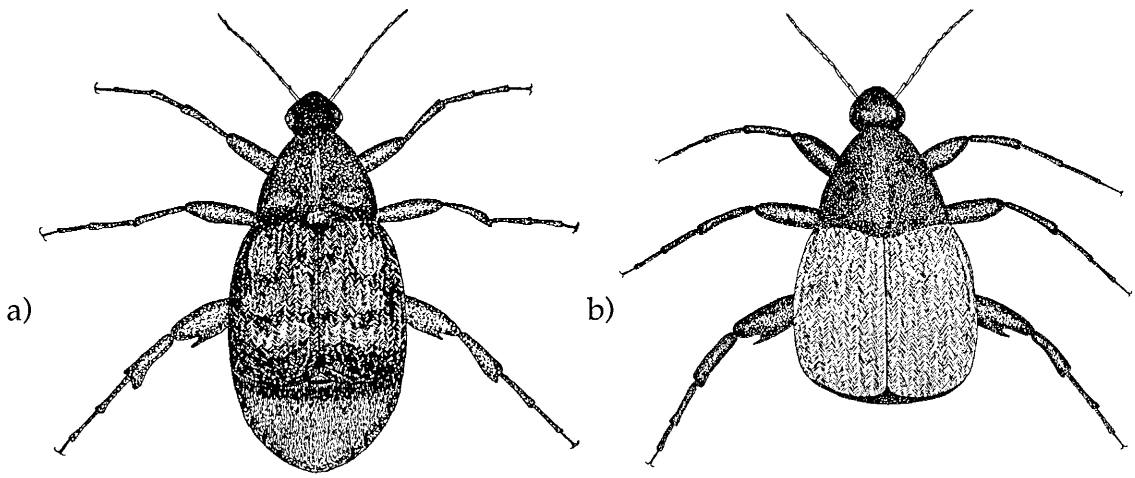

Figure 4
Adult (a) female and (b) male seed beetles.

Seed beetles parasitise mung and black-eyed beans. They can be used to study:

- habitat selection - choice of bean depends on the species of bean, its size and whether or not an egg has already been laid on it
- laying behaviour
- locomotion.

Fish

Fish are in many ways the best vertebrates to keep in school for behavioural studies. Three-spined sticklebacks (*Gasterasteus aculeatus*) (Figure 5) can be obtained from the major biological suppliers and used to observe their courtship and reproductive behaviour (see Reiss, M. J. (1984). Courtship and reproduction in the three-spined stickleback. *Journal of Biological Education*, **18**, 197-200). However, sticklebacks and other native cold-water fish are quite difficult to keep and a tremendous amount can be learned from a tropical freshwater aquarium containing a mixture of species. Such fish can, of course, be obtained from most pet shops. The most common fault is to try to keep the fish at too high a density.

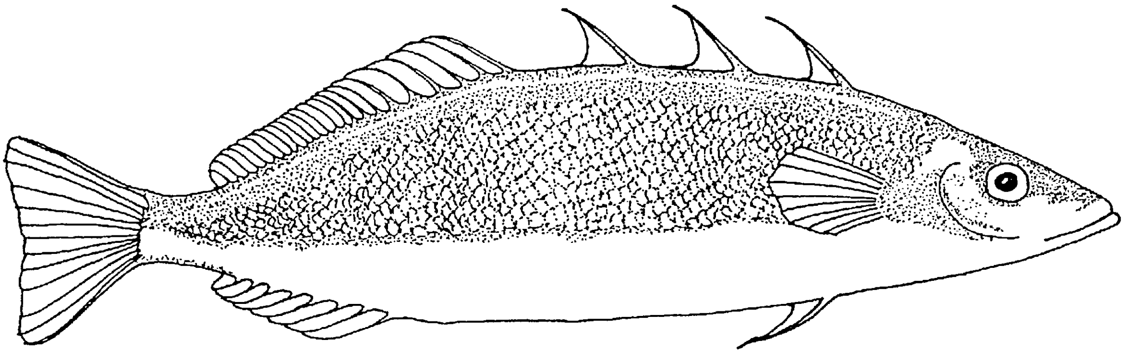

Figure 5
Three-spined stickleback.

Once a tank, with aerator and thermostat, has been set up, studies can be made on:

- niche separation - different species are found in different parts of the tank
- schooling - some species are solitary, others shoal
- learning - fish soon learn to expect feeding; habituation can also be investigated.

Small mammals

A number of different small mammals can be kept in school, provided suitable technician support is available and the animals can be housed well. Suitable species include the house mouse (*Mus musculus*), the laboratory form of the brown rat (*Rattus norvegicus*), the Syrian (golden) hamster (*Mesocricetus auratus*), the Russian hamster (*Phodopus sungorus*) and the Mongolian gerbil (*Meriones unguiculatus*) (Figure 6). For information about keeping such animals see RSPCA (1989). *Small Mammals in Schools, 2nd edn*, RSPCA, Causeway, Horsham RH12 1HG, Tel: 01403 264181 and CLEAPSS (1994). *Small Mammals, L52*, School Science Service, Brunel University, Uxbridge, UB8 3PH, Tel: 01895 251496.

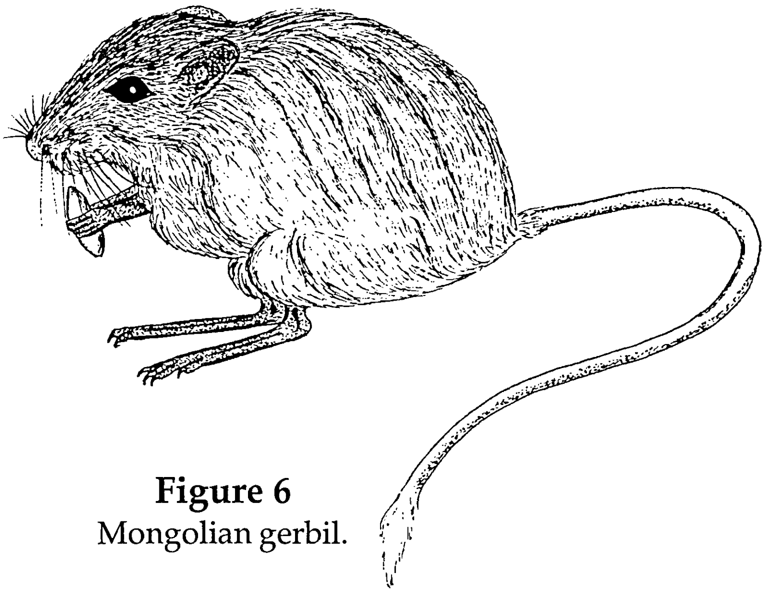

Figure 6
Mongolian gerbil.

Possible behavioural studies that can be carried out on small mammals include:

- grooming behaviour - precisely how do individuals groom themselves? Are there differences between species? Are there differences between individuals within a species? Is grooming learned, innate or a blend of the two?
- learning - how does the length of time and the number of 'mistakes' that a small mammal makes as it goes through a maze decrease with experience?
- nest building, paper shredding and cotton wool gathering.

Further sources of information and biological suppliers

Blades Biological, Cowden, Edenbridge, Kent TN8 7DX. Tel: 01342 850242; Fax: 01342 850924.

FEEDBACK, available from Michael Dockery (ASAB Education Officer), Department of Biological Sciences, John Dalton Building, Manchester Metropolitan University, Chester Street, Manchester M1 5GD, Tel: 0161 247 1149; Fax: 0161 247 6365.

Griffin & George, Bishop Meadow Road, Loughborough LE11 0RG. Tel: 01509 233344; Fax: 01509 231893.

Nature of the World, Alvaston House, Dancing Green, Ross-on-Wye, Herefordshire HR9 5TE. Tel: 01989 750840.

Paul W. Batty [butterfly & moth livestock and wild flower seed], 4 Byron Road, Dinnington, Sheffield S31 7LP. Tel: 01909 550272; Fax: 01909 564025.

Philip Harris, Lynn Lane, Shenstone, Lichfield WS14 0EE. Tel: 01543 480077; Fax: 01543 480068.

Poole, T. (1987). *The UFAW Handbook on the Care and Management of Laboratory Animals, 6th edn*, Longman Scientific and Technical, Harlow. ISBN 0582 40911 X.

Reiss, M. J. (Ed.) (1996). *Living Biology in Schools*, Institute of Biology, 20-22 Queensberry Place, London SW7 2DZ. Tel:0171 581 8333; Fax:0171 823 9409. ISBN 0 900490 32 2.

RSPCA (1995). *Animals and Education; making your school animal-friendly*, RSPCA, Causeway, Horsham RH12 1HG, Tel: 01403 264181; Fax: 01403 241048.

Sciento Educational Services, 61 Bury Old Road, Whitefield, Manchester M25 5TB. Tel: 0161 773 6338.

The Budding Naturalist, Unit 23a, Grays Farm Production Village, Grays Farm Road, Orpington, Kent BR5 3BD. Tel: 0181 309 1813.

The Mealworm Co. Ltd., Unit 1, Universal Crescent, North Anston Trading Estate, Sheffield S31 7JJ. Tel: 01909 568953; Fax: 01909 568666.

Worldwide Butterflies, Sherborne, Dorset DT9 4QN. Tel: 01935 74608; Fax: 01935 29937.

SAFETY AND LEGISLATION

Given care, familiarity with running practical activities in schools and common sense, the use of live animals (and pupils) for practical work in animal and human behaviour should not give rise to significant safety or legal problems. Laboratories are among the safest places in schools and the advice included here is intended to help maintain that record.

General safety principles

All practical work should be preceded by a risk assessment of the sort now familiar to most teachers in the UK. Any practical activity must be carefully considered for the chance of its causing harm in the actual or likely circumstances of its being undertaken. In the light of this assessment, any precautions to be taken should be decided upon and written down.

Safety policies exist for all Local Education Authorities. In addition, up-to-date information on specific issues to do with safety in practical work is published in *School Science Review* (published by the Association for Science Education), *Journal of Biological Education* (published by the Institute of Biology) and *FEEDBACK* (published by the Association for the Study of Animal Behaviour).

Specific safety issues relating to the use of live animals

Aquaria

Metal frames and hoods must be earthed and residual current circuit breakers must be fitted. Aquaria should stand on thick polystyrene tiles (or the equivalent) on a strong surface and should not be moved unless empty.

Invertebrates

Bee stings can be dealt with using anti-histamine preparations. For small numbers of people, bee or wasp stings can be life-threatening though this is very unlikely the first time someone is stung. Emergency medical aid must immediately be sought if a pupil or other person reacts to a sting by showing any irregularities in breathing or heart-beat or becomes drowsy.

Giant African land snails should only be obtained from reputable sources as there is a risk of imported individuals carrying a parasitic lungworm which can infect humans.

Locusts should not be kept continuously in classrooms as some pupils develop allergies.

Vertebrates

Amphibians and reptiles may carry *Salmonella*. The risk of infection can be minimised if animals are purchased from reputable sources and if hands are always washed thoroughly with soap and water after contact, as is advisable after the handling of any (non-human) animal.

Exposure to birds and small mammals may result in pupils, teachers or technicians becoming sensitised to fur, feathers or droppings. The usual symptoms that result are skin rashes, dermatitis or asthma. Sensitised individuals should avoid contact with and exposure to the appropriate animal(s).

Specific safety issues relating to fieldwork

In addition to the safety requirements accompanying any practical activity (including the undertaking by their teacher of a risk assessment), pupils should only undertake fieldwork if:

- their parents/guardians have given written permission
- they work in pairs or (preferably) threes
- they know what to do in the event of an accident
- parents/guardians and teachers know precisely where they are at any given time, should they be working out of sight of their teacher.

Legalities

The Protection of Animals Act 1911 essentially prohibits certain acts of cruelty - which includes abuse, neglect or causing any unnecessary suffering - to captive and domestic animals. Invertebrates are not excluded from this Act.

Following the Animals Scientific Procedures Act 1986, the Department for Education and Science (DES) in 1990 advised that the following, *inter alia*, are illegal in schools:

- the injection of hormones to cause spawning in *Xenopus* (African clawed toad) unless this is carried out solely for husbandry purposes
- nutritional experiments involving restricted or excessive diets, although investigations which entail determining the growth rate of a mammal on a normal diet are perfectly acceptable
- an experiment involving the tossing of a young mouse from hand to hand
- toe clipping.

Good practice relating to the use of pupils as subjects

Before undertaking any work on human behaviour with pupils or others, ensure that these principles are followed:

- Be prepared to be accountable for your actions.
- Ensure that the informed consent of participants in obtained. When pupils are aged under 16 you need to obtain the consent of their parents/guardians for all but the most innocuous of studies.

- Use only willing participants. For example, it is only acceptable to startle participants and then measure their responses if they have explicitly consented to this in advance.
- Protect participants from psychological or physical harm.
- Don't transgress cultural boundaries of modesty and respect. This rules out, for example, surveys on sexual behaviour.
- Debrief thoroughly. This is particularly important if you haven't told the participants the precise focus of your study before they consent to it.
- Allow participants to withdraw from the study at any time and inform them of this right in advance.
- Maintain and respect confidentiality.

Further reading

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ETHICS OF USING LIVE ANIMALS IN SCHOOLS

The use of animals (i.e. non-human animals) for human ends - whether in farming, medical research, entertainment or education - raises ethical issues. Should we use animals for human ends? More specifically, should live animals be used in schools for the study of behaviour? Our belief is that the use of live animals in schools is educationally desirable and ethically defensible, *provided* certain conditions are met.

Arguments in favour of using live animals in schools

There are perhaps three main reasons for using live animals in schools for the teaching of animal behaviour:

- The use of live animals enables a direct learning experience. Such experiences may be complemented by the use of books, videos and computer simulations, but they cannot entirely be replaced by them.
- Exposure to living organisms can fascinate and motivate pupils, helping to foster natural curiosity and scientific enquiry.
- The use of live animals can help develop a caring attitude among students.

Arguments against using live animals in schools

However, positive benefits do not necessarily flow from the use of live animals. Indeed, the inappropriate use of live organisms can demotivate pupils, lead to little learning taking place and lead to animals - and the environment in general - being less rather than more respected.

There are two main arguments against using live animals in schools:

- The use of animals can lead to suffering.
- We have no right to use animals for our own ends.

These arguments need to be considered separately. The argument that the use of animals can lead to suffering is an argument about the *consequences* of an action. In a school setting, it is our view that any animal suffering is unacceptable whatever the purported educational benefits.

The argument that humans have no right to use animals need not be an argument about consequences; it may be more to do with whether something - in this case the use or exploitation of animals - is right in itself, that is, *intrinsically*.

Getting pupils to debate the issues

It is our belief that the use of live animals in schools *is* a moral issue. It is an issue on which more than one position can validly be held. For this reason, it behoves a teacher to respect any intellectually and ethically defensible position adopted by a pupil.

This means that allowing pupils to debate the issues can be a valuable form of moral education in itself. The way in which such a 'debate' is handled can, of course, vary considerably. Possibilities include:

- A formal, structured debate where pupils prepare positions in advance.
- A less formal debate that takes place without prior preparation by the pupils.
- Structured role play with positions prepared in advance.
- Less structured role play.
- Whole class discussion.
- Small group discussion followed by a plenary.
- Individual work where pupils write creatively from two or more perspectives.
- Individual work where pupils objectively examine the issues in writing.

The sorts of notions that a teacher might wish a GCSE group to end up understanding are the following:

- Suffering involves an awareness of pain or distress.
- The consensus amongst biologists and philosophers is that most adult vertebrates can suffer. Whether most invertebrates (e.g. insects) can suffer is less likely.
- Good housing and treatment can ensure that animals (including small mammals and fish) kept in schools do not suffer.
- The notion of human rights (e.g. the right to life and the right to freedom of speech) is accepted by many people, though different cultures differ in their understanding of what a human right is.
- Some people believe that animals have rights; other people don't.
- Religions vary in their teachings about the use of animals. Some religious traditions argue that humans have the right to exploit animals, so long as this is not done cruelly. Virtually all religious traditions argue that humans have a responsibility of care for the whole of the natural environment.
- Humans have a long history of using animals, for example as beasts of burden, for wool, for food and as companions.
- A variety of ethical positions about the use of animals by humans can validly be held.

Six principles about the use of live animals in schools

To maximise the likelihood that the use of live animals in a school will lead to desired rather than unintended consequences, we suggest that the following principles might be observed *in addition* to those described in the section on 'Safety and legislation' (pp. 21-24):

- Live animals are used only when there are clear educational benefits.
- Where possible, animals are observed in their natural settings free from human interference - for example, spiders might be observed making their webs, bees pollinating flowers and birds singing or displaying.
- If animals are removed from their natural environment to the school laboratory, for example, to observe movement in earthworms or feeding preferences in garden snails, they are returned unharmed to their original habitats as soon as is possible.
- Animals are only kept in school laboratories if they can be kept in excellent health. Health should be interpreted broadly. Many small mammals kept in schools are kept in cramped conditions and suffer from boredom.
- Pupils are encouraged to debate the ethical issues about the use of live animals in schools.
- Pupils who prefer not to work with live animals have their views respected and, so far as is possible, are provided with meaningful and stimulating educational alternatives.

Further reading

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PRACTICALS

ORIENTATION OF BRINE SHRIMPS TO LIGHT

Background

The brine shrimp, *Artemia salina*, is a crustacean that lives in salt lakes in sub-tropical areas. They feed on algae which occur either in the water or on the material at the bottom of the lake. The numbers of shrimps in a lake can build up very rapidly since there are no fish predators, though some birds, such as flamingoes, do eat them. The absence of fish in apparently suitable lakes is due to the fact that the lakes dry out completely on occasions.

The adult brine shrimp is 8 - 10 mm long when fully grown. They have eleven pairs of legs which as well as being used for swimming are also used as gills and to filter food from the water. The female shrimp is brown/red in colour and has a brood pouch which holds her eggs. The males are translucent and have a pair of large claspers to grip the female when they are riding around together prior to mating.

Both male and female shrimps have three eyes: one is a small eye in the centre of the head, the other two are stalked eyes which are on either side of the head, see Figure 1. The eyes are used to enable the shrimp to orient to light. Adult shrimps are usually seen swimming upside down, i.e. they orientate their body so that their eyes are facing upwards, towards the source of light. They do, however, flip over when they are feeding on the algae which occur on the sand and gravel at the bottom of the lake or the tank/bottle.

In this investigation you will put some shrimps in a glass dish to see what happens to their swimming position if a strong light source, i.e. stronger than normal daylight, comes from below the dish (by placing the dish on an overhead projector) in which the shrimps are swimming. This practical therefore is concerned with **orientation.** Does a brine shrimp change its swimming position in response to a change in the direction of a light stimulus?

What would be a suitable hypothesis to test in this experiment?

You might make your hypothesis: ' there will be no change in the swimming position of a brine shrimp when the light source is from above or below the dish in which they are swimming'.

Equipment

You will need the following pieces of equipment for this experiment:

- an overhead projector
- saltwater (a concentration of 30 - 35 g per litre - this needs to be made up before you begin the experiment)
- 12 adult brine shrimps (the sex of the shrimps is probably not important, though this could be a factor you might wish to control)

- a stop watch (or stop clock)
- a dessert spoon (or wide-mouth pipette) to catch the shrimps from the tank or the bottle in which they are kept
- a sheet of acetate (or you can use a clean section of the acetate roll that is on an overhead projector)
- an overhead projector pen, preferably black
- a circular glass tank (one that is 150 mm in diameter and having a depth of 40 - 80 mm is ideal) - the tank should fit inside the glass top of the overhead projector
- a sheet of black card, or black paper, that is just over half the size of the glass tank
- a sheet of plain white A4 paper
- a pair of scissors.

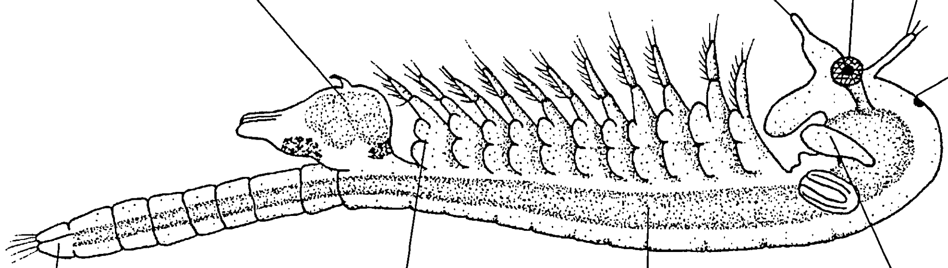


Figure 1

A side view of an adult female brine shrimp. The shrimp is shown in the 'normal' (upside-down) swimming position.

Procedure

Put some clean saltwater into the glass dish, a depth of about 3 - 4 cm is adequate. Put the 12 adult shrimps into the dish and then leave it on the top of the bench. If the bench surface is not white then it is helpful to put a piece of white A4 paper under the dish in order to see the shrimps more easily. With the black overhead pen draw a large cross (i.e. two lines at right angles) in the centre of the sheet of acetate and let the ink dry. Then put the acetate under the dish, placing the centre of the dish at the centre of the cross, and leave the shrimps to settle for two minutes.

After the two minutes have elapsed observe the shrimps carefully. Daylight, or possibly a ceiling light in the lab, is now lighting the dish from above. Look at the shrimps swimming in open water, i.e. those away from the sides of the glass dish, and note their swimming position. Record the number that are using the 'normal' swimming position (i.e. upside-down) and those that are using a 'non-normal' swimming position (i.e. non-upside down).

You might want to be sure that the position a shrimp uses when you observe it is the usual position for that shrimp. How could you test this? [You may want to carry out this study before getting on with the rest of this experiment.]

Take the sheet of acetate from under the dish and place it on the glass top of the overhead projector. Then put the dish with the shrimps on the projector (see Figure 2), locating the centre of the dish over the centre of the cross. **Take care not to spill any water on the top of the overhead projector**. Leave the brine shrimps to settle for two minutes. [Where is the main source of light to the dish now?]

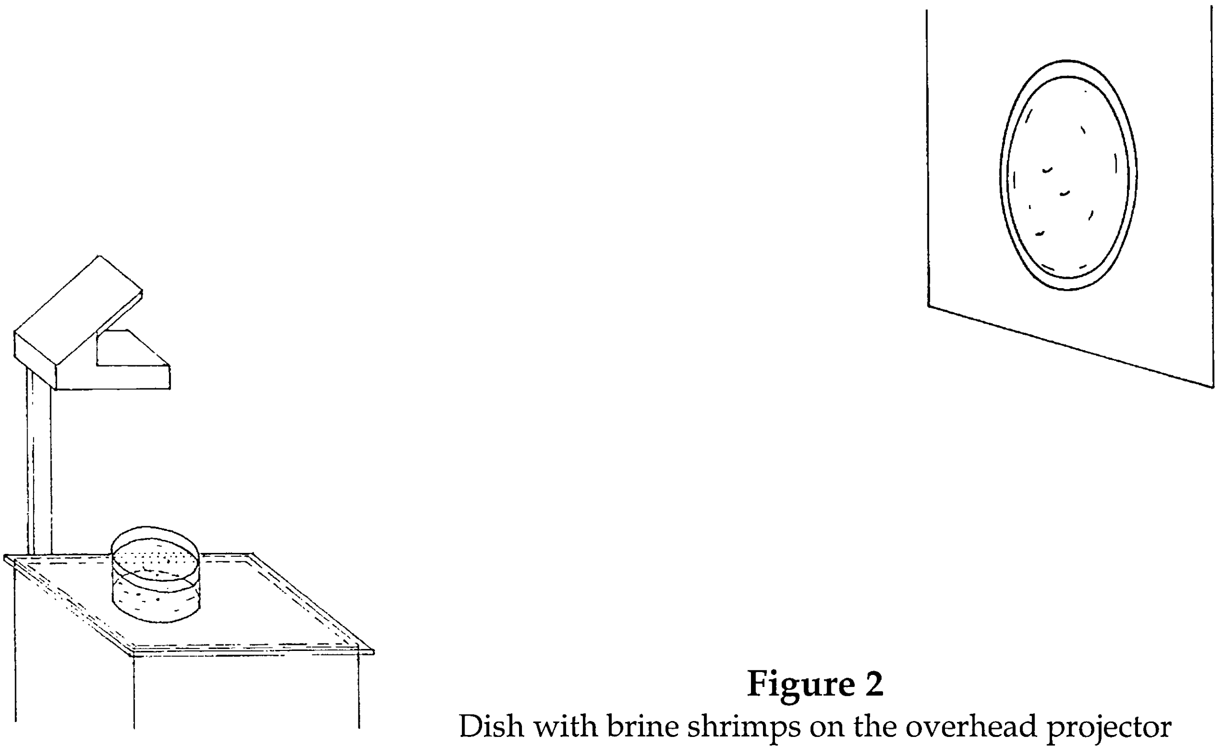


Figure 2
Dish with brine shrimps on the overhead projector and their movement projected onto a screen.

