ASAB

A guide for teachers and lecturers in biology and psychology for use in conjunction with the Association's video, Stimulus Response

CONTENTS

Stimulating Responses

VIDEO RUNNING TIME GUIDE

Minutes/Seconds

00.00 Introduction

- **Reflex action—five steps in the stimulus-response chain**
- **Learned reaction—five steps in the chain**
- **Effect of rearing regime on farm animals**
- **Scientific investigations into the behavior of animals**

05.02 Stimuli

- **Visual stimulus—hens, goats**
- **Heat and tactile stimuli—piglet**
- **Olfactory and visual stimuli—piglet**
- **Internal stimulus—pigs and hens**

08.18 Receptors

- **Visual receptors—hens**
- **Olfactory receptors—pigs**
- **Tactile receptors—pigs**
- **Auditory receptors (plus visual and olfactory)—sheep**
- **Visual receptors—hens**
- **Physical coordination—hens**

14.20 Coordination

- **Types of learned behavior**
- **Habituation—calves**
- **Classical conditioning—sheep**
- **Trial-and-error learning—hens and pigs**
- **Observational learning—sheep and hens**

19.37 Effectors and Responses

- **Irritation—cows**
- **Internal effectors and responses—calves**
- **Stress in a non-stimulating environment—piglets**
- **Stimulating environment—piglets**
- **Enriched environment—piglets**
- **Stereotyped behavior—pigs**
- **Nesting behavior—hens**
- **Foraging behavior—hens**

25.09 Summary

This booklet suggests learning activities to stimulate student interest and class discussion when used in conjunction with the video Stimulus Response.

Designed for a wide age range of 14 to 18 years, it allows teachers to select exercises suitable for the age and ability of their own students.

Although primarily designed for biology and psychology, some of the ideas are also of value in other areas of the curriculum, such as personal/social development, character education, and debate.

The material in the booklet is based on ideas devised for the Association for the Study of Animal Behaviour by Dr. Nicky Hayes, University of Surrey, England, and the late Professor Jürg Lamprecht of Max-Planck-Institut für Verhaltensphysiologie, Germany.

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STIMULI AND RESPONSES

The first part of the video, showing the basic stimulus-response connection, can be used to encourage exploration of the various types of stimuli that an animal or human being may experience.

Show this part of the video, then ask your students for examples of other stimulus-response connections.

Write as many as you can on the board. Some of these will be straightforward reflexes, but others will be more complex. Don't reject any that the students offer, even if they seem pretty wild: they will be useful for distinguishing between different types of connections.

When you have collected a good, varied set of examples, try organizing them into different categories. One possible categorization is into:

- direct connections—providing neural links to aid survival (such as jerking the hand away from a hot stove)
- learned behaviors—addressing undesirable physical states (such as the woman opening the window in the video)
- complex behavioral responses to complex social stimuli (such as the hens imitating the hens they saw on their video)
- cognitive responses to complex stimuli (such as the lamb learning by seeing his mother feeding from a trough).

This will lead you nicely into the topic of coordination and the many different ways that information can be coordinated by the brain.
It can also lead to discussion of the many different types of stimuli and responses. The five-part structure given in the video (stimuli—receptors—coordination—effectors—responses) gives you a good framework for structuring these discussions.

[*This section of the video, with its graphics sequences, has been found to be particularly valuable as a summary for the reflex/learning section of the curriculum. This is especially the case for younger students who don't always find it easy to grasp these ideas immediately.*]

THE SENSES

Exercises and discussions designed to explore the senses

EXPLORING PRIMARY SENSES

The Stimulus Response video shows animals reliant on different primary senses and illustrates how important or significant stimulation for one animal may be very different from important stimulation for another. For pigs, for example, the primary sense is smell and a pig is able to build up a complex and detailed picture of the world from using this sense. Chickens, like many birds (and like most humans), rely on sight. Visual stimuli, including different colors, are particularly important to them. The video demonstrates how sensitive sheep are to sounds and how they use their awareness of sound in different facets of day-to-day living.

Discussing primary senses

Student Sheet 2 invites students to identify the primary senses of other animals. You can use this exercise as the basis of a class discussion about the way that an animal's primary sense reflects its evolutionary adaptation and the survival demands of its ecological niche. Ask students to reason out how a particular animal might gain an advantage from having that particular primary sense.

