1

Introduction: Learning to Change

Chapter Outline

Preview

The Constancy of Change

Natural Selection

Evolved Behavior

*Reflexes*

*Modal Action Patterns*

*General Behavior Traits*

Limits of Natural Selection

Learning: Evolved Modifiability

Learning Means Change

What Changes is Behavior

What Changes Behavior is Experience

Habituation: An Example of Learning

Nature vs. Nurture

A Final Word

Recommended Reading

Review Questions

Practice Quiz

Query Answers

Main Points

Change is the only constant. Organisms cope with change through evolution and learning. Evolution depends on variation and natural selection. Natural selection has produced reflexes, modal action patterns, and general behavior traits that help species adapt to their environments. Natural selection is slow, since it necessarily takes place over generations, and is of no value to the individual in coping with change. (E.g., if the climate turns suddenly colder, natural selection will not come to the individual’s rescue, though it may save the species.) Learning, defined here as a change in behavior due to experience, resembles natural selection in that it is a mechanism for adapting to change. Learning is more rapid than natural selection and helps the individual to survive. The nature-nurture debate wrongly implies a choice whereas in fact the two are inextricably intertwined, like the fibers of a rope; it is never entirely clear where one leaves off and the other begins.

Class Notes

The constancy of change: Most of us think of changes in our environments as exceptional events, so when learning is described as a means of coping with change it may seem rather unimportant to some students. It is for this reason that the chapter begins by proposing that our environments are *constantly* changing. It may be useful to draw attention to the Lucretius quote, and to lead a discussion of what it means to say that change is the only constant. In the discussion, you might ask, “Is it truly the *only* constant?” “Can you name another constant?” “Is the constant [named by a student] truly unchanging?”

Some students may fail to see the significance of the March 11, 2011 earthquake in Japan. Severe earthquakes, even in Japan, are rare events. My point was to bring home to the student the idea that even the most stable parts of our environment, such as the soil on which we stand, are subject to change. We are all standing on tectonic plates, and those plates are constantly moving. (On average plates move at the rate at which fingernails grow, so we are generally unaware of them.)

Incidentally, I happened to be in Tokyo a few days after the Great East Japan Earthquake. Aftershocks were still common, and there was a serious threat of nuclear radiation. I spoke with Keiko (not her real name), and felt that her story would provide a memorable example of the constancy of change.

Natural selection: This edition of L&B includes a brief sketch of Darwin and a summary of his voyage as naturalist on HMS *Beagle*. One reason for including this is to personalize Darwin. This is also why I include a painting of him as a young; the image should make him easier for students to identify with.

The idea that evolution does not imply an intelligent agent will be difficult for some students to grasp. Richard Dawkins, in *The Blind Watchmaker*, deals with this problem nicely, and sections of his book might be read in class or assigned. His analogy of the segregation of stones on a beach shows how complex ends can be achieved through simple natural forces. Of course, the student may answer (as Newton did long ago) that God established the forces in the first place. The point is that we can account for natural phenomena (including evolution and learning) in a scientific way.

Although religion is a sensitive issue, it may be worth making the point that belief in evolution is not necessarily incompatible with belief in God. Many American students assume that to accept evolution, you have to be an atheist. But while most scientists, including biologists and behavior scientists, probably are not religious fundamentalists, many do believe in God.

Exercise: Nature’s Sieve

Instructors who enjoy photography might want to produce slides of beach stones as they are segregated by size by the action of the waves. (Photos might be taken at, say, 24-hour intervals.) These might then be shown to the class to illustrate order arising out of an unintelligent process, just as is the case with natural selection.

The Trut article on the fox farm study cited in a marginal note on p.5 of the text is available online at <http://www.terrierman.com/russianfoxfarmstudy.pdf>.The Goldman article is available at *Scientific American’s* blog cite (www.blogs.scientificamerican.com).This is fascinating research and illustrates how breeding imitates natural selection. There are videos illustrating the changes in behavior produced by the Russian breeding program. Some are available on YouTube.com; one example is *Evolution in Action: The Silver Fox Experiment*.

Some instructors may think I have devoted too much space to Darwin and natural selection, but I believe it is helpful in moving students toward the natural science approach to behavior. I suspect it is particularly helpful in getting students to understand operant learning, since it is clearly analogous to natural selection.

Evolved behavior. Students tend to think of evolution as involving physical characteristics; one point of including this discussion is to show that behavior is also partly the product of evolution. It is also important for students to have a basic understanding of reflexes since reflex responses are the behaviors that are modified by habituation and classical conditioning.

Because modal action patterns are sometimes very complex, students may have a hard time believing that the behavior is not learned. Dawkins’ beach stones may be useful again here.