After two minutes look at the shrimps carefully and record once more the number using the 'normal' and the number using the 'non-normal' swimming position. Again, disregard those in contact with the bottom or sides of the dish. As before, you might want to check that a shrimp is consistently using its preferred swimming position.

For the final part of the experiment you might find it easier to have just one adult brine shrimp in the dish: if so, put the others carefully back into their tank or bottle.

Put the piece of black card, or paper, under the dish but above the acetate on the top of the overhead projector. Adjust the position of the card so that one edge is on one of the lines of the cross on the sheet of acetate. Now, half the dish is lit from below and half from above. Leave the shrimp for two minutes to settle down.

After two minutes, observe the shrimp carefully, noting its swimming position in the half lit from below and the half lit from above. In order to do this, track the shrimp as it swims around the dish for five minutes. Take a reading at 15 second intervals and record in which half of the dish the shrimp is (you can call these the 'light' half and the 'dark' half) and whether it is using the 'normal' or 'non-normal' swimming position. You will now have a measure of how frequently the shrimp uses each swimming position in each half of the dish.

You could now return this shrimp to its bottle or tank and replace it with another to see if the behaviour of a shrimp is consistent. You could also put the card on the other half of the dish: you might try putting the card along the other line of the cross too!

Results

Put your data in a table and if other groups in your class have carried out similar experiments add their data to yours. Choose an appropriate graphical technique to represent the data.

Discussion

Have the shrimps been consistent in their choice of swimming position in each of the two conditions? Does the direction of the source of light affect their swimming position? If they use different swimming positions, depending on the direction of the source of light, why would shrimps need to be able to orient to a light stimulus?

How might the shrimps detect whether the light source is from above or below? How might you check to see if your answer to this last question is correct? **NB Do not carry out this experiment, however**.

Further work

You could develop this further to study another aspect of orientation in brine shrimps.

As the direction of the strongest light source changes, you may observe that the shrimps flip over so that they are swimming 'upside down' in relation to the source of light. There are three methods of flipping over, these are by rolling, back somersaulting and front somersaulting.

You could devise an experiment to determine the method that an individual shrimp uses and whether it uses this method consistently as it re-orients to the direction of the light stimulus.

CHOICE OF EGG-LAYING SITE BY FEMALE SEED BEETLES

Background

The seed beetle (*Callosobruchus maculatus*) lives in tropical areas and is a pest of stored legumes, such as peas and beans. As adults, the beetles do not eat, though they can live for 10-12 days. Adult beetles are mostly seeking opportunities to reproduce. The male beetles spend most of their time looking for, and mating with, females. After mating, females spend a good deal of time looking for suitable places to lay their eggs. In the wild, suitable sites are the surfaces of the seeds of leguminous plants. In a grain store, the seeds have already been separated from the plant and so females will have lots of beans, or peas, to choose from when laying their eggs. A few days after it has been laid, the egg hatches and the larva eats its way into the pea or bean. It completes all the stages of growth inside the seed and about 4-5 weeks after hatching an adult beetle emerges, see Figure 1.

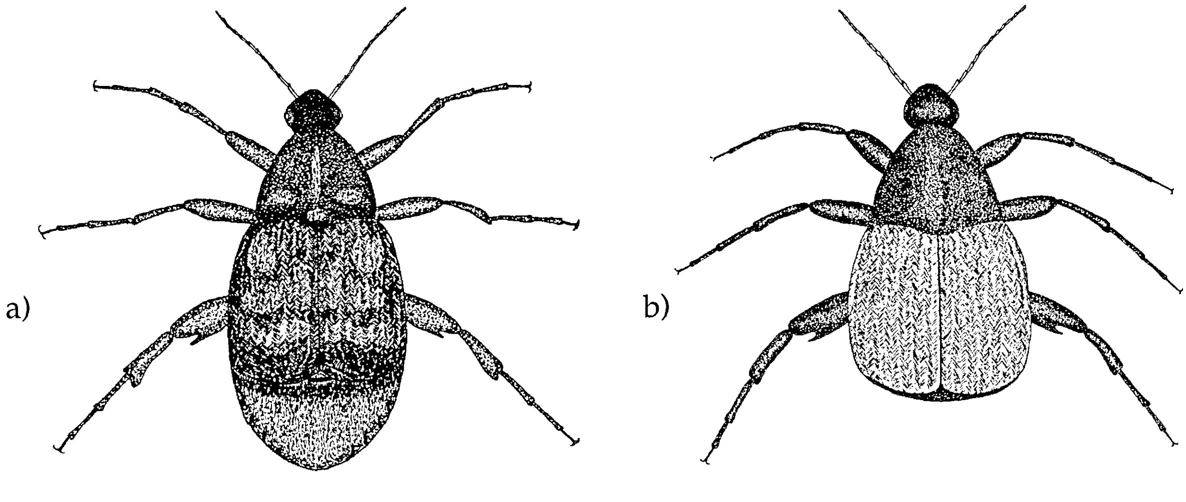


Figure 1
Adult (a) female and (b) male seed beetles.

In this practical you will use a choice chamber and beans to determine if certain surfaces are more frequently selected as egg-laying sites than others. This practical is therefore concerned with **habitat choice**. Which bean does a female beetle choose to lay an egg on? The choice of bean will be in response to stimuli from the beans which the female is able to detect.

What would be a suitable hypothesis to test in this experiment?

You might think this is appropriate: ' female beetles are equally likely to lay an egg on each of the four beans' - or 'there will be no difference in the number of eggs laid on each of the four types of bean'.

Equipment

You will need the following pieces of equipment for this experiment:

- mated female seed beetles
- choice chamber (see Figure 2)
- beans - three of black-eyed beans, mung beans, aduki beans, haricot beans
- Blu-Tack
- balance, to weigh the beans
- artist's brush or entomologist's forceps or pooter.

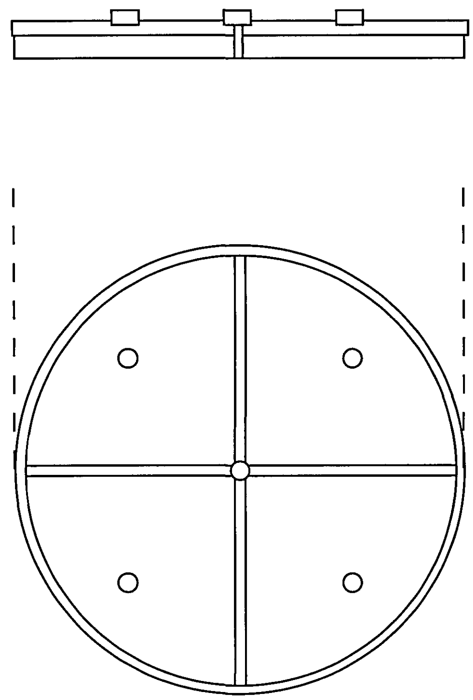


Figure 2
A choice chamber.

Procedure

You will need a stock of seed beetles for this experiment*. It would be best to use females that have fairly recently emerged and have mated as they will be ready to lay eggs.

You are going to need four types of bean. If possible use three of the following types which are all fairly readily available in a health food store or similar type of shop: black-eyed beans, mung beans, aduki beans or haricot beans. Weigh out the same mass of each type of bean (5 g will be sufficient). You may find it difficult to have exactly the same mass of each type but try changing one or two beans until you get very close to the mass suggested. You will then need to make some small balls of Blu-Tack. Manipulate the Blu-Tack into spheres, making them roughly of a size that is intermediate between the largest and the smallest beans that you use. Again, make sure that the total mass of the Blu-Tack balls is the same as for the real beans/peas. It should be easier to ensure that the total mass of the 'Blu-Tack beans' is 5 g.

When the weighing is completed, clean the choice chamber in soapy water, rinse it well and then dry it carefully. When it is ready, put the beans of each type into one of the four sectors of the choice chamber. It won't really matter which type of bean goes into each sector, provided it is done without conscious bias. However, if the experiment is repeated then alter the order to take into account any differences in the sectors. This is probably unlikely but would be a useful control in the experiment. When you put the beans into the sector of the chamber spread them out so that the beans are not touching each other. Place the chamber on a flat, level surface which is preferably lit from above, thus keeping the light intensity constant over each of the four sectors.

[If you are not able to use a commercially available version of a choice chamber it is possible to make an suitable alternative and a biology technician will be able to help you.]

Introduce females, one at a time, into the chamber. Transfer them from the holding container to the choice chamber using an artist's brush (or entomologist's forceps or pooter) and place the beetle on the centre of the raised perspex cross pieces, directly beneath the hole in the centre of the lid. Replace the bungs and record the total number of eggs laid on each of the four types of bean. After this female has stopped laying you need to replace her with another.

Note: seed beetles are highly mobile and can easily walk up a vertical surface, even plastic, so replace the bungs quickly.

The egg-laying behaviour of the females could take quite a while, though a mated female usually lays one, or more, eggs within a lesson. You might think it worthwhile to try an alternative strategy. You could either:

a) let the experiment run for a week but place new beans and beetles into the sectors of the chamber in the morning and afternoon, before the school/ college sessions begin

or b) set up a series of chambers and pool the data collected by the groups carrying out the experiment

or c) put a number of females into the chamber and record the number of eggs and the type of bean on which each was laid at the end of the lesson, or lessons. You could put a quarter of the females through one hole, a quarter through another, and so on. This is useful as it is quicker than just using the central hole.

Whatever you decide to do, record the total number of eggs laid on each of the four types of bean in your choice chamber. If other groups are carrying out the same experiment you can pool your data.

Results

The data you have recorded are the total number of eggs that have been laid on each type of bean that you have used. Determine also the mean number of eggs laid per bean for each type of bean. Both pieces of information should be tabulated and if you can think of a suitable way to graphically represent the data that would be advantageous. Say 36 eggs are laid, your hypothesis might be that 9 are laid on each of the four types of bean. Compare the expected number of eggs with the actual number of eggs laid to see if there is a difference for each type of bean. Can you devise a graphical technique to represent the data?

Discussion

Does the analysis of the data show that your hypothesis can be accepted or rejected? What do your observations suggest regarding the egg-laying behaviour of seed beetle females? How do you think females discriminate between what is, and is not, a suitable surface on which to lay an egg? What improvements to the experiment would you make if you decided to repeat the study?

Further work

In this practical you have investigated the egg-laying behaviour of female seed beetles and which habitat they chose to lay an egg on. You could develop the study if you wish.

You might offer the females only black-eyed beans but give half of the beans a coating of clear (transparent) nail varnish. If the female beetle tests a surface for cues to determine if it is a potential site (i.e. a suitable habitat) for egg-laying, then the coating may affect the cues she seeks.

You might discover from this experiment that female seed beetles prefer to lay eggs on one type of bean, say black-eyed beans. You might offer females moist and dry black-eyed beans to determine if females show a preference for one of these two types as a suitable site for egg-laying.

What would mated female seed beetles do if they did not have any access to suitable habitats for depositing their eggs? You could confine females to a Petri dish after mating and then observe their behaviour over a period of time. What will they do? They will be ready to lay eggs but have no seeds available!

* A starter population of these seed beetles can be obtained from:

Michael Dockery
Department of Biological Sciences
John Dalton Building
Manchester Metropolitan University
Chester Street
Manchester M1 5GD

Tel: 0161 247 1149 Fax: 0161 247 6365 E-mail: m.dockery@mmu.ac.uk

The cost is £5, which will include the cost of postage and packing: please make **cheques payable to 'ASAB'**.

Blades Biological also supply seed beetles: the catalogue code is LZJ 228.

Blades Biological, Cowden, Edenbridge, Kent TN8 7DX. Tel: 01342 850242; Fax: 01342 850924.

The seed beetles are not native to Britain and in many countries they are a pest of leguminous stored seed. It is, therefore, best to confine their use to a school or college laboratory and take the appropriate measures to minimise the chance of individuals escaping.

WHERE TO FEED? - DECISION MAKING IN PIGEONS

Background

Flocks of feral pigeons are a common sight in town and city centres. They are very successful birds and their numbers increased considerably from 1900. They originally lived on rocky coasts and nested on rock ledges and in caves. Today they nest on the ledges of buildings in towns and cities. Here there are fewer predators and they are able to exploit the feeding opportunities in urban areas, see Figure 1. They can be seen feeding on leftovers from take-away meals, spillage from shops, crumbs thrown to them by shoppers, etc..

Figure 1
Feral pigeons feeding in an urban area.

Often people put out food such as bread and corn for the pigeons. If the pieces of bread are scattered over the ground there are likely to be areas where more pieces fall and areas where there are few, if any, pieces. Once it is spotted by a pigeon, assuming it is hungry, the bird flies down in order to feed. But where does it land? Does it go to the areas where the food is concentrated (a high density area) or to where it is less concentrated (a low density area)? This study is about **decision making in pigeons**.

In this field experiment you can offer the pigeons a choice. They can feed in one of two areas: an area where bread is distributed at a high density and an area where the food is at a lower density. You record the numbers of birds that feed in each area - the suggestion here is that you use two squares as the feeding areas.

What would be a suitable hypothesis to test in this study?

You might think that this is suitable: 'there will be no difference in the number of birds feeding in each square'.

Equipment

To carry out this field experiment you will need the following pieces of equipment:

- a thin sliced, white loaf (white is suggested only because it is more easily seen)
- a couple of pairs of scissors
- a stop watch (or stop clock)
- a notepad and pencil/pen
- a 20 m tape
- three 1 m rules
- chalk (only needed if you are working in a paved area)
- a camcorder - is not absolutely necessary but would be extremely useful since a filmed record of the events allows you to check your observations.

Procedure

It is best to carry out this study in a park, a paved area in a town/city or a school playground. Try to select an area where people are unlikely to disturb the food or the birds whilst you are carrying out your observations.

If you carry out the experiment in a park or town/city centre you must ensure that you have the permission of the park or local authority to feed pigeons. Many towns, for example, have a policy of discouraging the feeding of pigeons. You should only carry out this study in a park or city centre if you are in a group of at least three people. Preferably have an adult nearby. If you use apparatus such as a camcorder you must have your teacher with you.

When you have selected a suitable site, mark out the area in which you will place the food. You need to mark out two squares, each with sides of 1 metre, separated by a distance of 5 m, see Figure 2. You need to select the area in which to carry out the study quite carefully. If you choose to work in a grassed area then make sure that the two squares contain grass of roughly the same height, that one square is not near a wall or a path, etc..

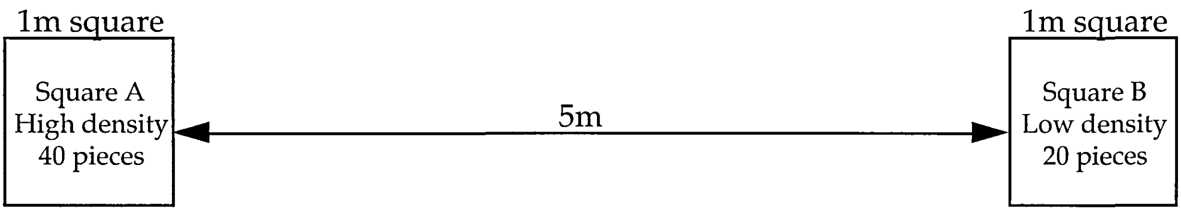


Figure 2
Arrangement of the feeding areas.

If you are carrying out this study in a paved area, in the school grounds for example, you can use chalk to mark out the two squares. If you are carrying out the study on a grassed area four small pegs could be stuck into the ground to mark the corners of each square. Draw a sketch of this arrangement in your notebook as it may be useful when recording your observations.

Prepare a check sheet to record your observations. You need to record the number of birds feeding in each square at a particular time interval, say 15 seconds. [This is called an *instantaneous sample* and is outlined on page 9.] Count the number of pieces of bread that remain in each square at the end of the period of observation, five or ten minutes is suitable. [If you decide to have a five minute period for observation then you need to record the number of pigeons in each square at 15 second intervals: if you decide to have a ten minute recording period then note the number of birds in each square at 15 or 30 second intervals.]

Cut up the bread into convenient sizes. First remove the crusts and then cut the bread into small squares, ones with sides of 5 mm would be suitable. This size, or slightly less if you wish, can be picked up by a pigeon as one food item. Cut up 60 such squares.

Place 40 pieces of bread in one square (say square A) and 20 pieces in the other (square B): the density of food in square A is thus twice that in square B. When doing so try to place the bread squares at roughly equal intervals inside each area.

When the food is set out, withdraw some distance away (20 m is fine, it could be less) so that you can observe the birds easily but you won't disturb them. Begin recording if a camcorder is available and also start the stop watch. Then record the number of birds in each square at each time interval. After 5, or 10 minutes, stop recording. Move into the feeding area and count the number of pieces of bread that have not been eaten in each square and record the numbers on your check sheet.

When the first recording session is over, remove all the remaining pieces of bread. After a period of about 20 - 30 minutes repeat the exercise but this time reverse the arrangement of the bread, i.e. put the high food density in square B and the lower food density in square A. If you want to carry out any further observation sessions, perhaps using different densities (say 40 pieces and 10 pieces of bread) then it would be best to do so the following day.

Results

Summarise your findings in a table. Draw a suitable graph, or perhaps two graphs, to show how many pigeons were feeding in each square for each of the two observation periods.

Discussion

What do your results suggest? Can you reject or accept your hypothesis? Can you see a pattern in the results? Did you see the same pattern of behaviour when the two squares containing the food were 'switched'? If the pattern is not the same this might suggest that the position of the squares is important. If this is the case try to identify how the squares, or the area surrounding the squares, may be different.

When birds are fed they generally seem to distribute themselves in such a way that they go where the chance of getting food is roughly the same. This is called the *'ideal distribution theory'*. Have the pigeons you observed behaved in the way that the theory predicts, i.e. did you find that roughly twice as many pigeons fed in square A than in square B? [The reverse should be true, of course, when the squares were switched.] If so, you have found support for the ideal distribution theory. If not, then some other factor (s) may explain why there are more, or less, birds than the theory predicts. If more, perhaps keeping together in a flock is advantageous: if less, perhaps one or two dominant or more aggressive birds prevent other pigeons from feeding.

Try to identify a couple of weaknesses of the field experiment and suggest how they might be overcome if the experiment was to be repeated.

Further work

You will observe that in a flock of feral pigeons the birds have different colour feather patterns. It is possible that you may see one or two very dark, almost black, birds and perhaps some very pale brown ones. Do the birds that have similar colour patterns behave differently from birds with other patterns? Perhaps one colour type are more aggressive. If so, this might explain the situation where there are too few birds in a square, as the ideal distribution theory predicts.

For a similar exercise involving the feeding of mallards on a pond or lake see Sigurjónsdóttir, H. and Jónsdóttir, V. 1996. *Birds: Behavioural Studies for Schools*. ASAB, London.

FLEXIBILITY IN THE CHOICE OF A CAT'S SLEEPING SITE

Background

Wild animals sometimes sleep in the same place each night. This is most clearly seen in animals that build dens, badgers for example. Companion animals, i.e. pets, are often encouraged by their owners to sleep in the same place. This may be because it is convenient for the owner or it may be that the owner does not want the cat to enter a bedroom, for example. Once the family pet has a spot in which it sleeps it generally returns to that place, often where there is a basket, each time it is ready to sleep, see Figure 1.

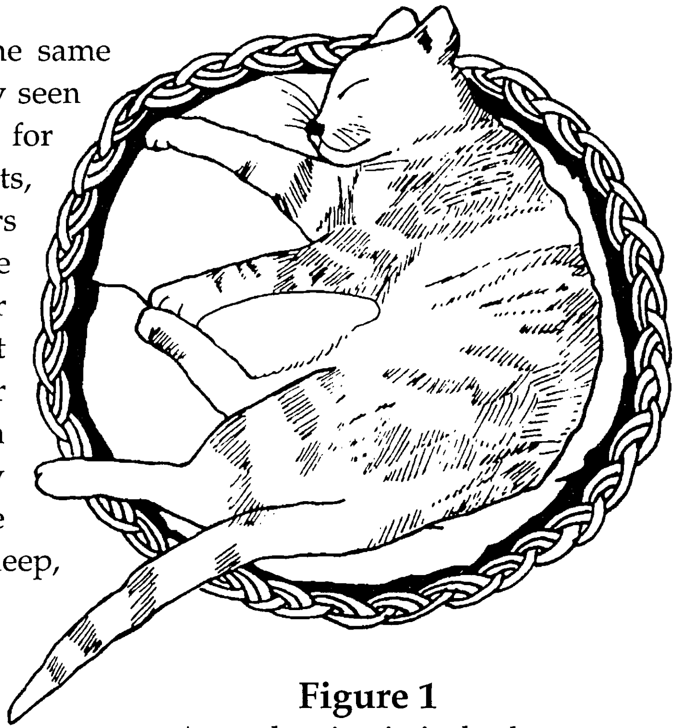


Figure 1
A cat sleeping in its basket.

In this study you can discover if there is some flexibility in the location of a cat's *usual* sleeping site. If the usual sleeping habitat of the cat is altered, does it show some flexibility and adjust to the new location, or does it return to sleep in its usual location, even if its basket is elsewhere? Is the cat sleeping in a preferred location or in its preferred habitat (basket)? [If you do not have a pet cat in your own home then perhaps this study could be carried out in the home of a friend who does have a cat.]

In this experiment you are going to manipulate the **location of a cat's sleeping site** (its basket - or whatever it usually sleeps in) to see how it behaves as a consequence.

What would be a suitable hypothesis to test in this experiment?

You could test the hypothesis : 'the cat will not show behavioural flexibility if the location of its preferred sleeping habitat (its basket) is altered'.

Equipment

The will need the following pieces of equipment for this study:

- pencil and paper
- a 20 m tape measure
- a camcorder - this is not an absolute requirement but it would be very useful.

Procedure

It would be very useful to make a sketch of the room in which the cat usually sleeps; on the sketch mark its sleep site. If your family has a camcorder it would be extremely valuable if you could record the cat's behaviour. This not only allows you to record in considerable detail but you can always rewind the tape to check your observations.

The first part of the study is to observe the cat just before it settles down in its 'usual' sleeping location. [For the purposes of this description we have assumed that the cat sleeps in a basket.] This needs to be carried out for a few days so that you can build up a picture of the cat's 'normal routine'. Record how the cat approaches the basket, how it enters the basket, how it settles down into the lying position, the direction in which it faces - just use local features of the room, for example, 'faces the fridge' - the room in which it sleeps, the floor on which it sleeps, if there are any objects in the cat basket, etc.. If it goes through these, or other, stages in a predictable manner you might think it is worthwhile timing each event.