Encouraging exploration of how animals use their senses for different survival purposes may also lead you into discussion of function and form. For example, the difference between frontally mounted eyes (owl, monkey) and laterally mounted eyes (rabbit, chicken) can be used to discuss the evolutionary advantages of each arrangement.

EXPLORING SECONDARY SENSES

The video shows animals using other senses, too (for example, the pig uses touch as well as smell to separate out her Sugar Puffs). Animals, like humans, have secondary senses as well as primary ones. You can use the Student Sheet 2 primary sense exercise as a lead-in to stimulate discussion about other important senses for these animals and what they use them for.

The primary sense for human beings is vision. But we have secondary senses and one of the more interesting class exercises that you can try is for the whole class (including yourself) to discover more about them by depriving themselves temporarily of vision in order to explore the senses

of hearing and smell. If you like, you can do the exercise twice exploring a different secondary sense each time. It will be more effective if you do both exercises in one period.

You will need blindfolds (those issued on airplanes to help people sleep are ideal). You will also need to have some teaching aids ready, arranged so that you can find them easily by touch. It is a good idea to have a timer that can be set to ring after an appropriate period of time, such as 10 or 15 minutes. Let the class know what the period of time will be and let them see you set the timer before you all put your blindfolds on.

Discussion during the adaptation period

After you are all blindfolded, carry on teaching so that your students' attention is partly on what you are saying rather than wholly on being deprived of sight. This will help them get through the period of adaptation.

There are two good topics to talk about. One is to discuss the problems of blind people and how they identify things in their world. The other is to discuss the video and, in particular, the different senses demonstrated. Invite students to imagine that they are sheep, listening to what is around them, or pigs scanning the air around by smell. Talk about nocturnal animals, like bats, or subterranean ones, like moles, or cave-dwelling creatures not reliant on sight for survival.

Prolong your discussion for several minutes to allow everyone time to get used to being without sight. When you judge that the novelty has begun to wear off and your students are beginning to adapt, you can carry out the exercises. The secondary senses will seem more acute after a period of adaptation, and students may be surprised at what they can detect.

Auditory exercise

You can begin with an exploration of the auditory sense. Remind students of the sheep in the video and the way they could identify the farmer's truck from any other vehicle. Then introduce a sensitivity test. Ask the students to tell you what they can hear. Have short periods of silence while they listen, then other periods while they tell you what they have heard. If they have had a little time being sightless, it is likely that they will be able to detect sounds that they wouldn't ordinarily notice: the clock ticking; the sound of floorboards or radiators expanding; traffic; other noises in the building; etc. See how many different sounds you can identify as a group.

Discuss with your students why it is that you can hear so much more than usual when your primary sense has been blocked. Invite the students to contribute hypotheses, or possible explanations. These are likely to include physical adaptation, increased focus of attention, etc., but they may come up with others as well. You can use these hypotheses later as the basis for designing a class experiment.

You can also play a voice-identification game, as long as you have prepared it before you put the blindfolds on. Each student should have a number that is kept secret from the others in the class. Choose a number, and ask them to say a simple sentence, such as "The pig was hunting Sugar Puffs." The class identifies the speaker.

If the students take to this, ask them to disguise their voices as they say the same sentence. It is much harder to disguise a voice than people expect, and the increased sensitivity produced by the blindfolds is likely to make it harder still. You can only use volunteers for this, of course, because the class members will have learned each other's identity from the numbers in the first round—unless you thought way ahead and gave everyone both a number and a letter!

Olfactory exercise

The pigs in the video demonstrated just how sensitive pig olfaction is. We often assume that the human sense of smell is weak, but some humans are remarkably sensitive, even though they have nothing like the sensitivity of pigs or dogs. This exercise allows students to explore their olfactory sense, once they have become used to operating without their primary sense of vision.

Prepare for this exercise by getting hankies or tissues, dabbing them with essential oils, and keeping them in separate plastic bags until they are needed. We recommend using peppermint, lavender, and geranium—they each smell quite different and are generally pleasant. You could use one of the citrus oils as well (orange, lemon, or grapefruit) and perhaps one of the resinous ones (pine, cypress, or juniper). Prepare at least three different smells, but you can have more if you want. You could also leave one tissue unscented if you like.