It probably bears repeating that what I have called general behavior traits are behavioral tendencies, not specific acts. They include the dispositions that people have in mind when they speak of temperament, and it is clear that to some extent these dispositions — aggressiveness, fearfulness, activity level, and so on — are largely products of heredity.

The first query appears in this section (p.12), and it may be worthwhile to spend a moment on it to encourage students to make use of the queries as they read. This will also be encouraged by using some query items in quizzes and exams.

Limits of natural selection. Lee Cronk’s article, *Old Dogs, Old Tricks*, is a wonderfully readable discussion of how evolved behavior can fail to meet the needs of current environments. Students should be encouraged to read it, and instructors may want to read parts of it aloud in class.

You might point out to your class that Darwin`s development of the concept of natural selection as the source of species was itself the product of a kind of slow evolution.

It is hard for some students to believe that mutations can play a role in evolution. You might want to emphasize that the vast majority of mutations are harmful or of no consequence. It is also helpful to remind students that evolution is a play in which a single act may last millions of years.

Robert T. Fancher (1992), in a letter to *The Sciences*, writes that “evolution is grossly inefficient: as long as organisms survive and propagate, evolution does not make much difference in what else happens” (p.4). This is a good point. Natural selection selects one characteristic over another only if one leads to an increased tendency to produce offspring that survive.

This section includes a number of new studies and examples to illustrate how slow natural selection typically is. People who reject evolution often do so because they fail to appreciate the gradualness of the process. Human eyes, brains, and behavioral tendencies took millions of years to develop.

In discussing evolution, I say nothing about “punctuated equilibrium,” the idea that evolutionary change may occur in fits and starts: i.e., sometimes rapidly and sometimes slowly. It might be worth mentioning this in classes since learning often follows a similar pattern, with behavior sometimes changing rapidly, sometimes slowly.

Learning: evolved modifiability. I refer to learning as evolved modifiability to underline the point that learning is itself a biological mechanism that is the result of natural selection. Along with reflexes, fixed action patterns, and general behavior traits, animals have evolved a special mechanism for coping with change: learning.

It is one thing to speak of learning as animal training or the acquisition of academic skills in the classroom. It is quite another to suggest, as the text does, that what we are as a species and who we are as individuals is largely the product of learning. This is a disturbing idea for some students. The idea that experience shapes behavior also wreaks havoc with *traditional* notions of responsibility, guilt, and innocence. These issues must be treated with sensitivity. Students should be shown that this new approach to behavior actually increases autonomy and holds the promise of improving our effectiveness.

Habituation: an example of learning. This discussion is meant to provide a soft introduction to the scientific approach to learning. It features a focus on changes in behavior due to experience.

Some students might argue that since habituation occurs as a result of the *repetition* of an event, this means that learning is not due to changes in the environment. But the repetition of an event is a change in the environment; i.e., the environment goes from one in which an event, such as a sound, is uncommon to one in which it is common.

Nature vs. nurture. Students often glibly acknowledge that both heredity and environment influence behavior, but I suspect that many of them do not truly get the inseparability of the two factors. I tried to illustrate this with Figure 1-7.

Education provides ample evidence of the interaction of nature and nurture. Some research in education (that of the late Benjamin Bloom, for instance) has shown that when students identified as fast and slow learners begin a lesson with similar competence on prerequisite skills, their learning rates become similar.

A final word. This section of each chapter is a kind of editorial, an unusual feature of texts. In some instances, students (and some instructors) may feel I am stepping out of bounds by trying to impose my views on students. In this chapter, for example, I raise the threat of climate change. I defend my position by pointing out that climate change is an example of environmental change that is bound to change our behavior, and is therefore directly related to the subject of learning. Throughout the text I try to convey that learning isvitally important to human survival and progress. In the Final Word sections I try to do this in a broader context.

Exercise: Photographing Change

One way of getting students to appreciate the pervasiveness of change is to show the students an old photograph of someone they know and ask them if they recognize the person. (A childhood photograph of yourself should work nicely, but you could use a figure from politics or entertainment.) You might show a series of photos, each one taken several years after the last. Once the students have guessed the answer, ask them to identify in what ways their own appearance has changed in the past 24 hours. The discussion should help the students begin to appreciate the fact that changes are taking place constantly, and we are constantly adapting to them.

Exercise: Exit Quiz

I don’t know who deserves credit for this idea, but I have used it with very satisfactory results: Five minutes before the end of class, take a position by the door and explain that you will ask each student a question on the day’s lesson. To leave the room, the student must answer the question correctly. Ask basic questions that can be answered in a few words (e.g., What is learning? What does MAP stand for? What are the two essential elements of evolution?). If a student answers incorrectly, send him to the end of the line, and then ask the next student the same question. If you ask no more than half a dozen different questions, students waiting in line will listen to the answers and learn from the experience. Most students seem to enjoy the activity, and if you start five minutes before class period ends, they are not delayed in getting to their next class.