Once you have established the cat's sleeping routine you can then consider altering the conditions and observing the reactions of the cat. The following suggestion relates to distance from the 'usual sleeping place' but there are other conditions that could be altered.

After the initial observation of a few days you can move the basket to a different place to see how the cat reacts. Your record of its behaviour will be either that it sleeps in its basket at the new location or it does not. After you have tried the first condition return the basket to the cat's 'usual' place and leave it there for at least three nights before trying another condition. You might consider moving the basket in 1 m intervals from its usual site in the room where it sleeps. The number of different locations will depend on the size of the room.

On each occasion record the behaviour the cat shows. Also make a note of any vocalisations (sounds) it makes and if it interacts with any of the humans in the house.

Results

The data you collect in your study may allow you to represent some of the findings in a graph or diagram.

Discussion

Has the cat shown flexibility in its choice of habitat for its sleeping site? Is the location or the habitat more important for the cat? Why do cats often sleep in the same habitat and location each night? Are there any disadvantages to doing so? Do cats in the wild show this behaviour?

Try to identify a couple of limitations of the study and suggest how these may be overcome if you had to repeat it.

Further work

In this study you have investigated one aspect of the behaviour of a cat - whether it can show flexibility in its choice of sleeping location. Do cats show flexibility in other pieces of behaviour?

You could repeat the study but instead of moving its basket move the cat's food tray. Can you predict what the cat will do in the light of its behaviour when you changed its sleep site?

Why would it be advantageous for a cat, or indeed any animal, to show some flexibility in its patterns of behaviour? Could this have implications for the survival of a species? What might be the evolutionary consequences of behavioural flexibility?

HOW FEARFUL ARE HUMANS OF CERTAIN ANIMALS?

Background

Many people are at least a little fearful if they come into close contact with some animals. In a few cases, it is clear why they should be afraid, for example, the animal may be a large crocodile! However, the majority of animals are not dangerous to humans. Many are very small, relative to humans, yet some people are very fearful of them; spiders and mice, for example. The degree of fear shown by people varies: it can be relatively mild, perhaps a slight increase in the heart rate; it can be severe, the person may rush out of the room.

A certain amount of fear can be helpful and may aid our survival. Thus we would probably expect most people to be fearful of lions, sharks and venomous snakes if they came into close proximity to them. However, mice and almost all spiders are not life threatening to humans and to be fearful of them is irrational. Irrational fears of objects, people or situations are known as *phobias*. The fear is such that it can affect the person's everyday life if they are exposed to the object or situation. The irrational fear of spiders is known as arachnophobia, that of mice is musophobia. Some fears can be shown to be learnt and one of the best known examples is that of Albert, a young boy who was conditioned to be fearful of a white rabbit (this study was carried out by Watson and Rayner in 1920).

In this study you will try to determine **how fearful people believe they are of certain animals**. Fear is something that is experienced internally and it is difficult to measure. We cannot measure it as we would measure time, length or mass. However, we can use categories which go some way to indicate the relative amount of fear that people believe they would feel.

It is possible that the fear people have of an animal is related to how closely they would approach it and how ugly they think it is. This survey will focus on twelve animals that could be seen in Britain and will measure:

a) how afraid people believe they are of each animal

b) how closely they might approach it if it was injured and immobile

c) how ugly they believe the animal is.

In this type of study you will be looking to see if two measures are related to each other. The research you will carry out is based on a study conducted by Bennett-Levy and Marteau (1984). It would be perfectly acceptable to consider just two of these three lines of enquiry; if so, make it either a) and b), or else a) and c). So you will be looking to see if their fear of an animal is related to how closely they might approach it, and if their fear of an animal is related to how ugly they think it is.

What would be a suitable hypothesis to test in this study?

In this type of study you will be looking to see if two measures are related. In fact, if you carry out the study with all three measures you will need two hypotheses. You could use this hypothesis for the first case: 'there will be no relationship between the stated fear of an animal and how closely people say they would approach it'. This might be suitable for the second case: 'there will be no relationship between the stated fear of an animal and how ugly people believe it to be'.

Equipment

For this investigation you will need the following:

- pens and/or pencils for the participants to complete the questionnaire
- copies of the questionnaire, one copy for each participant.

You can use the questionnaire outlined below, see Figure 1.

Procedure

This is a correlational study, i.e. you are going to see how closely two measures or variables are related, using a survey to gather the information.

Before you carry out the survey you will need to give consideration to a number of features.

Think about the number of participants you will use in the study. When carrying out a survey you will have very little control of variables and so it is important to try and make the survey as large as possible. Twenty would really be the minimum, thirty would be better and any number in excess of thirty would be advantageous. As with most surveys carried out in schools and colleges, the sample is likely to be an opportunity sample, or perhaps a systematic sample. It is therefore important that it is as large as possible so that it becomes more likely to be more representative of the population, i.e. your school or college population.

You need to devise a set of standardised instructions to read to each person. These can be read to them or they could be placed at the top of the questionnaire; in this case you must ask them to make sure they read them before they start to complete the sheet. Don't forget to add the question "Do you understand?" because you may have to explain to them what they have to do, or perhaps explain what a particular animal looks like. [We have tried to choose common animals but one or two participants may be unfamiliar with them. You must decide what you will do if this happens. You could either read out a one or two sentence description of it, or show them a photograph of the animal. Or you could omit their responses in your analysis.]

Since you may be asking people to complete the questionnaire in different locations it is important to ensure that nobody else disturbs them. Environmental conditions are probably not going to be too important, but try to find a fairly quiet place to carry out the task.

After they have completed the survey you need to give each response a score. For their fear score, score 1 if they tick 'not afraid', 2 if 'quite afraid' and 3 if 'very afraid'. For closeness, score 1, 2 or 3 again, 3 being given to the greatest distance. Score in the same way for ugliness, i.e. 1, 2 and 3, with 3 given to the 'very ugly' rating.

Make out a check sheet to contain the results. For each participant there will be two, or three, scores. The numbers you collect for each participant in the survey will represent:

a) how fearful of the animal they believe they are

b) how closely they would approach the animal

c) how ugly they think it is.

For each person, their total fear score, their total closeness score and their total ugliness score should lie in the range 12-36. Make sure that each participant completes every line on the questionnaire or you may not be able to use their data in your analysis.

When you approach potential participants, ask them if they are willing to participate in an investigation for your Biology/Psychology course. If so, move them to a quiet area of the school/college where they can complete the questionnaire without being disturbed. Read the standardised instructions to them in a neutral voice and answer any queries they may have. They can have an unlimited amount of time to complete it, within reason of course. You must then debrief them and thank them for their help. Finally, you will need to find the total scores for fear, closeness and ugliness for each subject who participated in the survey.

Results

Draw a table to display the results. If you have asked each person to assess the three measures then you will have three scores for them. The most obvious way to see if their fear score is correlated with their closeness score, or their ugliness score, is to draw a scattergraph; two scattergraphs will be needed if you have used all three measures. Put the fear score on the vertical axis and the closeness, or ugliness, score on the horizontal axis. When you plot each point on the scattergraph you might wish to use two symbols to be able to identify female and male scores separately. This may be useful when you comment on the results. It would also be useful perhaps to determine the mean female and male score for each of the two, or three, measures.

Discussion

The means and the two scattergraphs should enable you to say whether the correlations, or associations, between the fear of animals and the closeness that participants would approach them, and the fear of animals and their ugliness, appear to be significant. The pattern of points on each scattergraph should also allow you to say if the correlations, or associations, are positive or negative, although if there appears to be no obvious pattern there may be no correlation between the two variables concerned. Try to put forward some explanation for the findings and note whether any particular individual seems not to fit the general pattern of points. It is also worth looking at the scores to see if there is a greater range in one of the sets, and note what this means. As with other studies, try to spot one or two improvements you would make in the investigation if you were to carry it out again. For example, whether the participants have had actual contact with any of the animals listed in the questionnaire.

Further work

You have studied how fearful people believe they are of twelve animals and whether this is related to how closely they believe they would approach them and how ugly they believe them to be. It is possible for the fear of an animal, and for that matter any other fear, to be learned. If so, the fear scores, closeness scores and ugliness scores of your participants may be significantly correlated with the scores of their parents. So if a pupil is fearful of squirrels it might be that their father is fearful too and that the pupil has learnt to be fearful of the animal as well. The parent acts as a model for this piece of behaviour. If you ask the parents of your participants to complete a questionnaire this could be investigated.

Reference

Bennett-Levy, J. and Marteau, T. (1984). Fear of animals: What is prepared? *British Journal of Psychology*, 75, 37-42.

Questionnaire

	How fearful of the animal are you?			How close would you approach if it is injured or immobile?			How ugly do you think it is?		
Animal	not afraid	quite afraid	very afraid	pick it up	>1m <5m	≥5m away	not ugly	quite ugly	very ugly
Grasshopper									
Rabbit									
Frog									
Blackbird									
Cockroach									
Grass snake									
Butterfly									
Squirrel									
Robin									
Rat									
Lizard									
Crow									

Figure 1
Questionnaire for assessing aspects of human perceived fear of animals.

STRESS IN SOCIAL SITUATIONS

Background

Stress is an experience an individual feels in response to a challenge and, in itself, is not bad for us. In fact, most of us need challenges to function efficiently. The problem arises when the challenges become too much for us and we have difficulty coping with them. This can result in distress and anxiety.

Humans are social animals. We are subject to social pressure simply by being in the presence of others. Some people feel happiest in the company of others; some feel happiest when on their own. All of us, however, have to engage in a number of activities each day which bring us into contact with others. In some social situations we may feel relaxed, happy and confident; in others we may feel anxious and worry about how we will cope. In most social situations there is always some degree of stress. Usually this is not too great and we can cope without any great difficulty. When the situation is a little more stressful we may become anxious or apprehensive, for example, if attending a job interview.

In this investigation you are going to use a questionnaire which will try to assess how much **stress people believe they might experience in certain social situations**. We suggest you try to get roughly equal numbers of female and male participants so that you can discover if there is a difference between females and males in the levels of stress they believe they would experience in the social situations listed in the questionnaire.

What would be a suitable hypothesis to test in the investigation?

You might use this hypothesis: 'there will be no difference between female and male students in the difficulty they believe they would experience in social situations'.

Equipment

For this investigation you will need the following:

- pens/pencils for the participants to use to complete the questionnaire
- copies of the questionnaire, one copy for each participant. [You could devise you own questionnaire of course.]

Procedure

Before you ask your participants to complete the questionnaire you will need to give consideration to how the investigation will be carried out.

This is not an experiment or observation but a survey, using a questionnaire, which will reveal how people believe they would feel in certain situations. There will clearly be very little control over variables in a survey but every effort should be made to carry out the study in a rigorous manner.

The participants may complete the questionnaire in a variety of locations. However, do try and ensure that each one does so in relative peace and quiet. In particular, try to make sure that nobody else is nearby when they are completing the task.

Choose your participants carefully. It is highly unlikely that you will be able to use a random sample. It is much more likely that you will use a systematic or opportunity sample. The number of participants is important. Twenty would be a minimum for such a survey, thirty would be better and any number in excess of thirty would be a bonus. Try to get a balance of the sexes (and ages) too.

You need some standardised instructions. If you use the questionnaire provided, then there are some instructions at the top of the page but you will need to add some more. For example, the question "Do you understand?", or something very similar, needs to be asked. You will also need to emphasise confidentiality.

Once you have your participants, take them to a quiet place to complete the questionnaire. They can be given an unlimited amount of time, within reason, to do this. When they have done so, thank them for their help and explain what the study is about. Remember to ask them not to discuss this with other students until the survey is complete.

When they have left, calculate their total score. To score a completed questionnaire determine the total from the twenty individual numbers that have been ringed. The total for each individual will indicate how difficult they believe they would feel in the social situations listed. A high score would suggest that they believe they would find those particular situations rather difficult to cope with. A low score would suggest they think they would cope fairly easily.

Make out a table to contain the results. For each participant there will be a total score, which must lie in the range 20-100. Of course, some people may not answer every question and so you must check every questionnaire before they leave your sight. Ideally, you want each person to complete all the questions.

Results

From the total scores for each individual female and male calculate their mean score and draw another table to hold these data. You might also want to represent these data using an appropriate graphical technique. It would also be worth calculating the range in the male and female scores.

Discussion

The means and the graphs should enable you to identify if female and male students have scored differently. Which sex has the greater range in their scores? Can you accept or reject your hypothesis? Try to put forward one or two suggestions which might explain the findings of the survey. Look carefully through the response sheets because you might be able to identify if certain types of situation, for example, novel situations, are more stressful than others.

Try to identify a couple of weaknesses of the study and outline how you might try to overcome them if you decided to repeat the investigation.

Further work

In this study your participants have responded by indicating how much stress they believe they might feel in these situations. It is possible to get some indication of a person's stress level in a situation using a physiological indicator. This might be the galvanic skin response or, even easier, the heart rate. It is possible that you may be able to recreate some of the social situations in the questionnaire; numbers 10, 12, 13, 15 and 17 perhaps, and then see if the expected level of stress, as revealed by the questionnaire, is matched in the stress of the real situation. You may be able to use biodots* and check the stress levels whilst participants are experiencing situations 10, 12, 13, 15 and 17.

References

Looker, T. and Gregson, O. (1989). *Stresswise: a practical guide for dealing with stress.* London: Hodder and Stoughton.

[The book is now out of print but a photocopied ring bound version is available from Stresswise, PO Box 5, Congleton, Cheshire CW12 1XE. The cost is £5, plus £1 for postage and packing. The *Stresswise* book is to be replaced in 1997 by two separate books - these are:

Looker, T. and Gregson, O. (1997). *Teach Yourself Managing Stress.* London: Hodder and Stoughton. ISBN 0-340-66376-6 Price £6.99.

Gregson, O. and Looker, T. (1997). *Stress: Understanding and Coping With Stress.* London: Bloomsbury. ISBN 0-7475-2609-5 Price £7.99. Of the two books, the second is probably nearer to the original book.]

*Biodots (temperature sensitive self-adhesive discs which monitor skin blood flow) are available from: Stresswise, PO Box 5, Congleton, Cheshire CW12 1XE.

Questionnaire

Below are a number of fairly common social situations. We would like you to rate yourself on how difficult it would be for you in each situation. We would like you to use a five point scale:

Score	
1	if you would have no difficulty at all in that situation
2, 3 or 4	as the situation becomes more difficult
5	if you would find the situation very difficult to cope with.

Circle the number that is appropriate

1.	Walking down a familiar street	1	2	3	4	5
2.	Going into a supermarket	1	2	3	4	5
3.	Having an interview for a job	1	2	3	4	5
4.	Having a dental appointment	1	2	3	4	5
5.	Sitting next to a stranger of the same sex as yourself	1	2	3	4	5
6.	Sitting next to a stranger of the opposite sex to yourself	1	2	3	4	5
7.	Taking a taxi journey on your own	1	2	3	4	5
8.	Asking a stranger for change to make a phone call	1	2	3	4	5
9.	Mixing with friends at school	1	2	3	4	5
10.	Mixing with unfamiliar students at school	1	2	3	4	5
11.	Going out on a first date	1	2	3	4	5
12.	Being with people older than yourself	1	2	3	4	5
13.	Being with people younger than yourself	1	2	3	4	5
14.	Going to a club or disco	1	2	3	4	5
15.	Going into a room full of people on your own age	1	2	3	4	5
16.	Going to the funeral of a close relative	1	2	3	4	5
17.	Having to take part in a school assembly	1	2	3	4	5
18.	Complaining in a store about poor quality goods	1	2	3	4	5
19.	Having to be with your family on holiday	1	2	3	4	5
20.	Asking someone to repay the money they owe you	1	2	3	4	5

THE DEVELOPMENT OF BEHAVIOUR - REMOVING A SWEATER

Background

Most people wear sweaters at some time and obviously need to remove them, at least at the end of the day. How do people remove their sweater - that is, which style do they use? In this study you will be getting a group of people to show you which method, or style, they most frequently use. To the best of our knowledge, this specific area of research, how people remove a sweater, has not previously been investigated. However, you might think that it is likely to vary and that a number of styles are used.

It is likely that teenagers are fairly consistent in the style they use to remove a sweater. However, this style may have developed over time. If you had a video recording of the style you used as a seven year old it may be different from the style you use now. How did the style you use develop? Perhaps it is the most comfortable method for you. Perhaps it developed because your parents and/or infant teachers encouraged that style as they helped you dress when you were a child. This study concerns the **development of a piece of behaviour**.

In this investigation you are going to observe the styles that female and male students and adults use when removing a sweater (or sweatshirt). You need to record the style they use, together with any other relevant comments that they might make.

What would be a suitable hypothesis to test in this study?

You might use this hypothesis: 'there will be no difference in the styles used by male and female students when removing a sweater'.

Equipment

For this observational study you will need the following:

- drawings, or written descriptions, of the styles that could be used (see Figure 1)
- a check sheet, with the styles identified, to record your observations.

Procedure

Before you start the investigation you need to think carefully about how you will carry out your study.

Decide upon the standardised instructions that you are going to use. You need to ask them to show you how they **usually** remove a sweater. They do not necessarily have to take off the sweater if they are wearing one. Some of the participants you approach may not be wearing one; this does not matter, as they can still demonstrate to you how they usually do it.

You need to determine how many people you are going to use and how they are to be sampled. This study should not take more than a minute of their time and so it should be possible to generate results quite quickly. Try to get at least thirty people, more would be valuable. The type of sample that you use is most likely to be an opportunity sample. This is perfectly alright, but since it will not necessarily be representative of the population, you ought to try and make the sample size as large as possible. Try to get a reasonable balance between the sexes, and perhaps age groups, unless you want to control for one of these variables. If you are carrying out this study as a class exercise it is perfectly acceptable to pool your data provided that the procedures each group uses are the same.

Make sure that you ask the participants when they are on their own, the presence of other people might influence their behaviour.

No apparatus is required for this study. However, it would be useful to discuss the styles or methods that you think that you may find. There are, no doubt, a great many ways to remove a sweater. What is important, as we pointed out in the 'Describing and Measuring Behaviour' section of this book (see pages 5-11), is to name and define the styles of sweater removal carefully.

In research carried out by Lisa Strittmatter (a sixth form student at Loreto College, Manchester), six styles were recognised and she drew sketches of each. Here is an example where drawing a sketch describes quite accurately the method of removing a sweater. The labels that have been given to the styles were devised by Lisa and are a useful shorthand to use to identify each style. They essentially describe how an individual holds their hands and arms at the start of the process of taking off the sweater. You can use her drawings (see Figure 1) as a way to classify the styles you find, though you may discover that your participants use other methods too. [See also the front cover of the book which illustrates some of the styles used.]

What you record in your study is the style each person uses and so the numbers you produce, when you summarise your findings, represent the frequency of use of each of the styles you observe.

[You may wish to develop this study a little further by timing how long it takes each person to actually remove their sweater. It would be best if this was carried out in a school since the students will be wearing the same type of sweater. You also need to record the time without the student knowing that you are doing so. For convenience, it is best achieved if one person in the team has a stop watch in her/his pocket and starts/stops it at the start and finish of the removal process. Of course, for this study you must ensure that the person is dressed appropriately. Under no circumstances should you ask anyone to participate if, by doing so, they would be embarrassed.]

Make out a check sheet to contain the results, a simple tally table is all that is needed.

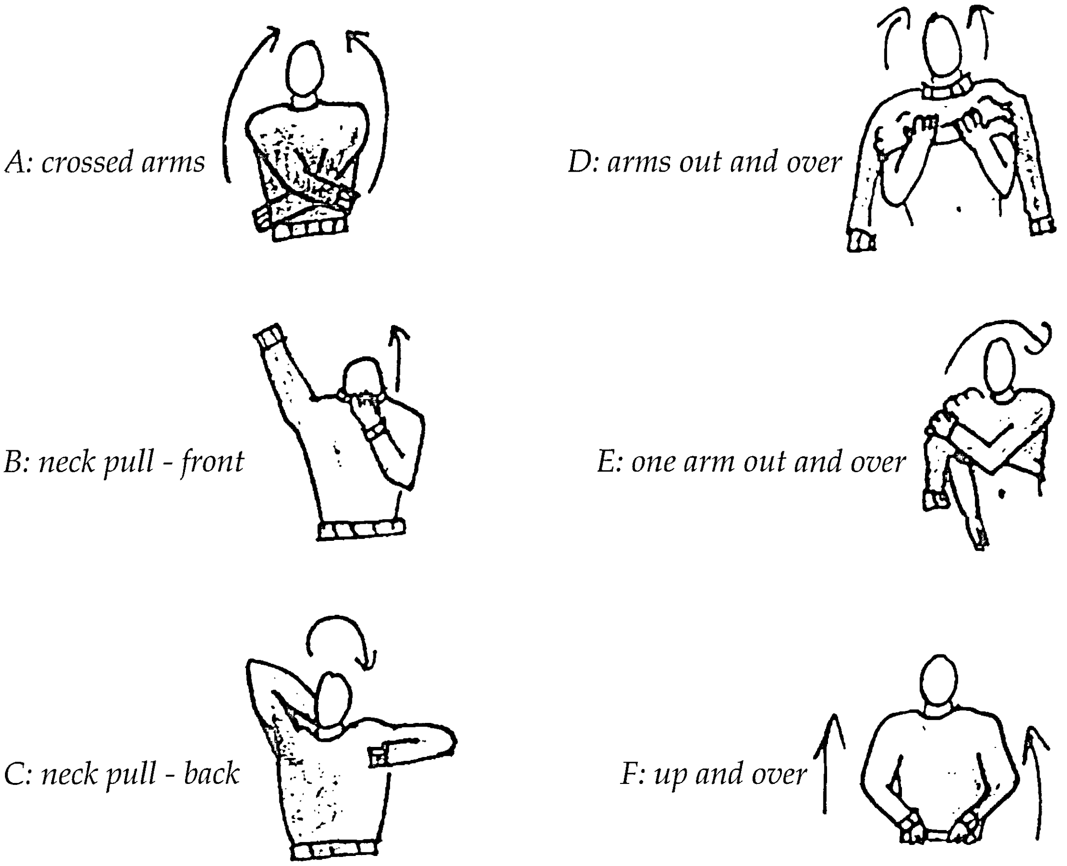


Figure 1
Some common styles of removing a sweater.

Approach participants when they are on their own, since the presence of others could be influential. Aim to get a reasonable balance of male and female participants: 30 males and 30 females would be fine, more if possible. Read your standardised instructions to them and answer any questions that they might have. Then record the method that they demonstrate to you. If you use Lisa Strittmatter's drawings but find that the subjects use methods she did not find and sketch, it would be helpful to try and draw your own version of the style they use. It would also be useful to ask if they have always used the method, in particular if they remember using it as a child. Remember to thank them for their co-operation and to tell them not to discuss it with other potential participants until the study is completed.

Results

The basic table to contain your findings will be just a frequency table showing the number of subjects that used a particular style and their sex. It would be useful to draw two bar graphs, one for females and one for males, to show the number of participants using each style. This will enable you to identify the modal style used by each sex.

[If you have recorded the time taken to remove their sweater, determine the mean time taken by each sex for each style and put these data in a separate table. This will allow you to see if there are any differences in the time taken to remove a sweater and if some styles are quicker than others.]

Discussion

You need to make some comments on the findings, which will be evident in the table and the graphs. It is probable that some styles will be more frequently found and you should suggest what might explain your findings. Are there any styles that are only used by females and any that are only used by males? If you have recorded details about how they removed their sweater when they were younger this might allow you to make a few comments about whether styles change over time. It is possible that cultural factors may be important. It would be worth considering what factors might influence the style that a person uses. Perhaps differences in upper body anatomy might explain male and female differences, as could hair length, hair style, etc.. Could cost be a factor? Perhaps people use one style with a very expensive sweater and another style if they are wearing an old sweater.