Before you put on your own blindfold, check that your plastic bags are handy, that you can open them without needing to look, and that you and your students are seated in such a way that it is easy to pass things from hand to hand without getting up. Make sure everyone knows to whom they should pass, so that nobody gets left out.

Also, ask your students to have a pen ready and a blank sheet of paper in front of them: they will need to write down some words even though they can't see the paper.

Pass round the tissues or hankies one at a time. Ask students to smell each one, to write down what they think it is, and then to pass it on to their neighbor. If they don't know a name for what they are smelling, ask them to write down what it reminds them of.

Discussing secondary senses

There will be much to discuss after your students have taken off their blindfolds. Effectively, during the period of darkness, they have actively explored the secondary senses of hearing and smell.

Here are focus questions you can use for the discussion:

Hearing:

Was their hearing more sensitive with the blindfold on? Can they still hear all the things they could hear then? What more do they imagine a sheep might be able to detect?

Smell:

Did they find it easy to distinguish between the smells? Did they seem more distinctive and definite than smells normally do? What more do they imagine a pig could detect?

Demonstrating and discussing different types of vision

Not all animals see the world in the same way.

There are several types of vision that are common in the animal world: compound images, black and white, the visible color spectrum, and ultraviolet. Begin to look at this topic by asking your students to identify animals with each of these types of vision. Bees, for example, see ultraviolet, while cows, cats, and dogs see only in black and white (the red of the matador's cape is unimportant: it is its movement that stimulates the bull to action). Monkeys and birds see color, while insects have compound eyes.

With some preparation, you can demonstrate the different types of vision. Compound lenses are available as small toys from science center shops and other outlets; disco lighting often highlights ultraviolet; and black-and-white can be obtained by adjusting TV monitors.

Ask your students to identify the evolutionary advantages of different kinds of vision.

What advantages does each type of vision have?

The main advantages likely to emerge from the discussion are:

- Color — fine detail
- Black-and-white — sensitivity
- Ultraviolet — additional information in daylight
- Compound — all-around vision with simple visual pits, not complex eye structure.

These are just suggestions: you may find others. You can go on from this to consider the evolutionary advantages and the psychology of color vision in human beings. Why did we evolve color vision? How early in our ancestry? How might color vision have helped gatherer-hunters to survive? How important is color to us now? How many different ways do we use color? Ask your students to list all the different ways that color affects their lives during a typical day, ranging from preparing breakfast to traffic lights. You can go on to consider how the world would be different if we could only see in black and white.

Two more discussion topics

1. Color coding is important to humans in many different ways. If our species only had black-and-white vision, what substitutes could we use for color coding?

2. Dogs don't have color vision as humans do, yet guide dogs are used to aid humans who are missing the primary sense of vision. Why guide dogs and not, say, guide monkeys?

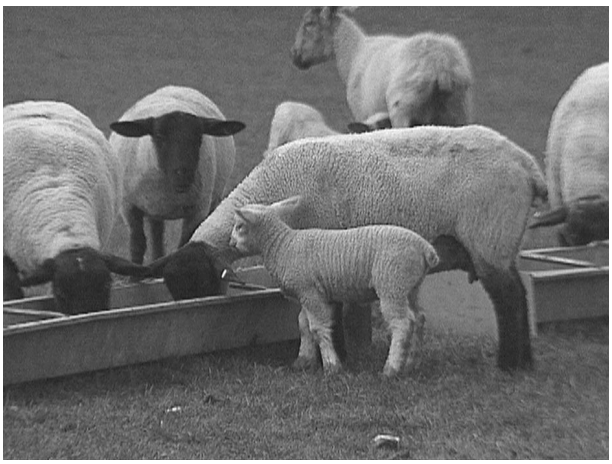
EXPERIMENTAL DESIGN AND INTERPRETATION

Suggestions and data to develop students' experimental skills

The material in this section is of wide value in experimental science classes. It is based on two studies published in scientific journals on which sequences in the Stimulus Response video were based. The questions, about animals' responses to stimuli, addressed by the investigations were:

1. Does the smell of urine from an alarmed sow cause other sows to avoid proximity to that location?

2. Do milk-fed lambs learn, in later life, which type of food they can safely eat, by observing their mothers?



EXPERIMENTAL DESIGN

The initial challenge is for students to attempt to design their own experiments to investigate the questions presented above. Tell them to imagine that they have as many animals as they deem practical and appropriate to use in the experiments. Ask them to ensure that their proposed design covers:

- the overall procedure
- ethical precautions
- experimental controls
- the type of data they would collect.

