third edition

Learning and Behavior

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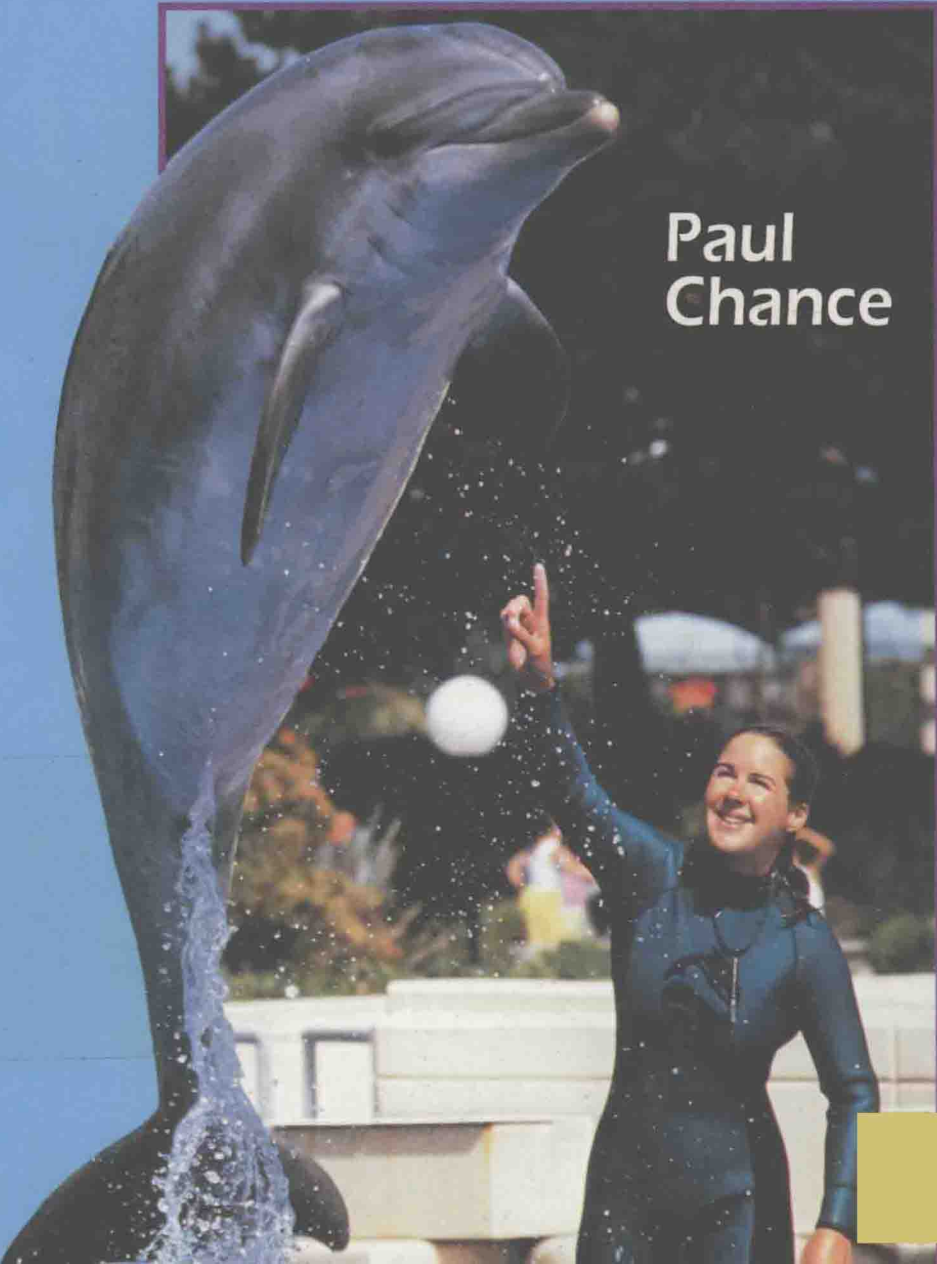

Preface

THIS THIRD EDITION OF *LEARNING AND BEHAVIOR* IS ALMOST AS DIFFERENT from the second as the second was from the first. One obvious difference is that there are now 12 chapters rather than 10. Three chapters have been added: one each on the application of Pavlovian and operant learning, and one on aversive control. The chapter on thinking is gone, but most of the material covered in it has been incorporated into other chapters.