Consider one or two limitations of the study and try to put forward suggestions as to how they could be overcome if it was to be repeated.

Further work

It would be interesting to ask students to try another style of removal, i.e. a non-preferred style. You might think that asking them to use a style that is quite different to their usual style is best; if they normally use method A then ask them to use method C, for example. Ask them to do this once each day for two weeks. If you surreptitiously record the time it takes them to remove the sweater on each day, does their performance improve over time, i.e. do they speed up and does learning take place?

THE INTERPRETATION OF A VISUAL STIMULUS - THE POWER OF AN ILLUSION

Background

In the course of a day we receive stimuli or signals through our senses of touch, hearing, smell, sight and taste. The term perception refers to how we interpret the information we receive. Perception allows us to recognise familiar faces, smells and voices and at the same time allows us to recognise new features and information from these stimuli. For many years researchers have been interested in how our perception of stimuli can sometimes be incorrect. This can be investigated using an illusion.

Illusions occur when we misinterpret a stimulus. If we are in a classroom and hear voices in the corridor outside we may believe we know who is talking. If, when we investigate, we find that it is not the person we thought it would be, we have experienced an illusion. In this case it would be an auditory illusion; we are more familiar with visual illusions.

There are many well-known visual illusions, perhaps the most famous is the Müller-Lyer illusion, see Figure 1.

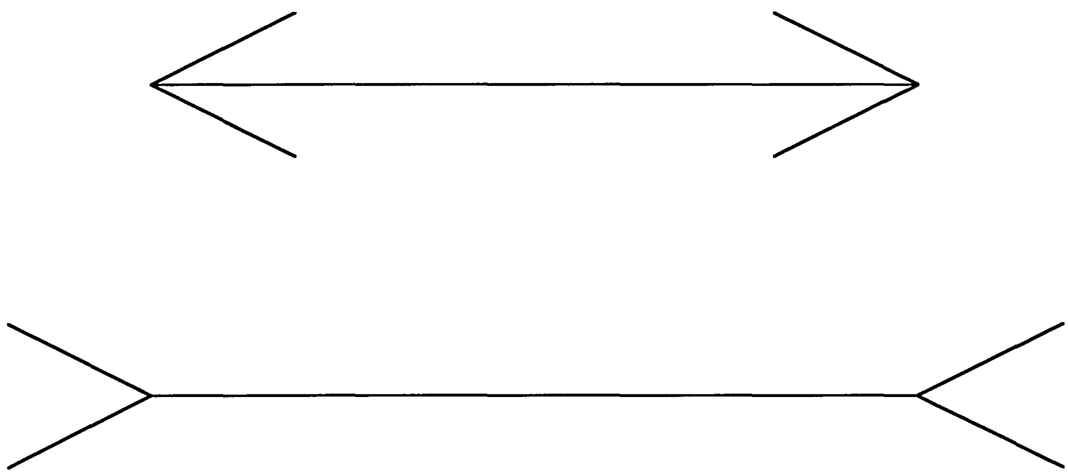


Figure 1
The Müller-Lyer illusion.

The lines have arrowheads at each end but the top line has them pointing inwards while the bottom line has them pointing outwards. To us, the top line appears shorter than the bottom line, even though the two lines are equal in length. We misinterpret the lengths because of the arrangement of the arrowheads. If you remove them, everybody would say the two lines were of equal length.

Interestingly, the susceptibility to this illusion may depend on the culture and environment in which people have been raised. In other words, this suggests perception can be learned. This was investigated in a very well-known study by Segall, Campbell and Herskovits (1963). They compared the performance of Europeans and Zulus and found that the Zulus were unaffected by the illusion, whereas Europeans were fooled by it. They believed that this was because Europeans live in a world dominated by straight lines and right angles. So when they see the illusion the lines remind them of the corners of rooms and buildings and they misinterpret the lengths of the lines. In this experiment you will investigate how the **susceptibility of people to the Müller-Lyer illusion** differs under two conditions.

What would be a suitable hypothesis to test in this experiment?

You might use this: 'there will be no difference in the error (see below) made by participants when they are presented with the Müller-Lyer illusion under Condition A and Condition B'. [For examples of possible conditions see below.]

Equipment

To carry out this experiment you will need the following:

- a Müller-Lyer illusion (see Figure 2)
- a sheet of 1 mm graph paper
- a pair of scissors
- card, not black
- thin black felt pen
- protractor
- a 30 cm ruler
- a soft lead pencil.

Procedure

Before you start assessing the behaviour of the participants you need to think carefully about how you will carry out the experiment.

You need to decide what the two conditions are that you will investigate: for convenience, we are referring to them as Condition A and Condition B. You might wish to see if the illusion is more powerful when:

a) the illusion is presented horizontally or vertically

b) the angle of the arrowheads are 30° or 60° (from the horizontal)

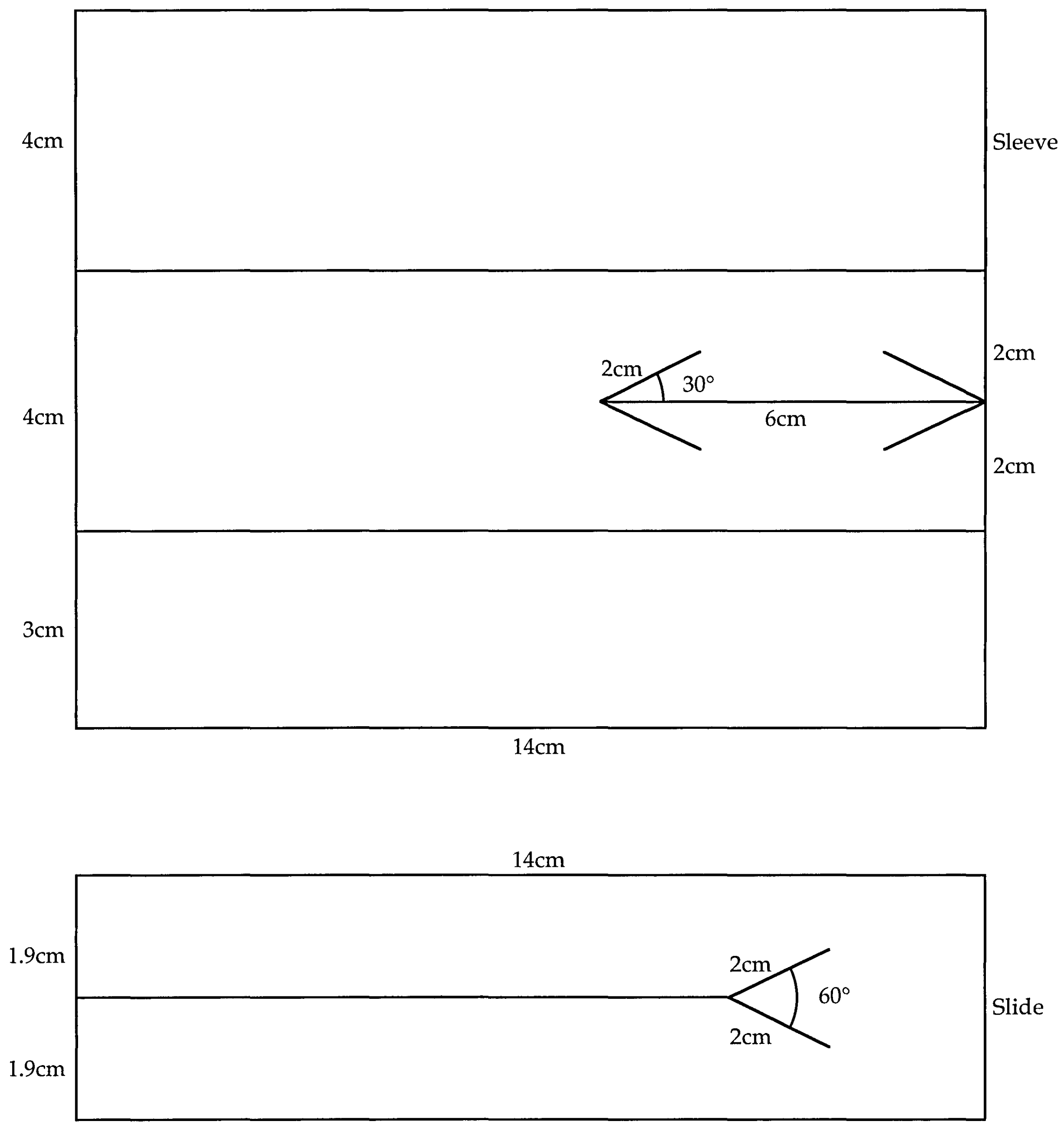
c) the slide is pushed in or pulled out

d) the illusion is viewed normally or through a mirror.

These are only a few suggestions and you may have other, more fascinating, ideas which would be worth investigating.

Whilst you are carrying out this experiment, try to keep the environmental conditions constant.

Make a Müller-Lyer illusion to use in the experiment, using the dimensions suggested in Figure 2.



NOTE: Do not write any measurements on the card that you use.

Figure 2
Suitable dimensions for a Müller-Lyer illusion.

Draw the illusion on the piece of card using the soft lead pencil. You may need to erase some of the lines so use only light pressure. The words 'sleeve' and 'slide' are only used for convenience when describing the two separate pieces of card. Cut out the pieces of card carefully, with a sharp pair of scissors. On the larger piece of card (the sleeve), mark out the 6 cm horizontal line using a fine black felt pen, making sure that the line is in the centre of the middle section. You then need to draw, using a pencil, the arrowheads. You will need to use a protractor to measure the angle of 30° accurately. When each of the arrowheads is drawn to the correct length (2 cm), use the fine black felt pen to go over the line. When the ink has dried, rub out any other pencil lines that you have drawn. On the inside of this sheet of card score along the lines (using the scissors and a ruler) separating the three sections, fold them over and sellotape down the open flap. Then carefully draw the line on the smaller piece of card (the slide). Make sure the horizontal line is in the centre of the card and then draw the arrowheads as you did before on the sleeve. On the reverse side of the slide draw a scale to allow you to measure the length of the line each person exposes. It is best to use a strip of 1 mm graph paper for this as it will then be very easy to read off the length. Make sure that the 0 on the scale is exactly at the point where the fins meet the horizontal line, as all measures will be taken from that point. Sellotape the strip of graph paper to the back of the slide - the sellotape will also give some rigidity to the slide. Put the slide carefully inside the sleeve and it should move in and out smoothly. When the slide moves, it should look like a continuation of the line on the sleeve, and will be if you have drawn it carefully.

Choose your participants appropriately and a large enough sample to give you meaningful results. For this experiment each person will work under both conditions, i.e. this will be a repeated measures experimental design. It would be best to decide the order of presenting the conditions to the participants randomly. The participants may well have seen the illusion before and you might think it would be worthwhile asking them whether this is the case. This does not mean that you could not use them, though it would be unwise to do so if they have recently been exposed to the illusion. However, it might be a good idea not to ask GCSE or A Level Biology and Psychology students to be subjects as they may be familiar with the effect of the illusion.

Devise suitable standardised instructions to give to the participants .

Decide how many times each person will use the illusion in each of the two conditions you are investigating. One trial for each condition would be insufficient, five of each would seem about right, ten of each might be too many as boredom may become a factor!

For each trial a participant adjusts the slide so that it is perceived as being equal in length to the line on the sleeve. When they have done this, take the slide from them and refer to the scale on the reverse of the illusion, noting the length of the line they have exposed on the slide. Then subtract this number from 6.0 cm to give the error, i.e. how far they are away from the true length (6.0 cm). Record the error value. What you have recorded is the error they have made and this represents how much the illusion fooled them on that trial. This procedure is repeated for the other trials.

When everything is ready, ask the participants, one at a time, to come into the room where the experiment is being carried out. It is easiest if they sit at a table. Read out your standardised instructions and if they have any questions answer them. When they are ready, present the illusion to them. Unless you are investigating the effect of a vertical and horizontal presentation, hand them the card horizontally and ask them to pull the slide out until they think the two lines are the same length. Take the illusion from them and record the error for that trial on your check sheet. Do not let them see the reverse of the slide, nor the record of the error on the check sheet.

After all the trials have been completed, thank each person for their help. It is also important to debrief them, i.e. explain what you have been investigating. Remember that this experiment uses an illusion so people will be expected to make 'mistakes'. You may therefore need to reassure them that making 'mistakes' is the normal response to this visual stimulus. As with most practicals ask them not to discuss it with others until all the participants have completed their trials.

Results

Determine the mean error for each person under the two conditions. Put the mean error values for each participant under the two conditions in a table and you can then scan the table to see if you can see any pattern in the results. It may be appropriate to graphically represent these data.

Discussion

The means, together with your graph, should enable you to see if the participants have performed differently under the two conditions. Will you be able to accept or reject your hypothesis?

In your discussion you should first of all say whether the participants were susceptible to the Müller-Lyer illusion. It is almost certain that they would have been, but it may vary from person to person and it will also probably vary under the two conditions. Make some comments on the variation in the susceptibility and under which condition the effect was more powerful. Put forward a possible explanation for this. See if the individual participants became more, or less, susceptible over the five (?) trials. What factors might explain the findings? Do your results tie in with those of Segall, Campbell and Herskovits as they relate to Europeans, since you probably won't have a sample of Zulus handy!

Try to identify a couple of limitations or weaknesses in the experiment and then suggest how these might possibly be overcome if the experiment was to be repeated.

Further work

The Müller-Lyer illusion is a very powerful one and illustrates just how our interpretation of a visual stimulus can be 'wrong'. This, and other experiments, suggests that perception can be learned. Can we 'unlearn' our susceptibility to the Müller-Lyer illusion? With another group of people you could test them as above initially and then explain to them the effect of the illusion, i.e. that people usually under-estimate the length of the line on the slide. Then give them further trials and see if they can learn to compensate for the effect of the illusion. It would be interesting to see if learning to compensate is permanent. How would you do this?

Reference

Segall, M. H., Campbell, D. T. and Herskovits, M. J. (1963). Cultural differences in the perception of geometrical illusions. *Science*, 139, 769-771.

THE INFLUENCE OF FEEDBACK IN LEARNING A SKILL

Background

There are a number of factors that have been shown to influence how well and how quickly humans learn. One of these factors is *feedback*. Feedback is knowing what the results of an action are. In general, the quicker and more complete the feedback is, the faster the learning. If we are trying to improve our performance at throwing darts, or learning a foreign language, we need to know how well we are doing. When learning German, for example, we would not make much improvement if the teacher never told us how well we were doing, or how to pronounce words correctly, or never marked exercises that we handed in, etc..

There are three forms of feedback:

1) no feedback - the person is not given any information about how they are doing
2) partial feedback - the person receives some information about their progress
3) complete feedback - the person is given all the relevant information about how well they are doing.

The feedback can be given at one of two rates:

1) immediate - the person receives feedback as soon as they have completed the task
2) delayed - some time elapses before the feedback is given.

The influence of feedback can be investigated in what appears to be a very simple task: a blindfold person tries to locate the position of a line they have previously seen on a large sheet of paper/card. To do this they will probably rely on their perception of where they think the line is positioned on the paper. Of course, this is a very easy task if we can use our eyes but is more difficult when we are blindfold. **Does feedback help in learning** to find the position of the target line?

In a similar type of experiment, Baker and Young (1960), people were asked to feel a piece of wood with their hands and were then asked to draw a line that was the same length as the piece of wood. They found that the feedback group were much more accurate than the no feedback group. Will you find the same?

What will be a suitable hypothesis to test in this experiment?

You might make this your hypothesis: ' there will be no difference in the accuracy of finding the target line between people who receive total feedback and those who receive no feedback'.

Equipment

- a large sheet of paper or card, A3 is fine but A2 would be better
- a metre rule
- a fine, black felt tip pen
- Blu-Tack
- a soft lead pencil.

Procedure

Before you start testing the participants you will need to think carefully about how you will carry out the experiment.

You will need to decide on the type of feedback to be investigated. Comparing two of the three types will be fine, and it is probably best to make no feedback one of the types you study. [In this investigation it is assumed that you will compare performance under conditions of 'no feedback' and 'total feedback'.] You will also need to decide on which rate of feedback to study - one of the two mentioned above is all you need, since one group won't receive feedback.

It is likely that the experiment will be carried out in a classroom, so do try to keep the environmental conditions, such as the noise level, as constant as possible whilst the participants are in the room.

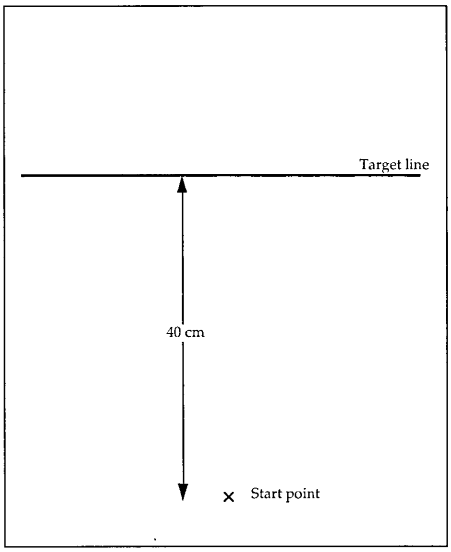


Figure 1
Suitable layout for sheet of A2 paper.

You will need to make the apparatus, which is very easy, see Figure 1. All that is needed is a large sheet of paper, A3 would do but A2 would be better. It does not have to be a piece of good quality paper, in fact a piece of smooth wallpaper, for example, would be fine. Fix the paper to a smooth surface with BluTack and draw a cross in the centre of the sheet of paper, 5 cm from the bottom of the sheet; this is the starting point for each trial. About 30 - 40 cm above this cross draw a horizontal line with a fine, black felt pen across the paper; this is the target line. See Figure 1 for a sketch of the sheet. The only other apparatus needed is a metre rule.

You will need to give some thought to how many participants to use and how to select them. You need two groups of participants, a minimum of ten in each group, fifteen would be better, or even more if that is possible. Suppose you decide to use thirty people in all, then you need to determine how to allocate them to the two groups, viz. fifteen in the group who will receive total feedback and fifteen in the group who will not get any feedback. It is quite acceptable to alternate the participants, provided that they come to the classroom in a non-biased manner. If it is possible, it would be best to allocate them to the groups in a random manner; your teacher will help you to do this.

It is most likely that you will be using students who just happen to be available, if so this is an opportunity sample. This is fine but it will not necessarily be representative of all the students in your school/college.

You must decide what instructions to give to the participants when they are ready to do the task. These are the standardised instructions and should be given in a neutral voice to each person when they are ready to be tested; it is best if they are read from a card or piece of paper. You will first of all need to ask students if they are willing to participate and your teacher may help here. However you get hold of them, sit them at the desk/table on which the paper is fixed and read your standardised instructions. These could be as follows: " Thank you for agreeing to help with our research. On the sheet of paper in front of you is a line. We will blindfold you in a moment and then ask you to indicate with a cross where you think the line is, starting from this point. Do you understand? [Answer any questions that arise.] We will ask you to do this six times. Please put the blindfold on now."

Make out a check sheet to record the results. It would be best to give each participant six trials. This is because the students in the total feedback group will only be given feedback on their second, and every subsequent, trial. Only data from trials 2-6 will be used in your analysis, though it will be useful to record the result of their first trial too. [Why might this be helpful?] Perhaps you might like to use the check sheet suggested below, see Table 1.

	TOTAL FEEDBACK							NO FEEDBACK						
Student	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	$\bar{x}$	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	$\bar{x}$
A														
B														
C														
D														
E														
F														
G														
H														
I														
J														
K														
L														
M														
N														
O														

Table 1 A check sheet suitable for recording the distances from the target line (cm).

For each trial the person marks on the piece of paper where they believe the target line is. You then measure how far this point is from the target line. This distance is the error they have made, so the numbers you collect in the study represent how inaccurate was their perception of the correct location of the target line.

When you are ready to begin the experiment bring in the first person and ask them to sit at the table which has the large sheet of paper fixed to it. You should then read the standardised instructions, after which they put on the blindfold. Place a pencil in their preferred hand and ask them to carry out the first trial. Tell them to draw a small cross where they believe the line to be. When they have placed their first cross on the paper, place the pencil point on the starting point, but ask them to wait before they have their second trial. Now measure the distance of the cross from the target line; when measuring the distance, keep the ruler at right angles to the target line. Record the distance, to the nearest millimetre, on the check sheet and then ask them to have their second trial. For the no feedback group this continues until they have completed all six trials. For the total feedback group, tell them how far they are from the target line and if they were above or below the target line (or on it if they hit the line!). Then ask them to have their second try. This procedure continues until they have had all six trials. [What rate of feedback is this? In fact it will be, well to all intents and purposes, immediate feedback. If you wanted to give delayed feedback you should wait, say a further 20 seconds, and then tell them if they were above or below the line.] When each person has completed the six trials thank them for their help and then explain what you have been investigating. It would be perfectly OK to tell them how they did but do ask them not to discuss it with other students until tomorrow. For this reason it is best to try and finish the trials in a day.

Results

The first thing that would be appropriate would be to calculate the mean distance from the target line for the five trials for each participant. This will give you a good idea as to whether the two groups have performed differently. Another good idea would be to draw two graphs to show the mean distance from the target line for each person in each group. These two ways of dealing with the data will allow you to see if the two groups have behaved differently.

Discussion

Your calculation of the means and the graphs should allow you to say if giving total feedback did enable this group to be more accurate in locating the position of the target line. Will you accept or reject your hypothesis?

From your findings you should be able to say, for the total feedback group,

a) if feedback has been influential

b) if learning occurred, i.e. did the students improve their performance over the trials due to experience?

Can human perception of the distance from a start point to a target line be learned?

Look for any variation in the performance of the participants; if you find individuals with results which are very different from the rest of the group what does that suggest? Do your results agree with those of Baker and Young? Try to identify one or two weaknesses or limitations of the experiment and suggest how they might be overcome if you were to repeat it.

Further work

A person's perception of the distance from the start point to the target line could be influenced by contact with the paper, perhaps through using their arm like a pair of compasses. Is accuracy affected if you move their arm for them, as opposed to when they move it for themselves? If you move a person's arm for them they will not be able to use a set of stimuli that might help with the task, viz. tactile (touch) stimuli.

Reference

Baker, C. H. and Young, P. (1960). Feedback during training and retention of motor skills. *Canadian Journal of Psychology*, 14, 257-264.

NAVIGATION IN THE ABSENCE OF VISUAL CUES

Background

Orientation is knowing your position relative to other animals and to other features of the environment. When sunbathing, for example, we orient our bodies to the sun's rays. Navigation, on the other hand, is the ability to head in a particular direction towards a goal. Birds, for example, need both these abilities in order to follow the route from their wintering areas to their breeding grounds.

On a very local scale, for example your own school or college, students can usually navigate accurately between two different parts of the building, even if they cannot see the goal when they begin the journey. For humans, the visual cues on such a journey are vitally important. If you were asked to walk in a straight line when you were blindfold could you do it accurately?

In this investigation you will be able to see if students can walk the path of the shortest straight line distance across a room when blindfold, i.e. **how accurately can people navigate if they cannot use visual cues**. This is best carried out in an assembly hall or gym, or some other appropriate building without any furniture in it. Since almost all students will not be able to take the path of the shortest straight line when blindfold, and since all of them could do it quite easily if sighted, it would be interesting to study an effect that might influence their behaviour when they are blindfold. The most straightforward design would be one with two conditions under investigation. For example, walking in shoes and walking in socks/tights, or walking unhindered and being asked to carry a reasonable load in one hand, some books or a shopping bag of groceries, for example.