You can award marks for each of these categories, if you like. Encourage your students to be as practical as possible, even though they are not actually going to carry out the study (conducting student experiments with live animals is no longer considered ethically justifiable). The point of the exercise is for them to explore issues of experimental design and control, as well as the practical implementation of ethical issues in animal research.

The study must be designed with ethical considerations in mind. You can provide them with a copy of the ASAB ethical guidelines. Together with our sister association, the Animal Behavior Society (ABS), in the United States, we have produced a set of guidelines for all who are engaged in behavioral research and teaching activities involving animals. These "Guidelines for the Treatment of Animals in Behavioural Research and Teaching" may be viewed on ASAB's Web site (www.asab.org/) and are also reprinted in each January issue of the journal *Animal Behaviour* published jointly by ASAB and ABS.

One useful way of approaching this is to divide the class into small groups of four or five individuals. Each group has 20 minutes of class time to develop its own ideas (you can stretch this to half an hour or 40 minutes if you have the time available). Then they must report back to the class as a whole. Leave plenty of time for reporting back, since you may get several different types of design, and they will need to be compared and discussed.

EXPERIMENTAL INTERPRETATION

Provide students with copies of the student sheets that describe the procedures and results of the published studies on pigs and lambs. Put them to work in groups of two or three. Allow them about 20 minutes to come up with general conclusions and an evaluation of the procedures, and then ask each group to report back to the class.

Suggested solutions to Experiment 1: Alarm substances in pigs

(1) In nine out of 10 of the control groups, the first animal approached the food dispenser within one hour. However, in seven out of 10 of the experimental groups (i.e., those that were exposed to the urine of the alarmed sow), it took the animals much longer.

(2) It seems that the urine of an alarmed sow contains substances that remain detectable by other pigs for a long period, i.e., at least 14 hours, and that cause individual animals of the same species to hesitate. A substance that is released by one animal and affects the behavior of others is called a ***pheromone***. In this case, it functions as an alarm substance.

CONCLUSION

There are substances in the urine of an alarmed sow that cause other sows to avoid the marked area. This seems to be a mechanism by which a pig can mark certain areas as “dangerous” (Vieuille-Thomas & Signoret, 1992). It is, as yet, unclear whether pigs will permanently memorize such scented places as “dangerous” or if the avoidance decreases with the evaporation of the alarm substances.

Suggested solutions to Experiment 2: Observational learning in lambs

(1) The ewes with unweaned lambs who were put off food type B never fed from this type of food in front of their young. Their lambs, when weaned, hardly ever fed from food type B, either. Mothers of the control group showed a slight preference for food type A, as did their lambs, but both fed from both food types.

(2) During the preference tests, lambs of the experimental group exhibited a clear preference for food type A—the second test showed that this preference was a permanent one. The lambs of the control group, however, exhibited no preference for any of the food types (the slight divergence from 50 percent can be explained by chance).

CONCLUSION

It became clear that during the experimental phase, while they were together with their mothers, the lambs acquired a food preference that matched that of their mothers (Mirza & Provenza, 1990).

Animal Learning

Exercises for students of animal behavior and comparative psychology

HABITUATION

The video gives several examples of habituation in animals, such as the calves becoming accustomed to the opening umbrella or the sheep in the field ignoring traffic noise. Begin an exploration of this topic by asking students to identify as many of these examples as possible.

Follow this up by asking for other examples of habituation in the wild and in everyday life and its adaptive value. Some examples you might use to stimulate suggestions are: horses not responding to the noise of traffic; birds ignoring scarecrows; children ignoring nagging; and, of course, desensitization therapies.

One of the challenges facing the hens emerging from battery conditions in the video is the large number of new situations they will encounter. Invite your students to list all the different types of stimulation to which those chickens would need to habituate. This list can be used to help them to understand how important habituation is in day-to-day living.