Recommended Reading

Although the recommended reading throughout the text includes many classic works, I have tried to include items that students might actually read. That means items that are short, easy for undergraduates to understand, and perhaps a bit entertaining. Examples in this chapter include the article by Angier on the difficulty a student had in defining the meaning of the word biologist, and Heligman’s book on Charles and Emma Darwin and their differences over religion.

To draw attention to the recommended readings, I have included questions about them in the test bank.

Key to Review Questions

Note: Review questions are intended partly to help students digest the material in the chapter, and partly to prompt them to think critically about what they have read. Some instructors require students to provide written answers to review questions, some assign a few questions, but probably most use selected questions as a way of initiating class discussions. Some of these questions are very difficult; some, in fact, do not have satisfactory answers. Some instructors believe it is a mistake to ask students questions they cannot answer, but we cannot expect students to believe that a field is challenging if we ask them only easily answered questions.

1. Define the following terms. Give an example or illustration of each that is not taken from the text.

Behavior: Anything an organism does that can be measured. This definition does not exclude thinking and feeling, but in practice the term usually refers to publicly observable behavior.

General behavior trait: Any general behavioral tendency that is strongly influenced by genes. Examples include introversion and general anxiety. GBTs are more variable than FAPs and are not dependent on a releasing stimulus.

Habituation: A decrease in the intensity or probability of a reflex response resulting from repeated exposure to a stimulus that elicits that response.

Hybridization: The cross-breeding of closely related species. This is a way in which species can adapt to changes in their environments.

Learning: A change in behavior due to experience. Some instructors like to say that learning is a “relatively enduring change” in behavior. I do not favor this modification because there is no consensus about what enduring means. Other instructors like to say that learning is due to “certain kinds of experience.” While this is true, it doesn’t seem to add much unless you specify the kinds of experience, in which case the definition becomes unwieldy. Other instructors like to say that learning is a change in the *potential* for behavior, but since we can measure potential only by measuring changes in behavior, this modification seems meaningless.

Modal action pattern: Any largely inherited series of interrelated acts, usually elicited by a particular stimulus (the releaser); formerly called instinct.

Mutation: Any change in a gene. When the mutation occurs in a reproductive cell, the mutation may be passed on to offspring. The term *mutation* may have a negative connotation for students (film monsters are sometimes mutants), but from the standpoint of science *mutation* is a neutral term.

Natural selection: The tendency for characteristics that contribute to the survival of a species to persist, and for those that do not to disappear.

Reflex: A relationship between a specific event and a simple response to that event. It may be worth emphasizing that the term *reflex* refers to the relationship, not to the response, per se. The patellar reflex is not the knee jerk itself, but the relation between the blow to the patellar tendon and the movement of the foot.

Releaser: Any event that reliably elicits a fixed action pattern. The light from which the cockroach runs is a releaser.

Stimulus: Any environmental event that affects, or is capable of affecting, behavior. One could argue that an event is not truly a stimulus until it affects behavior.

2. Are humans still evolving? How could you prove that they are or are not?

*Some students think of evolution as a process that took place in the past, and we and other creatures are its finished products. They need to understand that so long as environments change, evolution will continue. Proving that humans are still evolving requires identifying changes in response to environmental change. As a practical matter, proving that we are still evolving may be impossible, since evolution occurs over generations.*

3. Why has the field mouse not evolved into an animal as large and ferocious as the grizzly bear?

*The first thing that might be said is that perhaps it has! A mouse the size of a grizzly bear might once have evolved and then died out, replaced by today’s diminutive creature. The point is that evolution does not require getting bigger and stronger; it requires surviving long enough to produce offspring that will survive. Whatever contributes to the survival of the species, whether it be bigness and ferocity or smallness and timidity, will persist. If the field mouse has not evolved into a large, ferocious animal, it is because being a small, timid animal works.*

4. In what sense is natural selection the product of experience?

*Experience refers to changes in environment, and it is the environment that selects characteristics.*

5. In what sense is learning the product of natural selection?

*Learning ability is the product of natural selection. Therefore it can be said that learning is indirectly the product of natural selection.*

6. Invent a new reflex that would be helpful to humans.

*The point of this question is to help students appreciate that evolution is a very effective mechanism: It is very difficult to think of useful reflexes that humans do not already have. An example might be gagging induced by eating food contaminated by botulism. People happily eat contaminated food, and the body does not react in a timely fashion. A gagging response to botulin-contaminated food could save lives. Another lifesaving reflex might be awakening from exposure to smoke. Many people die during their sleep as the result of smoke inhalation during house fires. If smoke caused people to awaken, fewer would die.*