What would be a suitable hypothesis to test in this investigation?

Perhaps you could use this: 'there will be no difference in the error made when students walk with shoes on or with socks/tights'.

Equipment

- a sports hall, assembly hall or other suitable building
- chalk
- two 20 metre tapes
- a couple of metre rules, or any long piece of wood with a straight edge
- a blindfold (or a clean scarf if no blindfold is available).

Procedure

You will need to think how far you will ask the participants to walk when blindfold. The length of a hall or gym is probably too far and may result in them bumping into a wall. A distance of about 15-25 m is adequate. You may find it useful to use a sports court that is painted on the floor of the gym. However, be aware that if the marking is thickly painted the students could use this as a guide, especially when walking in socks/tights. If the floor has no marking you will need to draw a line, with chalk, on the floor, or else put down a 20 m tape at the end of the distance they will walk. A suitable arrangement is outlined in Figure 1.

If the person follows the shortest straight line distance across the hall they should cross the target line at point X. If they cross the line at Y, then a measure of their error is the distance XY (measure this to the nearest centimetre).

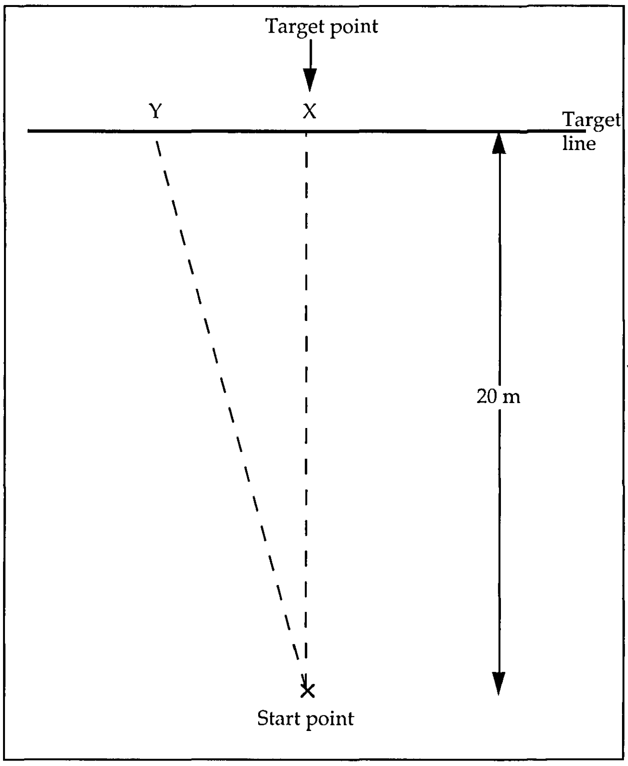


Figure 1
Arrangement for the experiment.

Try to keep the environmental conditions constant, especially the possibility of other people coming into the hall or gym and disturbing the person whilst she/he is walking.

Choose the participants carefully. This could be a repeated measures design, i.e. each person will participate under both conditions, e.g. half the students walk with their shoes on and then in socks/tights, the other half walk in socks/tights first and then with their shoes on. Aim for 10 - 15 students if you use this design. You could make it an independent samples design, however, i.e. half the students perform with shoes on, the other half with socks/tights on. In this case it seems quite reasonable to assume that all the students are likely to be equally adept at the task and so you could allocate them to the two conditions alternately. On the other hand, you could allocate them to the two conditions randomly. Aim for 20 - 30 people in all.

Think about what standardised instructions you will give to the participants.

It might be appropriate in this investigation to use a pilot study first. In a pilot study the researchers test the experimental set up on just a very small sample of people so that any snags can be ironed out before the real experiment takes place. It may be useful here to test that 20 metres is not too far to ask the students to walk across the room. If they are not very accurate in aiming for the target line they could bump into a side wall before they cross the line. If the people in the pilot study do this it would be worth shortening the distance the participants in the experiment will walk.

Make a check sheet to record your results. Each participant will only do one, or two, trials. As well as recording the error distance it would be useful to record whether the person veers to the left or to the right of the target point.

When all is ready, ask the students to come into the room, one at a time, and take them to the start point, so that they are facing the target line. Then read the instructions to them and answer any queries they may have. Then ask them to put on the blindfold. Once this is in place they can begin to walk, at their own pace, towards the target line. Do not say anything as they are walking, but do follow them so that you can prevent them from bumping into the walls, doors, wall bars, etc.. Once they cross the target line, make a mark on the floor with a piece of chalk where they crossed the line and then measure the distance of that point from the target point. [You will need to think about this carefully since their foot might not actually touch the target line as the cross it!] After they have completed their trial(s), thank them and explain what you have been studying. Ask them not to discuss the study with other students, at least not until the investigation is finished.

Results

Calculate the mean error distance for each participant for each condition. It might also be useful to calculate the range of values in each condition, since the variation in the error values may be greater under one condition. It is probably useful to draw an appropriate graph to illustrate the data.

Discussion

The graph, means and ranges should allow you to determine if the participants have performed differently under the two conditions. You will also be able to reject or accept your hypothesis.

It may be that the students will perform differently so make some comments on this and put forward some explanation for it. What senses do you think the students might be using to complete the task? It is likely to be the senses of touch and kinaesthesia. [Kinaesthesia is the sense of knowing where parts of your body are, without actually seeing them. If you are blindfold, and are asked to touch your left knee with your right hand you will do so accurately; you don't need to see your knee to know where it is.] When people are lost in mist on a flat area of moorland they tend to walk in a circle. The same behaviour has been seen in other animals too. Perhaps we just find it difficult to walk in a straight line. One study found that most people have a longer left leg than right. Could this explain another research finding that most people tend to veer to the right? This might tie in with your findings. Try and find a couple of weaknesses or limitations of the experiment and then suggest how you might overcome these if the study was repeated.

Further work

Orientation and navigation in humans might be affected by the external cues they receive. When the students come into the hall, and you explain what they need to do, it is very likely that they will already be facing in the direction in which they will move when you blindfold them. They will be focused on the end point and they will then try to head for it. If you give each person a turn (i.e. rotate them through 360°) before they set off will this affect their performance? In other words, does the turn disorientate them, by disturbing the external cues they had tuned in to, so that their error in navigation is greater?

Reference

Howard, I. P. and Templeton, W. B. (1966). *Human Spatial Orientation*. London, Wiley.

DATA RESPONSE EXERCISES

SPIDERS' WEBS

Spiders are carnivorous and feed almost exclusively on prey which they catch for themselves, although a few species take prey caught by other species of spiders and some species actually catch and eat other spiders.

All spiders produce silk, but not all spiders spin webs, and there are many approaches to prey capture. Trapdoor spiders live beneath ground and build a subterranean burrow. At night, they raise the silken door to their burrow and then swoop on any prey that passes within reach. Hunting spiders actively go in search of their prey. Some hunting spiders are agile, long-sighted predators which run down or pounce on prey seen with their highly effective eyes. Scaffold web spiders are mostly found in caves, though some species, including the one shown in Figure 1 (*Achaearanea riparia*), are found in open woodland. *Achaearanea* catches crawling insects which blunder into the vertical threads of the web. These threads hang down and are attached to the ground. Near their base they are covered in sticky globules (droplets).

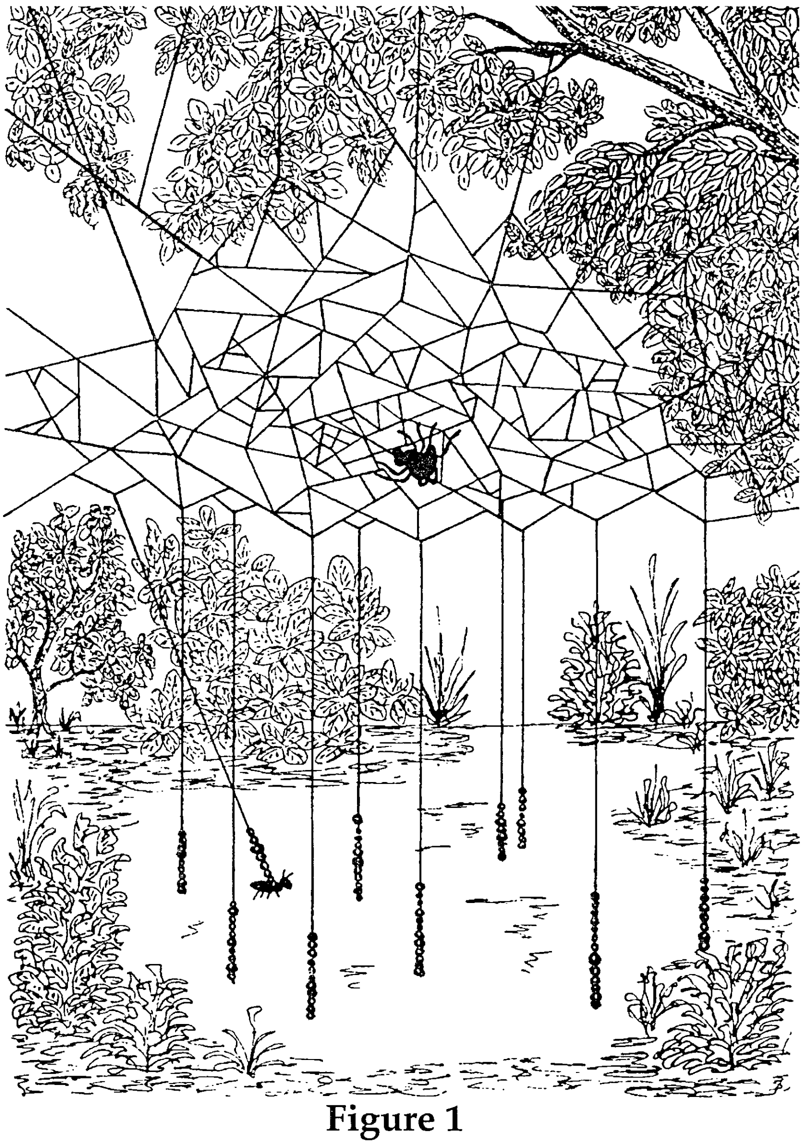


Figure 1
Web of *Achaearanea riparia* showing the sticky droplets on the ends of the vertical threads.

Intermediate tier

1. What does carnivorous mean? (1)

2. Suggest why many species of scaffold spiders are found in caves. (2)

3. Suggest how *Achaearanea* can tell when a prey has been caught. (3)

4. Why do you think *Achaearanea* attaches sticky globules to its hanging threads? (1)

5. Suggest **two** reasons why some web-spinning spiders don't have sticky globules on their webs. (2)

6. The silk with which all spiders make their webs is both strong and elastic. Give **two** reasons why these properties of silk are advantageous. (2)

7. Spiders' webs are often very noticeable in the early morning. Why is this? (1)

Higher tier

1. Suggest why trapdoor spiders feed at night. (2)

2. State **one** advantage and **one** disadvantage to being a hunting spider. (2)

3. Suggest why many species of scaffold spiders are found in caves. (2)

4. Suggest how *Achaearanea* can tell when a prey has been caught. (3)

5. Why do you think *Achaearanea* attaches sticky globules to its hanging threads? (1)

6. Suggest **two** reasons why some web-spinning spiders don't have sticky globules on their webs. (2)

BEES AND FLOWERS

Many species of flowering plants have flowers that are visited by insects. Figure 1 shows a photograph of a bramble flower being visited by a worker honey bee. Honey bees live in colonies of up to 60,000 bees and are able to keep the temperature inside a hive remarkably constant at close to 37°C.

Figure 1
A honey bee on a bramble flower.

Intermediate tier

1. What are the two things that a honey bee can obtain from a flower it visits? (2)

2. Explain the benefit that the bramble gets from being visited by the honey bee. (2)

3. What do honey bees make from their visits to flowers? (1)

4. Explain why honey bees can almost be described as warm-blooded. (1)

5. Outline an investigation that would allow you to see how honey bee visits to flowers depend on the weather. (6)

Higher tier

1. What are the two things that a honey bee can obtain from a flower it visits? (2)

2. Explain the benefit that the bramble gets from being visited by the honey bee. (2)

3. Honey bees have a communication system. A bee that has found a new, rich source of food dances within the hive on her return. Suggest why it may be advantageous for honey bees to have such a communication system. (2)

4. State **one** advantage and **one** disadvantage of maintaining a constant high body temperature. (2)

5. If a honey bee stings a bird or a mammal, it usually dies. Explain why stinging occurs even though it results in the death of the individual. (2)

6. Flowers visited by honey bees are often brightly coloured. Suggest why this is so. (2)

WATER-FINDING IN ADULT TURTLES

Tortoises, turtles and terrapins are reptiles. Tortoises live on land, turtles in water and terrapins are found on both land and water. They all have a body that is covered by a tough shell, from which the tail, legs and head emerge. The upper part of the shell is called the carapace.

An American species of turtle is the yellow-bellied pond slider turtle (*Trachemys scripta*), see Figure 1. These are quite common in the USA. In southeastern United States the ponds in which they live often dry out and this forces the turtles to either bury themselves or migrate in search of ponds.

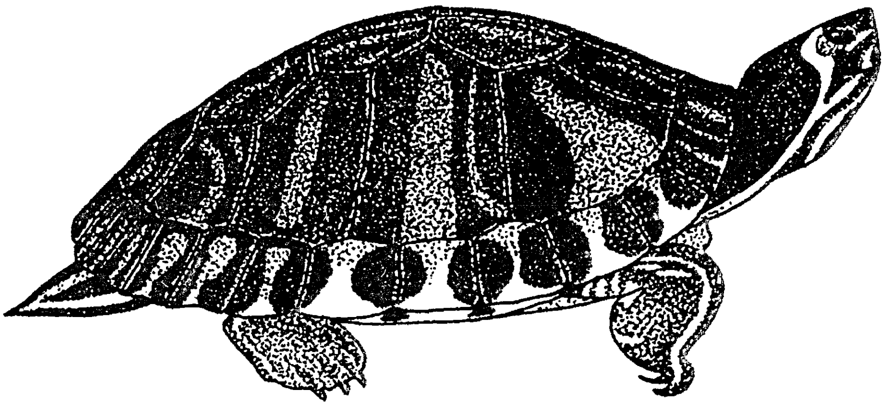


Figure 1
A yellow-bellied pond slider turtle.

This is an orientation problem for the turtles. Can turtles orient to water? That is, can they head in a direction that would take them to the nearest body of water or do they wander aimlessly in a random direction?

One researcher* decided to investigate how well yellow-bellied pond slider turtles could find water when moving to a new site. She trapped adults in a pond and put them in a holding tank, a plastic wading pool. The animals were fed regularly and allowed a few days to get used to their new environment before she started her experiments. The experiments took place in three arenas which were all about 300 - 400 m from a pond. The wading pool in each arena was surrounded by ten tripods in a circular arrangement, see Figure 2.

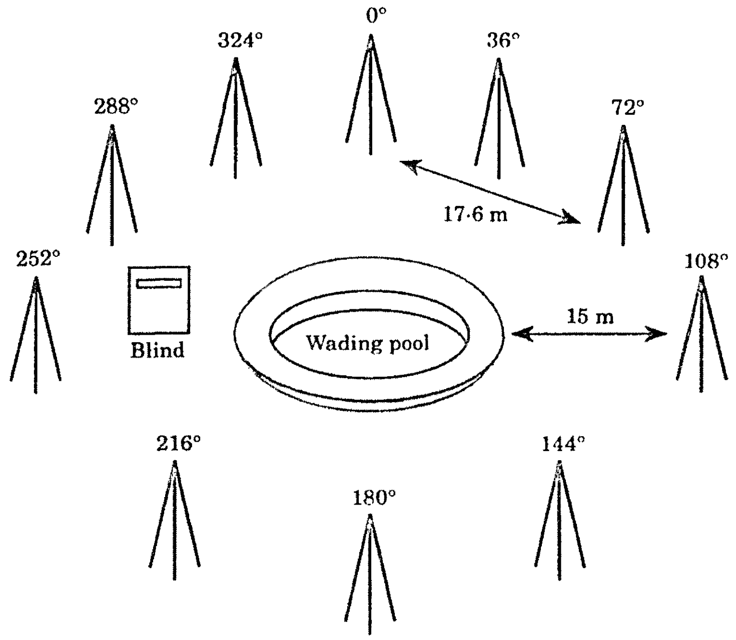


Figure 2
The arrangement of the tripods at each arena.

At the top of each tripod was a pulley. A black plastic bucket was inverted and tied to a line which went over the pulley to a blind where the researcher hid. A turtle was placed under a bucket at the start of the experiment and when an experiment was running five turtles were tested simultaneously. When all the lines were pulled the buckets lifted up and the turtles were released. The results of the experiments carried out in the three arenas are shown in Figure 3.

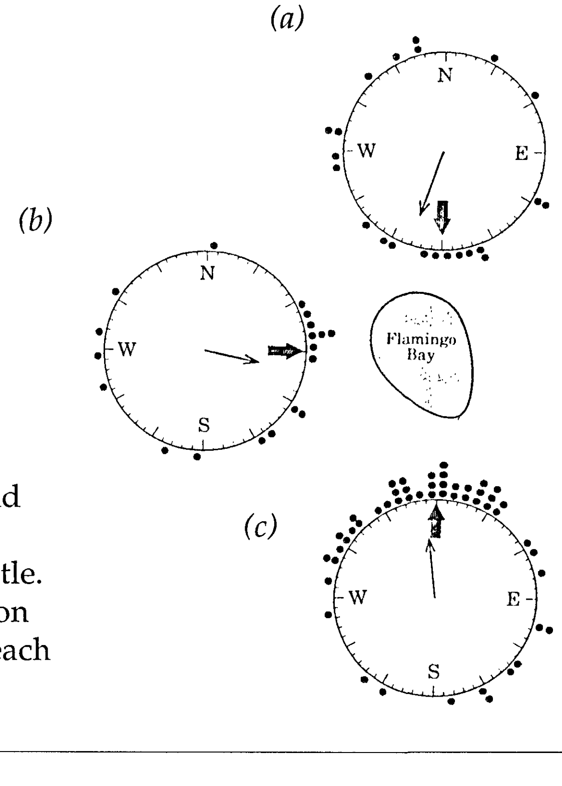


Figure 3
The orientation of the yellow-bellied pond slider turtles released at each site.
Each dot represents the heading of one turtle.
Bold arrows indicate the expected direction and the thin arrow indicates the mean for each group.

Since the arenas were to the south, west and north of the freshwater pond the researcher expected that if the turtles did have the ability to head for water they should move north, east and south respectively. She made a note of whether the turtles were released on sunny, rainy/overcast or mixed weather days and she found that the turtles were more likely to head towards the water on sunny days.

*Yeomans, S. R. (1995). Water-finding in adult turtles: random search or oriented behaviour? *Animal Behaviour*, 49, 977 - 987.

Intermediate tier

1. Referring to Figure 3 (c), determine how many turtles the researcher released in the arena to the south of the freshwater bay during the running of the experiments. (1)

2. What percentage of the turtles released in the arena to the south of the freshwater bay headed between

a) south west - south east

b) north west - north east? (2)

3. What conclusions can you draw from the data shown in Figure 3 (c)? (2)

4. Why do you think that the turtles were less likely to head in the direction of water on rainy/overcast days? (2)

5. Why did the researcher give the animals a few days to get used to the arena before she started the experiments? (2)

6. Identify **one** disadvantage for a turtle of leaving a pond that is drying up to go and search for a pond with water. (1)

7. Identify **two** problems for turtles if they stay in a pond which is drying out. (2)

Higher tier

1. What conclusion can you draw from the data shown in Figure 3(c)? (1)

2. Why do you think that the turtles were less likely to head in the direction of water on rainy/overcast days? (2)

3. Why did the researcher give the animals a few days to get used to the arena before she started the experiments? (1)

4. Identify **one** disadvantage for a turtle of leaving a pond that is drying up to go and search for a pond with water. (1)

5. Identify **two** problems for turtles if they stay in a pond which is drying out. (2)

6. The researcher fitted each turtle with a spool of thread which unwound as the turtle was released and moved off. This allowed the path of the turtle to be identified since the thread catches on plants as the animal moves through the vegetation. The researcher then compared how close the path taken by the turtle was to a straight line. She found that the turtles followed a straighter path on sunny days than on rainy days. Explain this result. (2)

7. How would natural selection favour those turtles that could move quickly and efficiently from a dry pond to one filled with water? (3)

COLOUR PATTERNS OF SNAKES AND MILLIPEDES

Many snakes have a banded appearance, the bands usually being red, black and yellow. One group of snakes having this banded appearance are the coral snakes, see Figure 1.

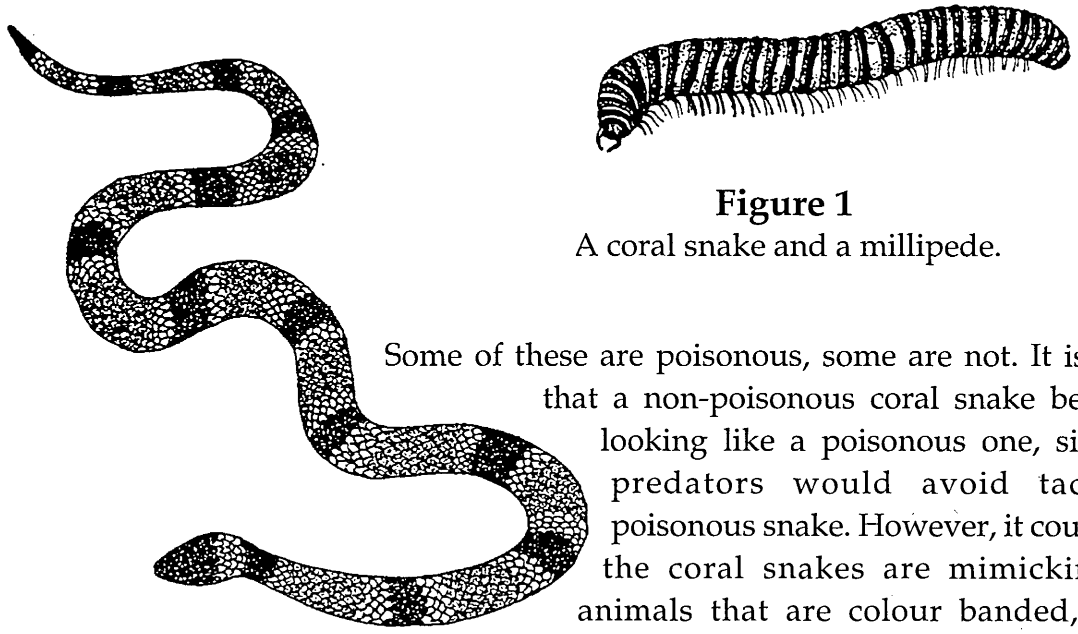


Figure 1
A coral snake and a millipede.

Some of these are poisonous, some are not. It is thought that a non-poisonous coral snake benefits by looking like a poisonous one, since most predators would avoid tackling a poisonous snake. However, it could be that the coral snakes are mimicking other animals that are colour banded, such as millipedes. Just like millipedes, snakes are slender and some are approximately the same size. Also, millipedes are frequently toxic to birds, which learn to avoid them.

The question is, can one prey species benefit by looking like another prey species that a predator avoids?

Two researchers* carried out a series of field experiments to see if bird predators could distinguish between millipedes and snakes. The researchers used plasticene millipede-sized models which they sculpted to look like snakes and millipedes. They tested three plasticene models:

a) an unmarked brown model

b) a red and black narrow ringed-model, looking like a millipede

c) a red and black wide-ringed model, looking like a poisonous coral snake.

[In both models b) and c), red rings alternated with black rings.]