The list can also be used to raise the question of adaptation and the way that adaptation can operate on several different levels. You can use it to illustrate the various ways that humans and animals can adapt: on a long-term scale through evolution; in the shorter-term through conditioning; through other forms of learning; and so on.

Habituation test

The calves in the video habituated quickly to the opening umbrella. Human beings often habituate quickly, too. You can demonstrate this with a party noisemaker or something else that makes a sudden loud noise. Ask students to undertake a fine coordination task, while someone stands behind them and makes the noise at random intervals. Only use volunteers for this, since nervous anticipation is unpleasant for some. It is likely that they will show fewer errors as they become habituated to the stimulus.

A good coordination task for this activity is one of those games in which the person has to pass a wire loop over a series of bends in a wire, with a bell ringing if the loop touches the wire. Alternatively, you can ask the student to trace a complex figure by keeping the pencil between two parallel lines. Errors occur each time the pencil touches either line.

This is a class activity, but it could also be the basis for a formal experiment. Do it as an activity first, then invite the students to work out how it could be adapted into a coursework study. There will be many different factors to consider: controls, measurement, specific hypotheses, etc. If their ideas prove both practical and ethical, allow them to go ahead and carry out the study.

CONDITIONING

There are very few ethically acceptable ways of demonstrating conditioning in the classroom. However, you can explore the topic retrospectively by asking students to provide you with examples of (a) conditioning in animals and (b) conditioning in human beings. The main example given in the video is of the sheep responding to the sound of the farmer's truck.

Strict behaviorists would cite the video's example of the woman cooling herself by opening the window as an example of operant conditioning using negative reinforcement—a behavior that has been learned because it results in the removal of an unpleasant stimulus.

Other learning theorists, however, would argue (as the video does) that there is a significant cognitive component to the action that makes it a different form of learning. This can provide you with good material for a class discussion.

"TRIAL-AND-ERROR" LEARNING

The chicken in the video learned to run a complex maze through trial-and-error learning. An important aspect of this kind of learning is that it requires **feedback**—knowledge of the results of one's actions. You can explore the value of feedback in trial-and-error learning in the classroom.

For this activity, you will need some clean waste paper, a few large elastic bands, a trash can, a blindfold, and a piece of chalk. The paper needs to be rolled into small pellets, because the person doing the activity has to use an elastic band to flick waste paper pellets into the trash can or as close as possible. An alternative would be to use a series of sheets of letter-size paper. Each sheet of paper can be rolled into a ball and the ball then thrown into, or close to, the trash can. The advantage of this is that each ball will have the same mass: Pellets could vary in mass and this would be a confounding variable.

Place the trash can in an open space in the room, and use the chalk to draw target circles around it. Place a chair some distance away. You will need to do a certain amount of trial and error to find an appropriate distance for the chair on which the "flicker" sits. The task should be fairly hard but not impossible.

The best way to organize this activity is to divide the class into groups of six to eight, with each group having a target of its own. They begin by setting each person's "performance baseline" with normal visual feedback. Each group member has two practice shots, then five recorded trials. (Other members of the group can do the recording.) The target circles should be graded as A, B, C, and D, with A being the circle closest to the bin. This gives you a way of grading misses.

When the "performance baseline" has been obtained for everyone, the next round begins. The "flicker" has to be blindfolded for this round and should have 10 shots at the target. Let everyone in the group do this in turn. After each shot, they should be given auditory feedback in the form of one of the following: "hit," "A," "B," "C," "D," or "miss" if it has missed the circles entirely. It is a good idea to turn the "flickers" round once after they have put on the blindfold, before sitting them back in the chair facing the target. This is not to make them dizzy but to make sure they can't rely too much on precise visual memory.

The question is whether they are showing trial-and-error learning. You should be able to detect this by comparing how successful their first five blindfolded shots were with how successful the second five were. If you like, you can compare different kinds of feedback, such as simple "yes/no" feedback, provided by the sound of the pellet going in the trash can or not; delayed feedback given at the end of five tries; feedback using just three categories: "hit," "close," and "miss," and so on.