Most chapters have been heavily revised. Chapter Two's discussion of research design has been expanded and now includes material on anecdotal and case study methods. The discussion on the use of animals in behavioral research has also been enlarged. Extinction, previously discussed in conjunction with forgetting, is covered in the chapter on reinforcement schedules. Forgetting is now a chapter unto itself and includes a section on improving recall. (Instructors may want to encourage students to read the latter section early on so that they can apply it throughout the course.)

The chapter on observational learning is somewhat shorter than in the second edition, due primarily to the deletion of material on vicarious Pavlovian learning. This topic is problematic because it is extremely difficult to distinguish between vicarious Pavlovian conditioning and ordinary Pavlovian conditioning.

The new chapter on aversive control includes a discussion of noncontingent aversives, followed by negative reinforcement and punishment. Considerable space is devoted to problems associated with aversive control and to its alternatives, including response prevention and functional communication training. I believe the latter may be the most promising alternative to aversives yet developed.

Each chapter of the new edition begins with one or two quotations. These are meant to set the stage for what is to come in the chapter. Presumably, the students will have a different understanding of the quotations after reading the chapter than they had before. The quotations might also be useful as a springboard for class discussion or as the basis for essay exam questions.

The third edition includes questions that appear throughout the text. Most of these queries ask simple, straightforward questions about the material just read. The idea is for the student to read the query, attempt to answer it without looking at the preceding text, and then turn to the end of the chapter and read the answer given there. It is hoped that this activity will not only help the student assess his or her progress, but add to the reinforcers for reading the text.

The queries are fairly straightforward; the chapter review questions are another matter. Many of the latter are quite challenging (some students would say annoying) and require considerable thought. The questions ask the students to apply what they have learned by, for example, designing an experiment, setting up a treatment program, or providing an example that does not come from the text. I believe that grappling with such questions can help students master principles. In any case, the questions have proved useful in stimulating discussion. In hopes of increasing their usefulness, I have provided guidelines concerning points that might be made in answering them in an instructor's guide. (The guide also includes test items for each chapter, text commentaries, and other material.)

Several things about the text remain essentially unchanged. The theme that learning is a biologically evolved mechanism for coping with an ever-changing environment runs through every chapter, if not every paragraph. The book continues to supplement research studies with "real-world" examples and applications. (The working assumption is that laboratory research has a lasting impact on the typical student only if it is shown to have some relevance outside of the laboratory.) As in the past, I have tried to write in a style that is simple, clear, and engaging without trivializing the material. To avoid giving students the impression that learning is something only rats and pigeons do, I have included many studies and examples involving humans. And humorous remarks (such as the one in the previous sentence) continue to appear here and there, intended not so much to enlighten the reader as to reinforce the act of reading.

Although this text is longer than the previous edition, the difference has less to do with additional concepts than with additional examples and illustrations meant to increase understanding. The text makes no attempt to be encyclopedic. It is not meant to expose students to the vast variety of topics in learning research, but to help them master the fundamental principles of learning.

This notion of what an introductory science text should do has gained some support in recent years. The American Association for the Advancement of Science (1989), in its report, *Science for All Americans*, argues that what is needed to improve science instruction is not more course content, but less. Students, the report argues, need to embroil themselves in a relatively small number of concepts and skills for a prolonged period, rather than memorize long lists of terms, facts, and figures. Others are hearkening to this message (for example, Dempster, 1993). Whether the AAAS philosophy is sound is subject to debate; instructors should know, however, that it is the philosophy upon which this text is based.

As in the past, I had a good deal of help in preparing this edition. Nothing is so useful to a textbook author as honest criticism. I therefore offer my sincere thanks to Carl D. Cheney, Utah State University; R. H. Defran, San Diego State University; William E. Gibson, Northern Arizona University; Robert J. Grissom, San Francisco State University; Charles O. Hopkins, University of Illinois at Urbana-Champaign; Mike Knight, University of Central Oklahoma; John Lutz, East Carolina University; Brady Phelps, Utah State University; David Paul Ribbe, Medical University of South Carolina; Ronald R. Ulm, Salisbury State University; and Jerry Venn, Mary Baldwin College. I must single out Carl Cheney and Jerry Venn for special thanks. They not only put this and previous editions under their microscopes, but offered constant support for my efforts. They have been good friends and colleagues.