*In discussing proposed reflexes, it might be useful to ask why they have not evolved. Part of the answer lies with the fact that evolution is not an intelligent process in which the environment decides what a species needs and then builds that characteristic. Another part of the answer may have to do with the proposed reflex involving low incidence events. It would certainly be useful to have a gagging reflex in response to botulin-contaminated food, but since botulism is relatively rare and since most people affected survive, the proposed reflex would have limited survival value for the species. In other words, if we designed a couple with the gagging reflex, their offspring might not be significantly more likely to reproduce and rear young than other children.*

7. Why is natural selection “behind the times?” Is learning behind the times?

*The evolution of a useful feature typically requires many generations, but the environment can change dramatically within a single generation. Although learning is much more rapid than evolution, learning is a response to past experiences; future changes in environment may make what we have learned, even recently, inappropriate.*

8. How are reflexes, modal action patterns, and general behavior traits alike? How do they differ?

*All are, in general, less variable and more dependent on genes than other forms of behavior. They differ chiefly in the degree to which they vary and in the degree to which they can be modified by experience. Reflexes are less variable and generally less malleable than general behavior traits, with fixed action patterns falling between the two.*

9. Learning is a mechanism for adapting to change. Are the changes ever *non-*adaptive?

*Learning is an adaptive mechanism, but it is not perfect. There are many instances in which learning is not only non-adaptive, but maladaptive. Among people, most superstitions, phobias, and prejudices have limited adaptive value, and some interfere with efficient functioning.*

10. Captive animals often behave very differently from animals in the wild. In which circumstance is their true nature revealed? Where should one look to see true human nature?

*This is another of those questions that keep philosophers awake at night. There is probably no right answer, and the point of asking the question is to encourage students to wrestle with the nature-nurture problem, for that is what the question is really about.*

*Many ethologists assume that one sees true animal nature only in the wild, in the organism’s “natural” habitat. Some anthropologists argue that we see true human nature only in pre-industrialized societies, our species’ “natural” habitat. But while the behavior of lions in zoos is in many respects different from the behavior of lions in African savannas, both are lions. Similarly, the behavior of humans in cities is often different from that of humans in tribal villages, but we are talking about people in both situations. We cannot arbitrarily say, “We will accept the behavior of this organism in situation X as representative of the species, but we reject the behavior of this organism in situation Y.” What situations X and Y reveal is not natural behavior and unnatural behavior, but the powerful effects of environment on behavior.*

Key to Practice Quiz

1. Learning is a change in behavior due to experience.

2. The human fondness for sugar and salt/sex illustrates that behavior that has survival value at one time may be harmful at another time.

3. The sight of a chick with an open mouth reliably results in an adult bird providing food. The chick’s open mouth is an example of a releaser.

4. Evolution is the product of variation and natural selection.

5. A reflex is a relation between a specific event/stimulus and a simple response.

6. One example of a general behavior trait is shy/outgoing/aggressive/passive/adventurous/cautious, etc.

7. Habituation is a reduction in the intensity or probability of a response due to repeated exposure to a stimulus that elicits that response.

8. Learning can be thought of as evolved modifiability.

9. The chief limitation of natural selection as a mechanism for coping with change is that it is slow.

10. Darwin likened natural selection to the breeding of animals.

**Note**: The quiz that follows is set off so that you can photocopy it and use it in class. A key follows. A quiz for each chapter of the text appears in this IM.

**Chapter 1 Quiz: Learning to Change**

1. Learning is a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ due to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

2. Modal action patterns are elicited or induced by events called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

3. Evolution is the product of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

4.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ said, “Change is the only constant.”

5. Repeated exposure to a stimulus that evokes a reflex response results in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

6. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ may be thought of as evolved modifiability.

7. The first “eyes” were not eyes as we know them, but \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

8. Behavior is anything an animal or person does that can be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

9. Instincts are now often called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

10. The author of your text believes that learning is an evolved mechanism for coping with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**Key to Chapter 1 Quiz**

1. Learning is a change in behavior due to experience.

2. Fixed action patterns are elicited or induced by events called releasers.

3. Evolution is the product of variation and natural selection.

4. Lucretius said, “Change is the only constant.”

5. Repeated exposure to a stimulus that evokes a reflex response results in habituation.

6. Learning may be thought of as evolved modifiability.

7. The first “eyes” were not eyes as we know them, but light-sensitive cells.

8. Behavior is anything an animal or person does that can be measured.

9. Instincts are now often called modal (or fixed) action patterns.

10. The author of your text believes that learning is an evolved mechanism for coping with change/a changing environment.