OBSERVATIONAL LEARNING

Begin an exploration of observational learning by asking your students to identify as many different examples of observational learning in the video as they can. (Don't forget the delayed observational learning shown by lambs learning about the food their mothers are eating while they are too young to eat it themselves.) Then ask them to give other examples that they may have come across of animals showing observational learning. They may, for instance, have seen Japanese macaques washing sand grains from rice on wildlife programs on TV or have examples of companion animals imitating one another.

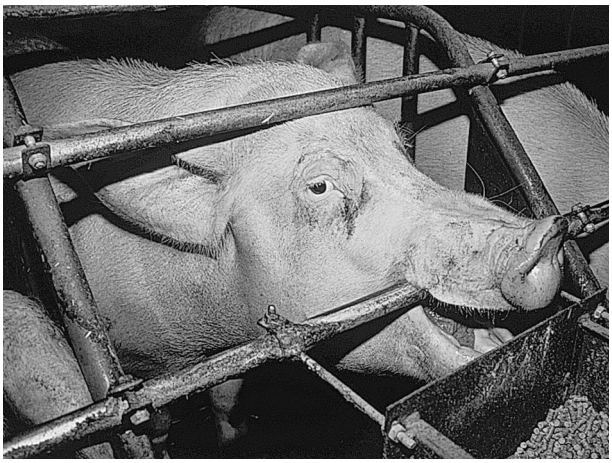
Invite your students to consider the evolutionary advantages of observational learning, as opposed to learning everything by trial and error. You may also like to lead your class into discussion about whether observational learning is cognitive or not. Researchers distinguish between the simplistic kind of representation involved in observational learning and more complex forms of cognition such as decisionmaking; but applying these distinctions is always a judgment call.

Often, too, the exercise of judgments such as these is really an expression of a deeply held belief about the differences (or lack thereof) between animals and human beings. If your class seems divided on the question, you might like to organize a class debate on the question of whether animal learning is fundamentally different from human learning. Instruct those with strong views to form two opposing sides, give them 20 minutes to prepare a case and then five minutes to present it. Allow some time for discussion and then a two-minute summing up for each side. Finally, hold a vote on the matter to see which side has been more convincing to the uncommitted members of the class.

Ethical Issues

A topic for debate

The video contains several scenes that make us aware of animal-welfare issues in farming. This is where ethical viewpoints and considerations come in that go beyond the field of biology but which can very well be discussed in biology lessons. Teachers of English and subjects such as personal/social development and character education will also find this video of value in triggering discussions and debates. The following suggestion for a classroom debate aims to encourage students to consider these topics rationally and to demonstrate the complexity of these issues.



FACTORY-FARMING DEBATE

You can set up a formal classroom debate on the factory-farming systems (e.g., meat chickens in large sheds, pigs on metal slats between concrete walls) illustrated in the video. However, as it is unlikely that you will find anyone to support such systems, try instead to set up a debate between vegetarians and omnivores based on the material they have seen. The vegetarian group could include those sympathetic to vegetarianism, even though not precisely following a vegetarian diet at present.

The vegetarian case is likely to be well known to those of your students who elect to pursue it, centering around meat-eating as unnecessary cruelty, nutritionally unsound, etc. The omnivore case should center around the importance of consumer insistance on free-range meat in order to show supermarket buyers that factory farming is not acceptable. Without such omnivores, there would be no consumer pressure to persuade supermarkets to sell free-range meat, since vegetarians do not buy meat anyway; and factory farming would therefore continue without efforts to develop acceptable alternatives for consumers.

Divide your class into two groups—vegetarians (and their sympathizers) and omnivores. Each side can have one week to prepare its case and should summarize it in a five-minute presentation at the start of the debate. It may be a good idea to insist that these initial presentations be written down so that they can be handed in. After each side has given its initial presentation, allow both sides to begin a more informal discussion. When you judge that this has gone on long enough, or after 10 minutes, give each side five minutes further preparation time, then two minutes to present its final case.

As a followup, ask each student to present a numbered list of five arguments for each side of the debate. This is good training, encouraging summarizing and balanced evaluation skills. It is best to do this a week after the debate, though, not immediately.

THE STUDENT PAGES

Solutions and notes

The Student Pages can be photocopied and given to students.

Sheet 1 is specifically linked to the suggestions relating to experimental design and interpretation of results.