The models were placed on tracks in tropical rain forest in Costa Rica, Central America. Fifty models of each type were left for 48 hours and then collected and examined. The researchers used the impact of a bird's foot or beak to determine if a model had been attacked. Their findings are illustrated in Figure 2.

*Brodie, E. D. and Moore, A. J. (1995). Experimental studies of coral snake mimicry: do snakes mimic millipedes? *Animal Behaviour*, 49, 534 - 536.

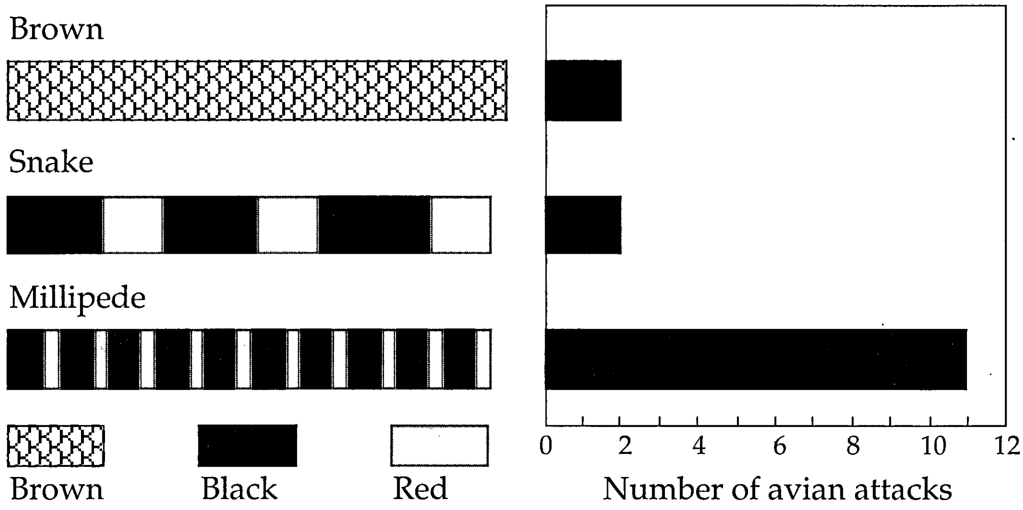


Figure 2

Colour patterns of the three model types used and the number of avian (bird) attacks on each type (out of 50 models each).

Intermediate tier

1. Using the data in Figure 2, draw a pie chart, using a circle with a radius of 5 cm, to show the proportion of the attacks on each type of model. (2)

2. How many more times likely were attacks on the millipede models than the snake models? (1)

3. What percentage of the total number of attacks were made on the models of millipedes? (1)

4. What conclusion can you draw from the results shown in Figure 2? (1)

5. Suggest, and explain, **two** weaknesses in using models made out of plasticene in these experiments. (4)

6. In spite of the weaknesses you identified in your answer to question 5, why do you think that the researchers used plasticene models in their study? (2)

7. Name **one** other colour banded animal that is dangerous to others. (1)

Higher tier

1. Using the data in Figure 2, draw a pie chart, using a circle with a radius of 5 cm, to show the proportion of the attacks on each type of model. (1)

2. What percentage of the total number of attacks were made on the models of millipedes? (1)

3. Suggest **one** reason why the brown model might not be attacked to the same extent as the snake model? (1)

4. What conclusion can you draw from the results shown in Figure 2? (1)

5. Suggest, and explain, **two** weaknesses in using models made out of plasticene in these experiments. (4)

6. In spite of the weaknesses you identified in your answer to question 5, why do you think that the researchers used plasticene models in their study? (2)

7. Name **one** colour banded animal that is dangerous to man and **one** other animal that mimics the first but is not dangerous to man. (2)

REACTIONS OF DUCKLINGS TO A FLYING SHAPE

In 1939, and again in 1948, scientists put goslings (young geese) in a large outdoor enclosure and then moved a shape, like that illustrated in Figure 1, across the top of the enclosure.

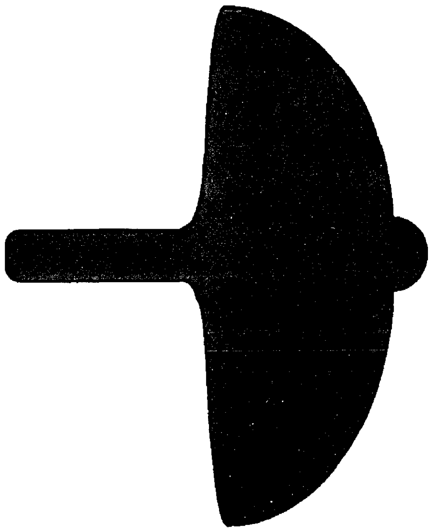


Figure 1
The shape used in the tests.

The scientists thought that when it was flown one way the goslings might think that it was a 'goose' flying overhead; when flown the other way it would be like a 'hawk'. They reported that when it was flown as a 'hawk' the goslings showed fear but not when it was flown as a 'goose'. They thought the goslings could recognise a 'hawk' shape from birth and did not have to learn this.

In 1995 it was reported that two scientists* in the United States repeated the experiments carried out in 1939 and 1948, though they used mallard ducklings (*Anas platyrhynchos*), not goslings. They wanted to see if the ducklings behaved the same way when the two shapes were flown. They tested the birds in an indoor arena and used video cameras to record the behaviour of the ducklings. Some ducklings had been reared in pairs, the rest had been reared alone. The ducklings were placed singly, or in pairs, in the centre of the arena, allowed three minutes to get used to these new surroundings, and then the shape shown in Figure 1 was flown overhead.

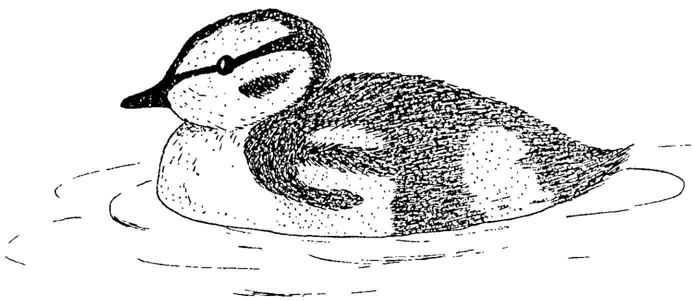


Figure 2
A mallard duckling.

The researchers recorded:

a) how far the birds fled in the 15 seconds after the shape appeared

b) whether they crouched

c) whether they gave a distress call.

The scientists found:

1) ducklings responded to the shapes flying overhead

2) ducklings responded more to the 'hawk' shape than to the 'goose' shape

3) birds tested alone were more likely to run when the 'hawk' shape was flown

4) birds reared and tested together were more likely to crouch to the 'hawk' shape than to the 'goose' shape

5) the ducklings rapidly got used to the shapes and didn't respond to the same extent as they did when the shapes were first flown.

*Canty, N. and Gould, J. L. (1995). The hawk/goose experiment: sources of variability. *Animal Behaviour*, 50, 1091 - 1095.

Intermediate Tier

1. The shape in Figure 1 could have been flown from left to right or from right to left. Identify which way it is flown to look like a 'hawk' and which way to look like a 'goose'. Explain your answers. (2)

2. Identify **one** important way in which these experiments were different from the 1939 and 1945 experiments, and explain why this may be important. (2)

3. Explain why you think the scientists used a video camera to record the behaviour of the ducklings. (2)

4. Why did the scientists give the birds three minutes to adjust after putting them in the arena? (2)

5. Why do you think that the ducklings responded more to the 'hawk' shape than to the 'goose' shape? (2)

6. Explain why the ducklings soon got used to the shapes flying overhead and didn't respond to them as they first did. (2)

Higher Tier

1. The shape in Figure 1 could be flown from left to right or from right to left. Identify which way it would be flown to look like a 'hawk' and which way it would be flown to look like a 'goose'. Explain your answer. (2)

2. Identify **one** important way in which the 1995 experiment was different from the 1939 and the 1945 experiments and explain why this may be important. (2)

3. Why did the scientists use a video camera to record the behaviour of the mallard ducklings? (1)

4. The scientists gave the ducklings three minutes to adjust to the arena before they flew a shape. Why is this an important feature of the control of the experiment? (1)

5. When the birds that had been reared alone were tested, they responded to the flying shapes. What does this suggest? (1)

6. Why do you think the ducklings responded more to the 'hawk' shape than to the 'goose' shape? (2)

7. Explain why the ducklings soon got used to the shapes flying overhead and did not respond to them as they first did. (1)

8. If these ducklings were released into the wild after the experiment was over, what effect might it have on their survival? (1)

9. Why, do you suppose, might the birds tested in pairs be more likely to crouch when the shape flew over than the birds which are tested singly? (1)

PARENTAL BEHAVIOUR OF BLUE TITS

Blue tits (*Parus caeruleus*) are birds that are commonly seen in British gardens. They are small, about 11 cm in length, very active and have the ability to feed hanging upside down. They nest in holes in trees, or in nest boxes provided by humans, and the female lays 6 - 14 eggs. They are primarily a woodland species, where they find it easier to find food for their young, but also feed in gardens. The food is chiefly caterpillars and a pair may need to bring 600 - 1000 caterpillars a day to the nest to satisfy the chicks.

A researcher* used an infra-red camera mounted inside a nest box† to record the behaviour of the blue tit parents feeding their chicks, see Figure 1. She wanted to see how the number of parental visits to the nest with food varied over the time the chicks spent in the nest box.

Figure 1
Parent bird and chicks in the nest box.

She recorded the activity in the box from 09.00 to 09.30 each morning for a period of eleven days, from six days after the eggs hatched until sixteen days after they hatched. She recorded the number of times one of the parents returned to the nest with food and whether the food was a caterpillar or not. These data are illustrated in Table 1.

		Type of food	
Days after hatching	Number of visits	Caterpillars	Not caterpillars
6	18	4	14
7	25	8	17
8	16	9	7
9	31	5	26
10	26	8	18
11	48	4	44
12	52	14	38
13	36	7	29
14	41	3	38
15	30	5	25
16	56	9	47

Table 1 Number of visits and type of food brought to the nest by the parent birds.

*Rowland, N. (1995). Parental behaviour of blue tits. B.Ed. research project, Homerton College, Cambridge.

†The infra-red camera and nest box are supplied by BoxWatch. For details about the nest box and equipment contact them at the following address: BoxWatch, Bracken House, Bank Farm, Cowden, Kent, TN8 7EG. Tel: 01342 850259.

Intermediate Tier

1. Using the data in Table 1, draw a fully labelled line graph to show the number of visits to the nest made by the parent birds over the eleven day period. Put the days after hatching on the horizontal axis and the number of visits to the nest on the vertical axis. (3)

2. What general trend does the line show? (1)

3. What was the total number of visits to the nest made by the parent birds and what was the mean number of visits made during the half hour recording sessions? (2)

4. Draw two circles, each with a radius of 5 cm, one circle to show the type of food brought to the nest on the sixth day after hatching and one for the thirteenth day after hatching. Using these two circles, draw two pie charts to show the proportion of food that was caterpillars and that which was not caterpillars. Label each segment to show the type of food brought to the nest. (2)

5. Why did the researcher record the behaviour seen in the nest at the same time each morning? (1)

6. Name **one** other food item, apart from caterpillars, that a blue tit parent might feed to its young. (1)

7. Why is a blue tit so called? (1)

8. Name **one** other member of the tit family you might expect to see in Britain. (1)

Higher Tier

1. Using the data in Table 1, draw a fully labelled line graph to show the number of visits to the nest made by the parent birds over the eleven day period. (3)

2. What general trend does the line show? (1)

3. What was the mean and median number of visits made to the nest by the parent birds? (2)

4. Draw two circles, each with a radius of 5 cm, one circle to show the type of food brought to the nest on the sixth day after hatching and one for the thirteenth day after hatching. Using these two circles, draw two pie charts to show the proportion of food that was caterpillars and that which was not caterpillars. Label each segment to show the type of food brought to the nest. (2)

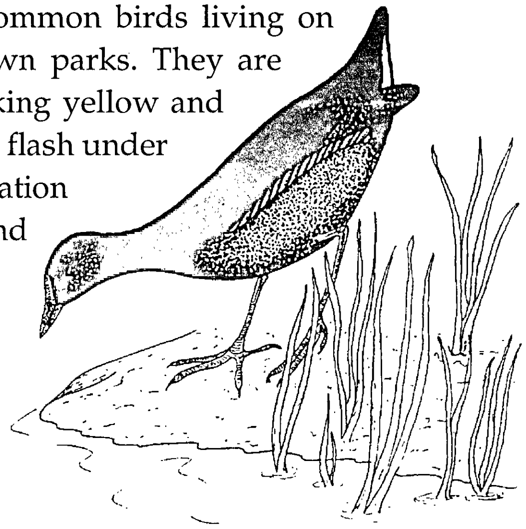
5. Why did the researcher record the behaviour seen in the nest box at the same time each morning? (1)

6. Name **one** other item of food, apart from caterpillars, that a blue tit parent might feed to its young. (1)

7. After giving chicks the food, a blue tit parent will wait to see if one of the chicks produces a faecal pellet, which the parent then removes from the nest. Why do you think the chicks don't just drop their faecal pellets into the nest material instead of presenting it to the parents to remove. (2)

EGG DUMPING BY MOORHENS

Moorhens (*Gallinula chloropus*) are fairly common birds living on lakes, ponds, canals, marshes and in town parks. They are largely black birds, though they do have a striking yellow and red bill, white streaks on their flanks and a white flash under the tail, see Figure 1. They feed amongst the vegetation on the edges of the water, taking pondweed and other aquatic plants, plus snails, insects and fish.



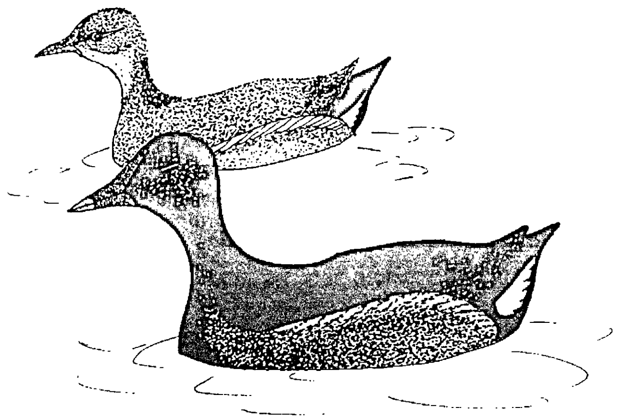


Figure 1
Moorhens.

Females lay 5-11 eggs in a bulky nest made of aquatic plants. Moorhen females are known to "egg dump", i.e. lay one or more eggs in the nests of other females. One study* found that at least 10% of nests in a waterfowl park in Cambridgeshire received eggs from other females. The researcher set out to test if moorhen females could recognise foreign eggs in their nests. She checked a number of nests in the breeding season when the females lay, and then incubate, eggs. A female usually lays one egg every 24 hours and she also found that > 80% of the females in the park laid their eggs between 1900 and 2200 hours. She added eggs (from other moorhen nests that had been deserted or that had failed to hatch because the eggs were infertile) to nests as part of her field experiments. A single egg was added to a nest between 1800 and 2100 hours and only when neither of the pair could see the nest. If the 'extra' (experimental) egg was there the following day it was scored as accepted. Some of the data she collected are illustrated in Figure 2.

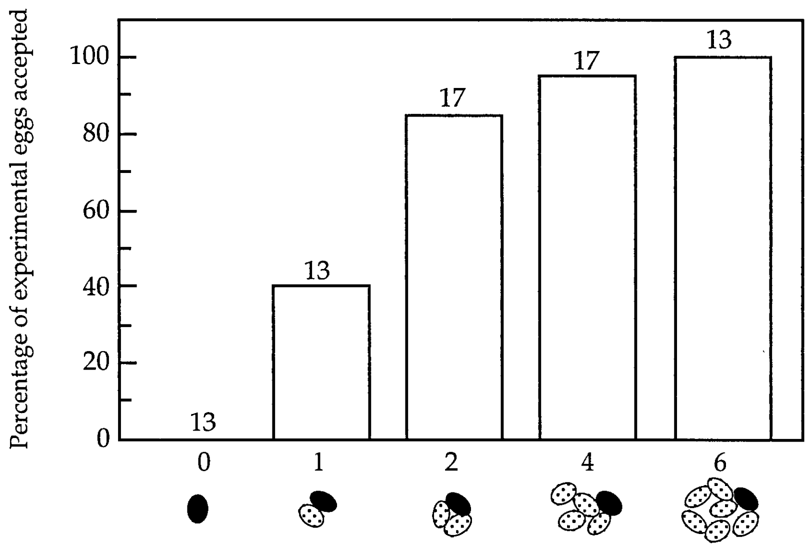


Figure 2

Percentage of nests in which experimental eggs were accepted in relation to the day of the host's laying period. The day in the host's laying period corresponds with the number of host eggs in the nest at the time the experimental egg was added. Sample sizes are indicated above the bars. [Experimental egg is black.]

*McRae, S. B. (1995). Temporal variation in responses to intraspecific brood parasitism in the moorhen. *Animal Behaviour*, 49, 1073 - 1088.

Intermediate tier

1. How successful were moorhens at detecting an experimental egg **before** they laid any eggs? (1)

2. Approximately what percentage of eggs were accepted if two other eggs were already in the nest? (1)

3. Describe the trend evident in Figure 2. (2)

4. Suggest, and explain, why it would be advantageous for a moorhen female to lay an egg in the nest of another moorhen. (2)

5. Why would it not be in the interest of moorhens to accept the eggs laid by another female? (1)

6. Name **one** other species of bird that lays an egg in the nest of another species, naming this host species also. Describe how the tactic of the bird laying the egg differs from that used by the moorhen female. (3)

7. Outline **one** tactic that a moorhen pair could theoretically use to ensure that they only accepted, and thus incubated, their own eggs. (2)

Higher tier

1. Approximately what percentage of eggs were accepted if two other eggs were already in the nest? (1)

2. Describe the trend evident in Figure 2. (2)

3. Suggest, and explain, why it would be advantageous for a moorhen female to lay an egg in the nest of another moorhen. (2)

4. Why would it not be in the interest of moorhens to accept the eggs laid by another female? (1)

5. Name **one** other species of bird that lays an egg in the nest of another and describe how the tactic of this bird differs from that used by the moorhen female. (2)

6. Suggest **one** tactic that a moorhen pair could use to ensure that they only accepted, and thus incubated, their own eggs. (1)

7. Describe how you would conduct an experiment to determine if the colour of the egg that was added allowed moorhens to discriminate between the egg of a moorhen and that of some other bird. (2)

8. Outline **one** disadvantage to the female moorhen that engages in laying an egg in the nest of another female. (1)

ASPECTS OF THE BEHAVIOUR OF STARLINGS

Figure 1
A starling (*Sturnus vulgaris*).

Intermediate tier

1. Starlings are commonly seen in towns and cities, frequently appearing in gardens searching for food. Suggest, and explain, **one** reason why they are so common in these areas. (2)

2. Look carefully at the starling's beak. Suggest **one** method it might use when searching for food in a garden and identify **one** food item it may obtain by using the method. (2)

3. A blackbird is about the same size as a starling. Outline how a male blackbird differs from a male starling. (2)

4. Starlings are usually found in flocks for much of the year, both during the day when they are finding food and at night when they roost. Suggest **two** reasons why being in a flock may be advantageous for a bird. (2)

5. Suggest why cities are often the location for a night roost for starlings. (2)

6. Suggest **two** reasons why some local authorities try to discourage the birds from roosting in their town or city centres at night. (2)

Higher tier

1. Starlings are commonly seen in towns and cities, frequently appearing in gardens searching for food. Suggest, and explain, **one** reason why they are so common in these areas. (2)

2. Look carefully at the starling's beak. Suggest **one** method it might use when searching for food in a garden and identify **one** food item it may obtain by using the method. (2)

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4. Explain why cities are often the location for a night roost for starlings. (2)

5. Suggest **two** reasons why some local authorities try to discourage the birds from roosting in their town or city centres at night. (2)

6. In 1890 eighty starlings were released in New York City and by 1960 they had colonised much of North America. Suggest **one** reason why this bird has been so successful in increasing its numbers. (1)

7. Starlings, especially those in captivity, have been found to be able to mimic the sound of the human voice. Suggest why a bird, like a starling, mimics phrases that humans use. (1)

PREDATION OF MOTHS BY BATS

As with many animals, male moths seek out females in order to mate with them. To find a female, males follow the chemicals emitted by her when she is at rest. These chemicals, called pheromones, are carried on air currents to the males. Males spend a good deal of time seeking females but when flying males can be caught by bats, see Figure 1. Moths are the chief food of some species of bats.

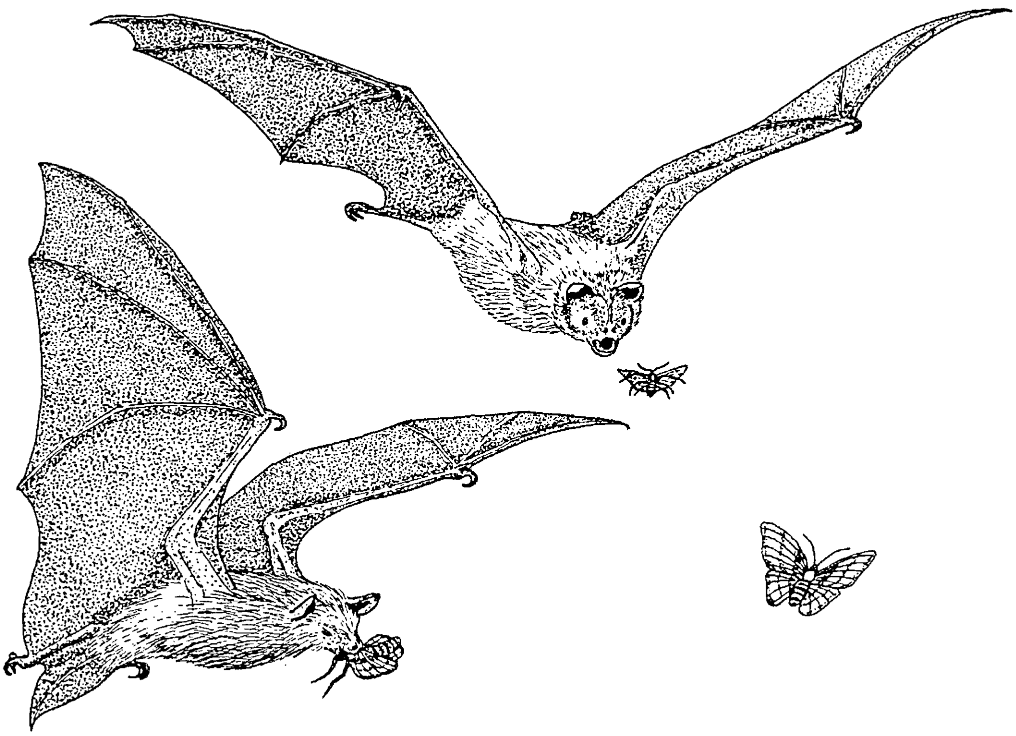

Figure 1
Bats hunting moths.

One study*, carried out in 1992 and 1993, investigated the number of male and female moths caught in moth traps and caught by bats in flight. The researchers wanted to see if bats catch similar numbers of male and female moths. Many moths are attracted to light and this is how researchers can catch them. A moth trap consists of a light in a box. The light attracts the moths into the box and they settle safely on egg trays in the box. The moth trap is opened in the early morning and, after the species and sex of each moth has been determined, the moths are released. To measure how successful bats are at catching moths the researchers collected the wings of moth that were lying on the ground. The wings of a moth are discarded after it has been caught by a bat, the bat only eats the body. The sex of a moth is readily identifiable by the wing: the hindwing of a male moth has a single stiff bristle (the frenulum) which holds the forewing and hindwing together when the moth is flying; females have a frenulum consisting of two or more bristles, see Figure 2. Some of the data the researchers collected are seen in Figures 3 and 4.