Sheet 2 can be used to:

- **remind students of key points;**
- **allow the teacher to check the accuracy of their recall;**
- **encourage those who have paid attention;**
- **focus and help structure students' memories of what they have seen in the video;**
- **provide a light-hearted activity around the topic.**

Solutions for Sheet 2

QUIZ

1. A man reacting to burning his fingers on a hot lid.

2. Hens in small battery cages; mother sows in metal-barred farrowing pens; piglets in barren indoor environments.

3. Prolonging indoor lighting beyond the period of natural daylight—up to 17 hours a day.

4. After two hours, a newborn piglet begins to react to the stimuli of smell and color in addition to the stimuli of heat and touch, which piglets recognize immediately after birth.

5. The blood thickens, becoming less dilute and stimulating thirst. Changes of hormone levels in the blood stimulate a wide variety of behavioral changes, including hens' and sows' attempts to build nests before producing young.

6. (a) Nose.
   (b) Eyes.

7. In the case of pigs entering a slaughterhouse.

8. A ewe—a female sheep.

9. Auditory stimulus.

10. Smell and vision.

11. Birds have more acute eyesight than humans because of the structure of their eyes. They have a wider angle of sight—360 degrees. Unlike humans, they are able to perceive ultraviolet light and perceive color in a way different from that of humans.

12. ***Habituation:*** Panic response of calves to the opening of an umbrella decreases with continued presentation of the stimulus.

    Classical conditioning: Sheep learn to specifically identify the farmer's truck as a food source.

    Trial-and-error learning: Hens succeed in reaching a nest box by completing the tasks in an obstacle course; pigs with collars learn to use food dispensers.

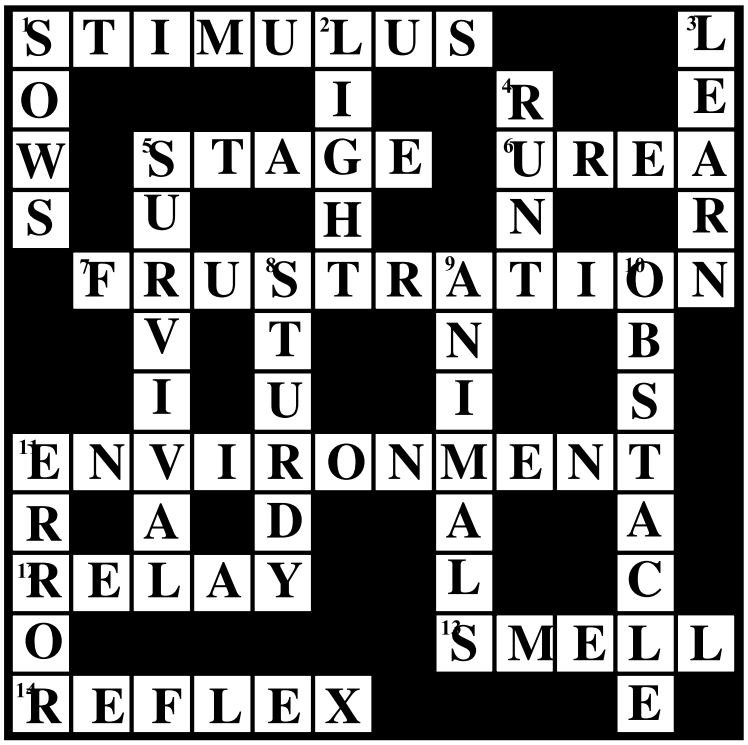
    Observational learning: Lambs learn what to eat by watching their mothers and will use this knowledge later; chickens learn from watching a video which color of container contains food.

13. Muscles, sweat glands, hormonal glands, color-sensitive cells (cichlids, chameleon).

14. "Toys," such as ropes and tires, were provided.

15. Zoo animals pacing from side to side on one spot; feather plucking in caged parrots.

Crossword



Primary senses

Visual	owl monkey pigeon
Auditory	bat rabbit
Olfactory	mole dog shark
Gustatory	snake
Tactile	worm

Examples of phenomena and processes of everyday life

Process	Animal example	Human example
1	e	h
2	c	j
3	a	f
4	b	i
5	d	g

The five steps from a stimulus to response

(Complete the missing terms)

Receptor—Coordination—Effector

References

Below are the references for the detailed accounts of the research referred to in this guide, plus a few other helpful articles.

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