*Acharya, L. (1995). Sex-biased predation on moths by insectivorous bats. *Animal Behaviour*, 49, 1461 - 1468.

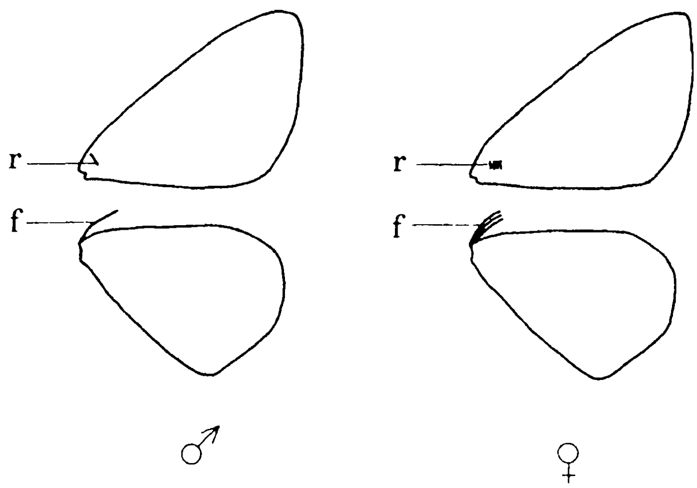

Figure 2
Drawings of the different wing coupling structures found in male and female moths; f - frenulum, r - retinaculum.

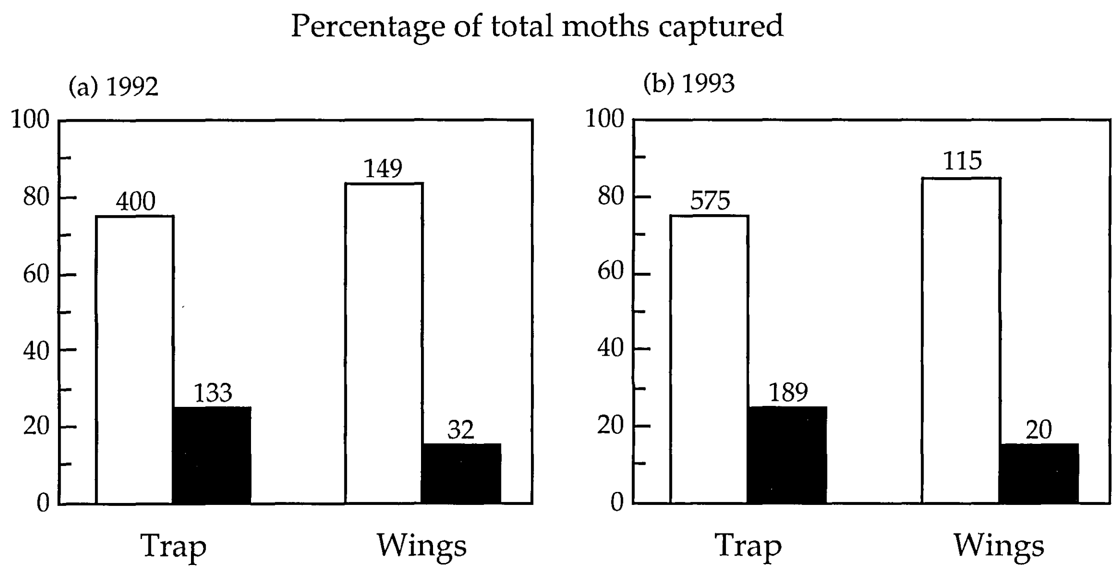

Figure 3
Number of male (❑) and female (■) moths (expressed as percentage of total moths) caught by a light trap and by foraging bats in a) 1992 and b)1993. Numbers above the bars indicate sample sizes of moths or wings captured.

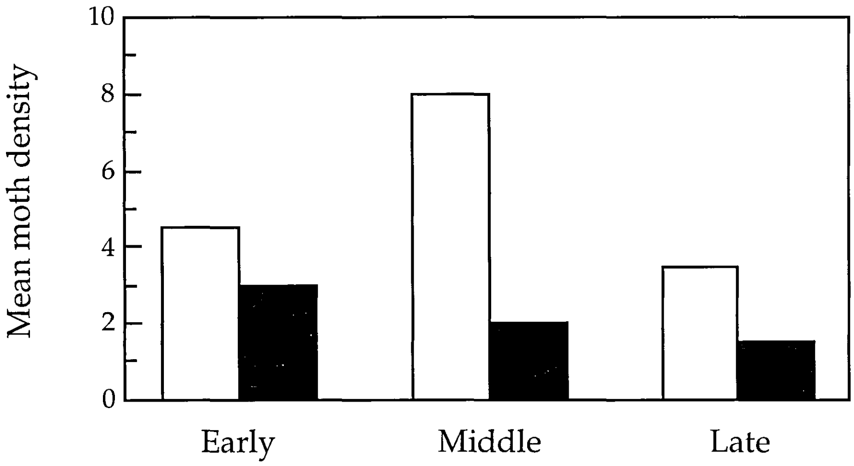

Figure 4
Mean number of male (❑) and female (■) moths caught per hour by a light trap in the early, middle and late periods of the night in 1993. [The trap was set once a week for 12 weeks from early June to late August 1993.

Intermediate tier

1. How many more moths were caught in 1993 than in 1992? (1)

2. In 1993, what percentage of the moths caught in a moth trap were female? (1)

3. On a sheet of graph paper, draw a bar chart (one bar for 1992 and one for 1993) to show the number of moths caught by the foraging bats. Divide each bar into two parts, one part for the female moths caught and the other part for the males. Label each part carefully. In which year was the greater percentage of females caught? (3)

4. Why do you think the female moths use a chemical signal, rather than a sound or visual signal, to attract a male moth? (2)

5. What type of signal does a bat use to detect a moth and what part of a bat's body is specially developed to receive the signal? (2)

6. Figure 3 shows the mean number of male and female moths caught per hour by a moth trap in the early, middle and late period of the night. When are male and female moths most likely to be trapped? (1)

7. Suggest when, and why, bats are most likely to be actively hunting moths during the night. (2)

Higher tier

1. In 1993, what percentage of the moths caught in a moth trap were female? (1)

2. On a sheet of graph paper, draw a bar chart (one bar for 1992 and one for 1993) to show the number of moths caught by the foraging bats. Divide each bar into two parts, one part for the female moths caught and the other part for the males. Label each part carefully. In which year was the greater percentage of females caught? (2)

3. Why do you think the female moths use a chemical signal, rather than a sound or visual signal, to attract a male moth? (2)

4. What type of signal does a bat use to detect a moth and what part of a bat's body is specially developed to receive the signal? (2)

5. Suggest when, and why, bats are most likely to be actively hunting moths during the night. (2)

6. Apart from street lights, suggest **two** other locations that you might expect bats to exploit when hunting for moths. (2)

7. Suppose that you wanted to carry out an experiment to ensure that it was a chemical signal to which male moths responded when seeking females. Briefly describe how you undertake such a study. (1)

ASPECTS OF THE BEHAVIOUR OF CARACALS

The animal in the photograph, see Figure 1, is a caracal (*Felis caracal*). The caracal is widely distributed in Africa and the south west of Asia, inhabiting grassland, woodland and semi-desert areas. It is about 75 cm in length, measures around 45 cm in height at the shoulder and is 15-20 kg in mass. It is uniformly reddish-brown above but paler beneath and has a very distinctive tuft of long, black hairs at the tips of its ears. [The Turkish name for the caracal means "black ears".] It is a solitary and nocturnal hunter, its prey consisting of small gazelles and deer, hares, peafowl and a number of other game birds. It has a remarkable ability to leap into the air, occasionally up to 2 m, which is how it catches birds. The female gives birth to two cubs which are usually reared in a rock crevice or at the base of a hollow tree.

Figure 1
A caracal.

Intermediate tier

1. What does the word nocturnal mean? (1)

2. Identify, from the photograph, **one** characteristic of the animal that indicates that it is a predator and explain why you think this is the case. (2)

3. Outline **one** reason why it could be advantageous for the caracal to have quite large ears. (2)

4. Like almost all members of the cat family, the caracal has claws that retract. Why would it be useful for it to have claws like this? (1)

5. Why do you think that the caracal does not have a spotted coat like other African predators such as the leopard and the cheetah? (2)

6. What do you suppose the animal in the photograph is doing and give a reason for your belief? (2)

7. This animal has been used in an advertisement by Canon to promote the sales of one of their cameras, the Canon Sure Shot. Why do you think that the advertising agency selected the caracal to persuade us to buy this product? (2)

Higher tier

1. Identify, from the photograph, **one** characteristic of the animal that indicates that it is a predator and explain why you think this is the case. (2)

2. Outline **one** reason why it could be advantageous for the caracal to have quite large ears. (1)

3. Like almost all members of the cat family, the caracal has claws that retract. Why would it be useful for it to have claws like this? (1)

4. Why do you think that the caracal does not have a spotted coat like other African predators such as the leopard and the cheetah? (1)

5. Lions, like caracals, are other predators found in Africa. Lions live in groups but caracals are solitary. Suggest **one** advantage and **one** disadvantage of being a solitary animal. (2)

6. This animal has been used in an advertisement by Canon to promote the sales of one of their cameras, the Canon Sure Shot. Why do you think that the advertising agency selected the caracal to persuade us to buy this product? (1)

7. Suggest, and explain, **two** reasons why the female might choose a rock crevice to rear her young. (4)

VIGILANCE OF HARBOUR SEALS

In 1996 two researchers, Terhune and Brillant, reported on their studies of harbour seals (*Phoca vitulina*) which they carried out in Canada. Harbour seals, see Figure 1, are 1.5 - 2.0 m in length, have greyish-white to yellow fur with lots of black spots. They are usually found where there are offshore sandbanks or rocky ledges on which they spend a few hours each day. These places where they lie during the day are called 'haul-out sites'. In some locations they haul out onto isolated beaches on the mainland.

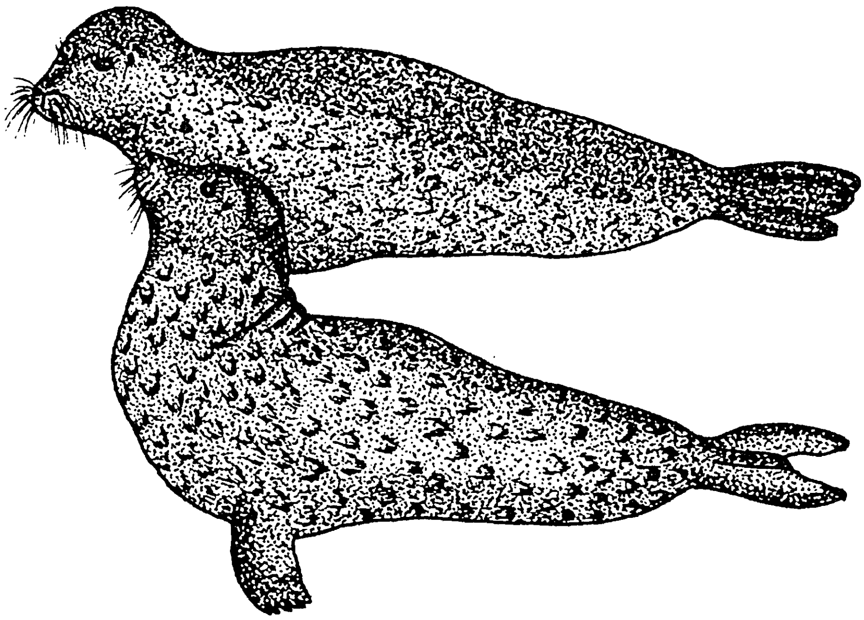

Figure 1
Harbour seals.

In this study the researchers* were interested in determining how much time seals spend looking for predators and in which direction they face when they haul out of the water. The researchers made their observations from a cliff top observatory using binoculars and telescopes. The observations were made between 1000 and 2000 hours from June to October. They were particularly interested in the scanning behaviour of the seals when they are on the haul-out sites. The seals are scanning for predators. When a seal scans, it raises its head from its resting position and looks around. After scanning, it lowers its head to the resting position. The time spent scanning was measured as the interval between raising and then lowering its head. Data relating to the time spent scanning and the size of a group are illustrated in Figure 2.

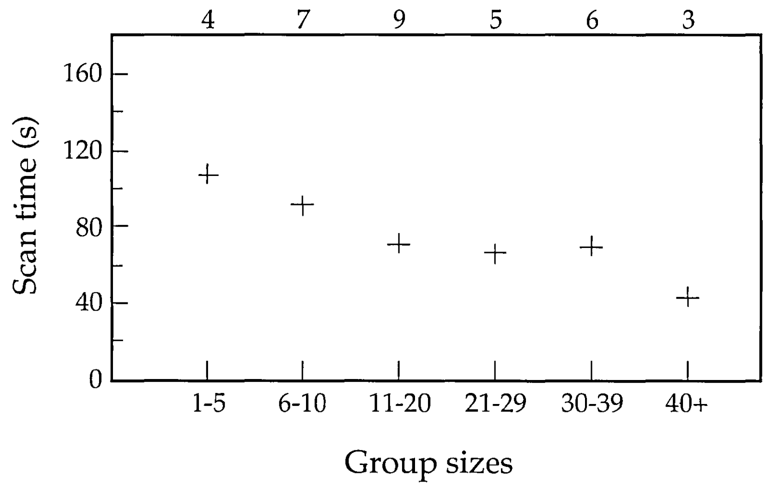

Figure 2

Mean scan times of harbour seals per 180 seconds time period and the group size on the haul-out site. The sample sizes are given above each point.

*Terhune, J. M. and Brillant, S. W. (1996). Harbour seal vigilance decreases over time since haul out. *Animal Behaviour*, 51, 757 - 763.

Intermediate tier

1. Suggest **one** reason why seals may come out of the water to lie on rocks or sandbanks. (1)

2. The researchers made their observations from a location which was 0.5 - 1.0 km from the ledges and sandbanks where the seals were lying. Why do you think they made their observations from such a long distance away? (2)

3. They did not make any observations of the seals when it was raining or foggy. Why was this? (1)

4. Some of their data are illustrated in Figure 2. The graph shows the amount of time (per seal per 180 seconds) that individuals spent scanning when they were in a group of a certain size. Describe the trend that is evident in the graph. (1)

5. Approximately how much more time is spent scanning, per 180 seconds, by an individual in a group of size 6-10 than by an individual in a group of 40+? (1)

6. How many groups of seals size 11-20 were studied? (1)

7. Another observation Terhune and Brillant made concerned the direction in which a seal's body was pointing when it was on the rocks. They found that most seals faced the water. Suggest **two** reasons why seals should face the water when they are on the rocks or sandbanks. (2)

8. Suggest **one** land-based predator of a baby seal. (1)

9. In a group of animals that collect together, where do you think the safest location might be from a predator? Explain your answer. (2)

Higher tier

1. Suggest **one** reason why the seals may come out of the water to lie on rocks or sandbanks. (1)

2. The researchers made their observations from a location which was 0.5 - 1.0 km from the ledges and sandbanks where the seals were lying. Why do you think they made their observations from such a long distance away? (1)

3. Some of their data are illustrated in Figure 2. The graph shows the amount of time (per seal per 180 seconds) that individuals spent scanning when they were in a group of a certain size. Describe and explain the trend that is evident in the graph. (3)

4. Another observation they made concerned the direction in which a seal's body was pointing when it was on the rocks. They found that most seals faced the water. Suggest **two** reasons why seals should face the water when they are on the rocks or sandbanks. (2)

5. Terhune and Brillant also recorded where individual seals were positioned in the group. They found that seals on the edge of the group spent more time scanning (mean time spent scanning for each three minute observation period was 38.5 seconds) than did those in the centre of the group (mean time spent scanning for each three minute observation period was 17.2 seconds). Why do you think that seals in the centre of the group spend less time scanning than those at the edge? (2)

6. The researchers were unable to identify individual seals in their study. Outline **one** disadvantage of not being able to do so. (2)

7. Suggest **one** land-based predator of a baby seal. (1)

ROLLING BEHAVIOUR IN DOMESTIC CATS

A feature of the behaviour of a cat (*Felis catus*) is social rolling. When a cat behaves in this way it rolls on the ground in the presence of another cat. It has its forepaws cocked and often has its legs splayed and its abdomen exposed, see Figure 1. It is thought that a roll can be a friendly act, revealing that the cat is relaxed, or it can show submission, indicating to the other cat that the rolling cat is not a threat. Whatever its function, when the cat is in this position it could be vulnerable to attack by another cat.

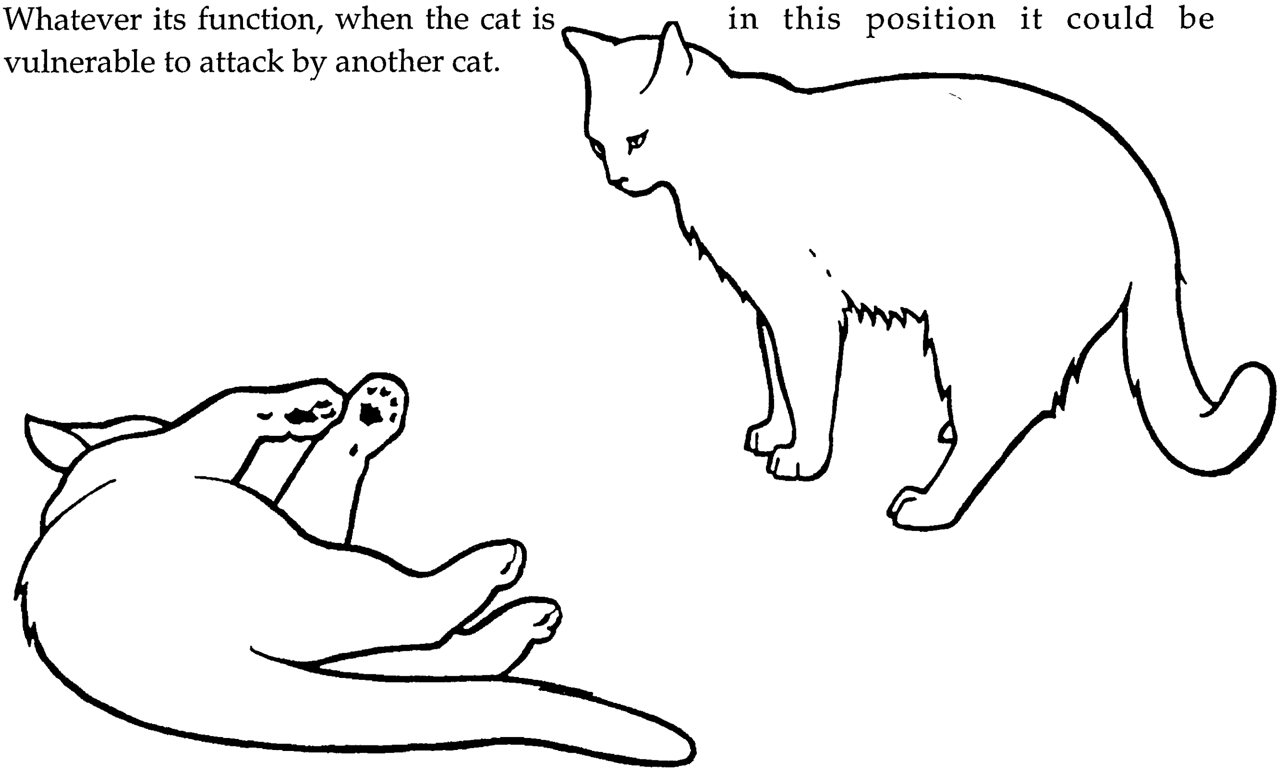

Figure 1
One cat rolling in front of another.

In 1988 and 1989 Hilary Feldman* observed rolling in a group of semi-feral cats kept in a large outdoor enclosure. She recorded the number of rolls shown by the cats, the age and sex of the cat that did the rolling (the 'initiator') and the age and sex of the other cat present (the 'recipient'). She observed that female cats mostly rolled before adult male cats, (female-male rolling), rather than juvenile male cats. She also found that female cats rolled more frequently to adult male cats at certain times of the year. Male cats also rolled to females at these same times of the year (male-female rolling) but male-male rolling happened throughout the year. The data she collected are seen in Table 1.

	RECIPIENT			
INITIATOR	Adult male	Juvenile male	Adult female	Juvenile female
Adult male	21	0	8	6
Juvenile male	25	6	21	0
Adult female	10	1	2	0
Juvenile female	29	3	5	1

Table 1 Number of rolls performed by cats, classified by age-class and sex-class for both the initiator and the recipient.

*Feldman, H. N. 1994. Domestic cats and passive submission. *Animal Behaviour*, 47, 457 - 459.

Intermediate tier

1. How many rolls did adult males receive from other cats? (1)

2. Draw a pie chart (or divided circle) to show the proportion of the four groups that initiated rolling to adult males. (2)

3. What percentage of the total number of rolls were received by adult males? (1)

4. Why do you think that juvenile male cats might roll in front of adult males? (2)

5. Suggest why adult female cats might roll to adult males? (2)

6. Suggest **one** other piece of behaviour, apart from rolling, that might indicate the submission of one cat to another and outline why this behaviour would indicate submission. (2)

7. Suggest **one** reason why pet cats might roll before their human owners. (2)

Higher tier

1. Draw a pie chart (or divided circle) to show the proportion of the four groups who initiated rolling to adult males. (2)

2. Why do you think that juvenile male cats might roll in front of adult males? (2)

3. Explain why 21 rolls of juvenile males to adult females were observed but only 1 roll of an adult female to a juvenile male. (2)

4. Feldman only observed females rolling before male cats at certain times of the year but male cats were seen rolling throughout the year. What might explain this difference in behaviour by the sexes? (2)

5. Suggest **one** other piece of behaviour, apart from rolling, that might indicate the submission of one cat to another and outline why this behaviour would indicate submission. (2)

6. In other social species of cats, such as lions, males usually leave the group into which they were born when they reach maturity. Why is this? (2)

WHICH DOG TO CHOOSE? - HUMAN DECISION MAKING

In the United Kingdom, dogs that have strayed or been abandoned are taken into shelters where they are housed and cared for. The shelters may be run by the local council or animal charities. Members of the public can visit a shelter to buy a dog as a pet. There are many dogs to choose from, so how do people decide which particular dog to select as a pet?

A researcher* was interested in the factors that might determine how humans decide which dog to choose for a family pet when they visit the shelters. Two factors that may be important are the behaviour of the dog during the visit and the cage environment. She used university students as the participants in her study. This is because university students are available in large numbers and are usually happy to take part in such a study. Each student is given a series of paired photographs of dogs. An example of such a pair is seen in Figure 1.

(a) *(b)*

Figure 1

One of the pairs of photographs used in the study: the dog in a) is at the front of the cage, in b) it is at the back of the cage.

The photographs were taken in a shelter in Belfast and for each pair the same dog was used and it was photographed in the same cage. However, in the pair of photographs one feature differed: this feature either concerned the behaviour of the dog or it concerned the environment of the cage. The students were given a pair of photographs and were asked to say which of the two they preferred. The data she obtained for four behaviour and four cage environment factors are illustrated in Table 1.

Dog behaviour factors	**Number of students**	
Dog's position in cage	Front of cage 478	Back of cage 49
Direction of dog's gaze	Away from camera 437	Towards camera 90
Sound made by dog	Dog apparently quiet 481	Dog apparently barking 46
Activity of dog	Alert (standing, apparently sitting) 406	Not alert (resting, apparently sleeping) 121

Cage environment factors	**Number of students**	
Ball	Present in cage 369	Absent from cage 158
Basket	Present in cage 385	Absent from cage 142
Cage wire	Present at front 423	Absent from front 104
Cage cleanliness	Clean (faeces absent) 381	Dirty (faeces present) 146

Table 1 Number of subjects preferring each photograph of a pair, for dog behaviour and cage environment factors.

*Wells, D. L. (1996). *The welfare of dogs in an animal rescue shelter*. PhD thesis. School of Psychology, The Queen's University, Belfast.

Intermediate tier

1. How many students participated in the study? (1)

2. Draw a pie chart (divided circle) to represent the preferences shown by the students for whether the dog was facing towards or away from the photographer. (2)

3. Which factor appears to be least important in determining which photograph the students preferred? (1)

4. Which factor appears to have been most important in determining which photograph the students preferred? Suggest why this was so. (2)

5. Suggest **one** other dog behaviour factor, i.e. one not investigated in this research, that might influence the preference shown by a student. (2)

6. If the dog was at the front of a cage, rather than the back, it was preferred by the students. Suggest **two** reasons why a dog in a shelter may be at the back of a cage rather than the front. (2)

7. Why did the researcher use the same dog in each pair of photographs? (2)

Higher tier

1. Draw a pie chart (divided circle) to represent the preferences shown by the students for whether the dog was facing towards or away from the photographer. (1)

2. What factor appears to be least important in determining which photograph the students preferred? (1)

3. Which factor appears to have been most important in determining which photograph the students preferred? Suggest why this was so. (2)

4. Suggest **one** other dog behaviour factor, i.e. one not investigated in this research, that might influence the preference shown by a student. (2)

5. Why did the researcher use the same dog in each pair of photographs? (2)

6. Outline **one** disadvantage of using photographs in asking participants to assess which of two dogs they prefer. (2)

7. Suppose you are the person in charge of such a shelter and the researcher presents her findings to you. Outline how you might change the environment to increase the likelihood of a dog being selected by a member of the public as a pet. (2)

OBEDIENCE OF DRIVERS AT TRAFFIC LIGHTS

Three sixteen year old students decide to carry out a study of driver behaviour. They want to see if drivers of cars obey the requirements of the Highway Code not to cross the white line at a set of traffic lights until the green light shows and it is safe to do so. Close to their school is a major road junction and they are able to sit on a bench, 20 m from the junction, to carry out their observations. They hide their clip board, on which they record their findings, behind a copy of a newspaper.

They decide to observe only what happens to the first car in the queue of cars at the traffic lights and record:

a) if the driver obeys the Highway Code

b) if there is a front seat passenger in the car.

They carry out their study in the early afternoon and limit their findings to the first twenty cars they observe with no front seat passenger and the first twenty cars with a front seat passenger. The results of their research are illustrated in Table 1.

A front seat passenger present in the car																				Y - obeyed N did not obey
Subject	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Behaviour	N	Y	N	Y	Y	Y	N	Y	Y	Y	Y	N	N	Y	Y	Y	N	Y	Y	N

A front seat passenger not present in the car																				Y - obeyed N - did not obey
Subject	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Behaviour	Y	N	N	Y	N	Y	N	N	N	N	Y	N	Y	Y	N	Y	Y	Y	N	N

Table 1 Frequency of obedience shown by car drivers at a set of traffic lights.

Intermediate tier

1. Draw two circles with a radius of 5 cm, one circle for the condition 'with a front seat passenger' and one for the condition 'without a front seat passenger'. Divide each circle into two segments to show the proportion of drivers that obeyed and did not obey the Highway Code. Label each segment to indicate the category or condition that it represents. (4)

2. What do the results of their study seem to suggest? (2)

3. Why do you think the students put their clip board behind the newspaper? (1)

4. What effect on the behaviour of the drivers might it have had if they had not hidden their clip board? (1)

5. Identify **one** practical problem the students might have had when collecting their data if they were 20 m from the traffic lights. (1)

6. State **one** advantage of carrying out an observational study in the field. (1)

7. Identify **two** factors, other than the presence of a front seat passenger, that might influence the obedience of drivers at a set of traffic lights. (2)

Higher tier

1. Draw two circles with a radius of 5 cm, one circle for the condition 'with a front seat passenger' and one for the condition 'without a front seat passenger'. Divide each circle into two segments to show the proportion of drivers that obeyed and did not obey the Highway Code. Label each segment to indicate the category or condition that it represents. (2)

2. What do the results of their study seem to suggest? (2)

3. Explain why it would be unwise for the students to generalise from the findings of their study and make statements about the behaviour of drivers at traffic lights. (2)

4. Identify **two** factors, other than the presence of a front seat passenger, that might influence the obedience of drivers at any set of traffic lights. For each factor explain how it might be influential. (4)

5. Suggest **two** ways in which the highway authorities might act to increase the rate of obedience of drivers at traffic lights. (2)

SUGGESTED ANSWERS

Spiders – Intermediate tier

1. feeds on animals
2. very little wind in cave so vertical threads don't become entangled
3. movement of the prey causes vibrations in the web which the spider detects
4. makes it harder for the prey to escape
5. web would become too heavy, energetic costs of making all the globules, globules not needed because prey becomes entangled in several threads, wind blown particles (leaves, etc.) would be a problem
6. less likely to be broken by wind or by struggling prey, can stretch a little when the prey struggle but they don't escape
7. the presence of dew, before it evaporates, makes the threads more visible

Spiders – Higher tier

1. dark, so that prey don't see them or their burrow
2. adv. - avoid cost of making web; disadv. - cost of locomotion when hunting prey
3. very little wind in cave so vertical threads don't become entangled
4. movement of the prey causes vibrations in the web which the spider detects
5. makes it harder for the prey to escape
6. web would become too heavy, energetic costs of making all the globules, globules not needed because prey becomes entangled in several threads, wind blown particles (leaves, etc.) would be a problem

Bees – Intermediate tier

1. nectar, pollen
2. pollen from one plant carried to another resulting in pollination
3. honey
4. they keep the temperature of their hives close to 37 °C
5. at regular intervals, e.g. every five minutes, record the weather, e.g. air temperature and cloud cover and humidity and wind speed, also record the number of bees visiting a group of flowers, that can be continuously observed, analyse and display findings and draw conclusions

Bees – Higher tier

1. nectar, pollen
2. pollen from one plant carried to another, resulting in pollination
3. rich food sources are unpredictable, allows other bees to find new food sources quickly
4. adv. - independent of outside temperature, more active at lower air temperatures
   disadv. - energetic costs, more food required for maintenance
5. benefits the whole colony, many bees so death of one not too important, all the worker bees in a colony related to each other
6. colour is a signal to the honey bees, tells them a flower is worth visiting, benefits both bee and plant

Turtles – Intermediate tier

1. 50 turtles
2. SE-SW 6=12% (allow 5 turtles too), NE-NW 30=60% (allow 28 or 29 too)
3. the turtles showed a preference for moving north of their release position (80% headed north) - this seems to indicate that they are able to detect the presence of a large body of water nearby
4. on rainy/overcast days the humidity would be higher, ground wetter, ponds may be deeper and the rate of evaporation is less, therefore the problem of drying out is less acute so it is less critical to head for water - it also might be more difficult to detect where water is
5. so they could familiarise themselves with the new surroundings - so they could orientate to

the position of the sun and/or sense cues of the proximity of a large body of water nearby

6. could be taken by a predator - might not find a better pond
7. food becomes limited - overheating - aggressive encounters are more likely as the amount of water decreases

Turtles – Higher tier

1. as intermediate 3
2. as intermediate 4
3. as intermediate 5
4. as intermediate 6
5. as intermediate 7
6. on a sunny day, the evaporation rate is higher and therefore it is more critical to head for water in the shortest time, and the straightest path, possible - it is easier for the turtles to detect the presence of water
7. those turtles that could move quickly in as straight a line as possible would have the greatest chance of making it to a pond, and less chance of being taken by a predator, therefore they survive and mate and pass on their genes to their offspring, if this is a trait that is inherited

Snakes and millipedes – Intermediate tier

1. brown 2/15 = 48°, snake 2/15 = 48° and millipede 11/15 = 264°
2. 5.5 times as likely
3. 73%
4. the birds preferentially attacked the models of the millipedes
5. the models would not move as real snakes and millipedes would - the plasticene may have an odour/smell which might influence the behaviour of the birds the models may not look sufficiently realistic
6. easy to manipulate the material, i.e. sculpt it to look like a snake or a millipede - using plasticene the researchers can alter the form to investigate a number of variables - from a distance, it might look convincing (to a human or a bird?)
7. wasp, hornet, tiger

Snakes and millipedes – Higher tier

1. as intermediate 1
2. as intermediate 3
3. they might not have been so easy to see on the forest trail/track - there might not have been brown snakes or millipedes in that part of Costa Rica so birds might not see it as a prey item
4. as intermediate 4
5. as intermediate 5
6. as intermediate 6
7. wasp, a mimic is a hover fly

Ducklings – Intermediate tier

1. L→R -a hawk (it has a short neck and a long tail as do all hawks/falcons)

   R→L - a goose (it has a long neck like all geese, ducks and swans)
2. it took place indoors - ducklings might not behave as they would outside -the birds might not expect hawks to be flying inside a building
3. a video camera can capture behaviour a human observer might miss - birds might be affected by a human observer - videotape can be viewed again to check observations
4. to allow them to get used to the conditions in the arena before the shapes were flown
5. they would have nothing to fear from a goose flying overhead but they would if a hawk flew overhead - if they see a hawk they need to respond appropriately and as soon as they see their first hawk
6. they habituate - they soon realise that they have nothing to fear, even from the hawk shape - the shape always stayed at the same height and didn't fly at them

Ducklings – Higher tier

1. as intermediate 1
2. as intermediate 2
3. as intermediate 3
4. as intermediate 4
5. that the birds don't have to learn from other birds how to respond
6. as intermediate 5
7. as intermediate 6
8. they might be picked off by hawks because they would have habituated to the shape - on the other hand, if they can discriminate, or learn by copying the behaviour of other hawks, they might realise it is a real hawk and respond appropriately
9. a number of birds (two or more) will be more conspicuous to a hawk and it might therefore be best to freeze and hope not to be seen

Blue tits – Intermediate tier

1. see graph
2. the number of visits increases as the chicks get older
3. total = 359 visits - mean = 34.45 visits
4. see pie charts
5. a control, the number of visits probably varies during the day so the time of the observations should be the same each day
6. flies, spiders
7. crown is blue, feathers on their wings are blue
8. marsh, long-tailed, bearded, great, willow, coal and crested

Blue tits – Higher tier

1. as intermediate 1
2. as intermediate 2
3. mean = 34.45 visits, median = 31 visits
4. see pie charts
5. see intermediate 5
6. see intermediate 6
7. it would make the nest very messy (especially if there are a large number of chicks in the nest) and it would get on their feathers - it would increase the likelihood of insects and other animals exploiting the faeces and perhaps passing on diseases to the chicks

Moorhens – Intermediate tier

1. completely successful, 100 % success
2. 85 % (± 3%)
3. as the number of eggs already in the nest increased, there was a greater chance of them being accepted - the trend is not linear, the chance more than doubles from 1-2 eggs, then it increases at a slower rate
4. she would increase the chance of leaving more offspring - she would not have to rear these 'extra' offspring
5. she would be rearing the offspring of other females, perhaps at the expense of her own, since the 'extra' offspring would be fed
6. cuckoo - in reed warbler, dunnock, robin, pied wagtail or meadow pipit nests - the female cuckoo removes an egg when she lays her own
7. one of the pair could always stay with the eggs - this would ensure that another female could not add any eggs to their clutch

Moorhens – Higher tier

1. as intermediate 1

2. as intermediate 3
3. as intermediate 4
4. as intermediate 5
5. as intermediate 6, but there is no need to mention the host species
6. as intermediate 7
7. collect a number of moorhen eggs and paint them to alter the colour background and/or the speckling - with a variety of colours, the eggs could be added to a series of nests to see if colour influenced acceptance
8. the egg might be detected and not accepted it wouldn't know how good the parenting qualities of the birds are - they may not be able to feed their own and the 'extra' one adequately - she has to leave her own nest while doing it

Starlings – Intermediate tier

1. availability of food in gardens and/or streets - people put out food in gardens to encourage and help sustain birds - fast food outlets have surplus food left by consumers close to their shops
2. they use it to probe in the grass and the top few centimetres of soil - they might get earthworms, beetles, spiders, berries
3. blackbird - has a yellow bill throughout the year and is all black

   starling - has a yellow bill in spring/summer but it darkens during summer and winter and has iridescent green/purple feathers as well as black
4. greater vigilance for predators - lowers the chance of an individual bird being taken by the predator - may be more efficient at finding food
5. offer convenient and safe places to roost, e.g. buildings urban areas are warmer, especially in winter
6. complaints about noise - bird droppings disfigure the buildings - possibility of disease

Starlings – Higher tier

1. as intermediate 1
2. as intermediate 2
3. as intermediate 4
4. as intermediate 5
5. as intermediate 6
6. omnivorous, therefore opportunistic feeding pays off - its association with humans is beneficial, e.g it comes into gardens for food - competition for food, nest sites, etc. from other birds was slight
7. when the bird makes the 'required' sound, or something that closely approximates to it, it is rewarded with food, interaction with the human, etc. - over time, its vocal behaviour is shaped to be the required sound

Moths and bats – Intermediate tier

1. 185
2. 189/764 = 24.7 %
3. 1992 - 32/181 = 17.7 % 1993 - 20/135 = 14.8 %
4. they don't use a visual signal because they are seeking a mate at night - they don't use a sound signal because it would be expensive to produce, it wouldn't travel as far as a chemical signal and it might attract predators
5. sound signal - its ears
6. male moths - middle of the night: female moths - early in the night
7. in the early/middle part of the night - females are flying around seeking nectar and a good site for signalling - males are flying and seeking females - towards the end of the night the moths are at rest in a good resting position for the coming day

Moths and bats – Higher tier

1. as intermediate 2
2. as intermediate 3
3. as intermediate 4
4. as intermediate 5
5. as intermediate 7
6. windows of houses because the moths are attracted to the lights - the windows and neon signs of shops - all night operating premises, such as hospitals, airports, etc.
7. obtain a number of virgin females - put half into individual airtight containers and the other half in containers which allowed the air to pass through - place in open and count the number of males attracted to each type of container

Caracals – Intermediate tier

1. mainly active at night
2. member of the cat family - has well developed canine teeth , typical of carnivores
3. it is active at night, therefore the ability to detect prey moving around would be advantageous
4. only used when they are needed and therefore they are less likely to be worn down or broken
5. leopard and cheetah are predominantly day hunters and camouflage is important because they both stalk their prey - there is no need for this strategy in a nocturnal hunter
6. yawning - its eyes are closed, it would be sleeping or resting during the day
7. it can stalk its prey using stealth and surprise - a photographer could do the same, plus the camera has a zoom facility to effectively 'creep up' on a subject [The camera is advertised as "near-silent, fast - unsuspecting subjects won't know you're there" - "its film advance and rewind mechanism is so quiet only the most sensitive ears will pick it up".]

Caracals – Higher tier

1. as intermediate 2
2. as intermediate 3
3. as intermediate 4
4. as intermediate 5
5. adv - need not share prey with others

   disadv - can't bring down such large prey items
6. as intermediate 7
7. a rock crevice would be a safe retreat during the day, the cubs would not be seen by predators, such as eagles - big cats like lion and cheetah do not use crevices to rear their young therefore there is reduced competition for safe den sites

Seals – Intermediate tier

1. rest - escape from marine predator - thermoregulation
2. avoids the presence of the observer affecting the behaviour of the seals - the seals would not haul out if they could see a human nearby and might raise their heads more frequently
3. visibility would be reduced
4. as the group size increases the mean time spent scanning decreases
5. about 45 seconds i.e. 25 %
6. 9
7. to see where they are diving - to make as rapid an entry into the water as possible
8. human - large dog or wolf
9. in the centre of the group since a predator is more likely to grab an animal at the edge of the group

Seals – Higher tier

1. see intermediate 1

2. see intermediate 2
3. as group size increases the time spent scanning decreases - this is because in a large group there are more animals that are scanning at any time and so an individual animal can afford to do less scanning, it can rely on the vigilance of others
4. see intermediate 7
5. a land based predator would approach the seals that had hauled out from the side – this would mean that the seals on the edge of the group would always be at greater risk than those in the centre since the predator would inevitably try to grab one nearest to it as it crept or ran forward - thus seals at the edge need to scan more because their risk of being taken by the predator is greater
6. they could not ascribe certain observed behaviour to specific seals - thus they would not know if certain individuals were more frequently to be found on the edge of a group that had hauled out
7. see intermediate 8

Cats – Intermediate tier

1. 85
2. adult male-89°, juvenile male-106°, adult female-42°, juvenile female-123°
3. 85/138 = 61.6%
4. the juvenile male cats are acting submissively to the adult males since they are exposing a vulnerable part of their body to the adult male cat - this reduces the likelihood of the adult males behaving aggressively towards the younger male cats
5. rolling by females is a feature of oestrus behaviour and is an indicator to males of their sexual receptiveness
6. avoidance of eye contact - this would indicate the cat was not about to launch an attack

   flatten its ears - this reduces the apparent size of the cat so it is less threatening

   running away - a fleeing cat would not attack

   lowering its tail - this indicates that it acknowledges that it is lower in the hierarchy
7. to interact with its owner - this might be to invite the owner to stroke it, to play with it etc.

   to be submissive to its owner - the cat displays subordinate behaviour in front of the human

Cats – Higher tier

1. as intermediate 2
2. as intermediate 4
3. the juvenile males may be able to mate with these females when they reach sexual maturity - there would be little for an adult female to gain from a juvenile male cat, they roll to sexually mature males since they need to mate at that moment in time

   the juvenile male may be trying to establish some form of bond with the female - this may pay off later, perhaps bringing sexual or social benefits
4. a female cat only comes into season twice a year and since they only roll when they are ready to mate this behaviour is limited to just a few days in the year - male cats roll to show submission and this behaviour is not linked to hormonal changes but is dependent on the presence of a dominant male cat
5. as intermediate 6
6. they might mate with their sisters, mother, aunts, etc. if they stayed in their natal group - inbreeding is more likely to have undesirable consequences, such as reduced fertility and a lower resistance to disease

Dogs in shelters – Intermediate tier

1. 527
2. towards 299°, away - 61°
3. whether there was a ball present, or not, in the cage (allow cleanliness too)
4. if the dog was barking - this may be because they might assume it would be noisy, aggressive or dangerous at home, it may be interpreted that the previous owner had little control of the

dog and it may be difficult for them to handle (allow dog's position in the cage too)

5. if the dog was wagging its tail, if the dog was baring its teeth (any other valid point)
6. it might be very timid or fearful of humans as a result of previous experience - it may not want to interact with humans at the time
7. it is an important aspect of control - if it was a different dog the preference may not be due to the behaviour or the cage environment but might be based on a preference of one dog rather than the other, perhaps due to its appearance

Dogs in shelters – Higher tier

1. as intermediate 2
2. as intermediate 3
3. as intermediate 4
4. as intermediate 5
5. as intermediate 7
6. a photograph only captures behaviour at one moment in time - film/video would be better
7. have toys, a basket, glass rather than wire, keep the cage as clean as possible

Humans/obedience – Intermediate tier

1. passenger present - N=7 (126°), Y=13 (234°): no passenger - N=11 (198°), Y=9 (162°)
2. there is some evidence that the front seat passenger does influence obedience - the influence operates through the passenger increasing the likelihood of the driver obeying the Highway Code
3. so that drivers would not be aware that their behaviour was being recorded
4. drivers may have believed that their driving was being monitored and obeyed the Highway Code
5. their view of one, or more, of the roads at the junction might have been obscured
6. the observers would see 'natural behaviour'
7. presence of a camera - the behaviour of other road users, especially those alongside or near the driver - presence of a member of the police force or a police vehicle - presence of a traffic warden

Humans/obedience – Higher tier

1. as intermediate 1
2. as intermediate 2
3. they only observed driver behaviour at one road junction, at one time of the day, on one day of the week, did not see a random sample of drivers, etc. - so it is unlikely that they observed behaviour that would be representative of a cross section of drivers
4. as intermediate 7 : presence of a camera - drivers would know that their behaviour was likely to be recorded and thus they would probably obey the Highway Code: the presence of nearby drivers - a driver alongside a vehicle at the stop line might cause the driver to try to accelerate away before the green light showed to beat the other driver
5. installation of video cameras at junctions with traffic lights - issuing of summons against every driver who disobeyed for a month or so to act as a salutary reminder of the Highway Code
6. typing task - or any other valid point

FURTHER RESOURCES

Organisations

Association for the Study of Animal Behaviour, ASAB Membership Office, 82A High Street, Sawston, Cambridge CB2 4HJ.

British Psychological Society, St Andrew's House, 48 Princess Road East, Leicester LE1 7DR.

The Entomological Livestock Group, c/o John Green (Secretary), 11 Rock Gardens, Aldershot GU11 3AD.

Journals

Catalyst - GCSE science journal, 4 issues a year. Available from Philip Allan Publishers, Market Place, Deddington OX15 0SE.

Feedback - education newsletter of the Association for the Study of Animal Behaviour, 2 or 3 issues a year. Free. Available from Michael Dockery, Department of Biological Sciences, John Dalton Building, Manchester Metropolitan University, Chester Street, Manchester M1 5GD.

Books

Cain, N. W. (1995). *Animal Behavior Science Projects*. New York: John Wiley.

Evesham, E. J. M. (1995). *A Guide to the Collection, Maintenance and Behaviour of Ants*. Association for the Study of Animal Behaviour.

Hoey, H. (1991). *Understanding Biology through Problem Solving*. Glasgow: Blackie.

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Reiss, M. J. (Ed.) (1996). *Living Biology in Schools*. London: Institute of Biology.

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ACKNOWLEDGEMENTS

We are extremely grateful to the following who suggested materials for inclusion, commented on portions of the manuscript, gave permission to use their illustrations or otherwise encouraged and helped us: David Barnard, Mike Hansell, Professor Terry Looker, Christine Nicol, Nikki Rowland, Lisa Strittmatter, Stephen Tomkins, the UK Cat Behaviour Group, the Universities Federation for Animal Welfare and Debbie Wells. Linda Gray, Judy Evans and Stephen Tomkins kindly drew the illustrations. Academic Press generously gave us permission to reproduce figures. The photographs were supplied by BoxWatch, Michael Dockery, Mick Hoult and Debbie Wells. Kind thanks are also due to the Headmistress (Miss Diggory) of Manchester High School for Girls and her Year 10 students. We are also grateful to several anonymous people for their thoughtful comments on the manuscript. Martin Hodge of MNL Consultants designed and produced the book.

Front cover photographs:

Top – Blue tit

Middle – Students removing sweaters

Bottom – Honey bee on bramble

ANIMAL BEHAVIOUR: Practical work and data response exercises at GCSE has two aims. First, to encourage the use of more practical work on animal and human behaviour at GCSE level. Secondly, to help pupils studying GCSE Biology, Psychology or Science to develop their study skills by tackling data response exercises (structured questions). Most of the book consists of suggested practical work and data response exercises. In addition, there are sections on describing and measuring behaviour, on the practicalities of using animals in schools, on safety and legislation and on ethical issues surrounding the use of live animals in schools.

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This book is available from Michael Dockery, Department of Biological Sciences, John Dalton Building, Manchester Metropolitan University, Chester Street, Manchester M1 5GD (Tel: 0161 247 1149; Fax: 0161 247 6365; E-mail: m.dockery@mmu.ac.uk).

ISBN 0-12-218859-4