The first two editions of *Learning and Behavior* were published under the Wadsworth imprint. During the preparation of the present edition, Wadsworth Publishing Company made certain organizational changes. One of these was a decision to place all psychology texts with Brooks/Cole, a part of the parent company. I am grateful to Ken King and others at Wadsworth for making this transition smooth and painless. I also want to thank my new friends at Brooks/Cole, including Carline Haga; Laurel Jackson; Marianne Taflinger; and manuscript editor Joanne Tenenbaum. I especially want to thank Marianne Taflinger for helpful advice and criticism and Laurel Jackson for guiding the book through production.

If the book pleases, much of the credit goes to those just mentioned and to those who have used earlier editions and offered feedback. If the book disappoints in one way or another, the complaints belong on my doorstep.

Either way, I hope you will give me the benefit of your reaction. Feedback from instructors is very helpful in revising a text, and I hope you will let me know how the book might be improved. You can write to me in care of Brooks/Cole or via e-mail. My Compuserve address is 72134,1263. If you are on BITNET, use INTERNET:72134.1263@CompuServe.Com. I look forward to hearing from you.

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Note to the Student

Before you begin reading the text, please consider the following points:

Queries. The queries that appear here and there in the text are meant to assist you in learning about learning. Most of them ask you to recall something you have just read. To get the most out of the queries, attempt to answer each one when you encounter it—without rereading the preceding section. Write down your answer on a scrap of paper, and then immediately compare your answer with the answer at the end of the chapter. (The reasons for this procedure should become clear when you read Chapter Five.) If your answer is incorrect, reread the section involved. Once you have finished a chapter, you may use the queries in reviewing. However, keep in mind that the queries touch on only a few topics in each chapter.

Review questions. The questions that appear at the end of each chapter are meant to help you review the chapter content. Many of these questions require something more than merely recalling points made in the chapter; they require you to use principles in the chapter (and perhaps in previous chapters) to solve new problems. Wrestling with the review questions should help you understand the chapter content better.

Both the queries and review questions should prove useful in preparing for exams, particularly if you compare your answers with those of other students. Ask your instructor about questions that you and your classmates are unable to answer satisfactorily.

Learning to remember. Chapter Eleven, "Forgetting," contains a section on learning to remember. This material includes practical advice, derived from research on learning and forgetting, that should improve your ability to recall the content of this text. *Do not read this* *material until directed to do so by your instructor.* Reading this material before it is assigned could give you an unfair advantage over students who do not read it. And you wouldn't want that to happen.

Feedback. Please let me know what you think of this text. There is a reply card enclosed for that purpose, or if the reply card is missing, you can write to me in care of Brooks/Cole, 511 Forest Lodge Road, Pacific Grove, CA 93950-5098. You can also reach me through e-mail at Compuserve; my address is 72134,1263. If you enclose a return address, I will try to reply to your remarks. I am not fishing for compliments, and I hope you will not hesitate to tell me of improvements you think need to be made. Your comments (positive or negative) will be appreciated and will be used when preparing the next edition of *Learning and Behavior.*

You are about to begin studying what I believe is the most fascinating and important subject in the behavioral sciences. Very likely your instructor feels the same way. I hope some of our enthusiasm for learning and behavior will rub off on you.

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Introduction: Nature, Nurture, and Behavior

Blood will tell.
—AUTHOR UNKNOWN

Just as the twig is bent, so the tree's inclin'd.
—ALEXANDER POPE

BACKGROUND

Change, said the Roman philosopher Lucretius 2,000 years ago, is the only constant. Yet we tend to regard change as an aberration, a brief disruption in a normally constant world. When a great volcano such as Mount Saint Helens in Washington erupts, as it did in 1980, knocking over thousands of trees and covering the earth for miles around with a blanket of volcanic ash, we think how strange it is that nature should misbehave so. It is, we tell ourselves, a momentary lapse, a kind of geological tantrum; soon our old planet will regain its composure, its sameness.

But the truth is that only our short tenure on earth deludes us into seeing sameness. In the course of an individual human's lifetime, volcanic eruptions, earthquakes, and the like are rare, but in the life of the earth, they are the very stuff of existence. Our time here is too brief to see continents crash together and tear apart, mountains rise and fall, vast deserts replace oceans; too brief to see thousands of animal and plant species come and go, like the ever-changing, varicolored crystalline shapes of a kaleidoscope.

Change is not the exception to the rule, then, but the rule itself. Throughout nature, the struggle to prevail is a struggle against change: food supplies dwindle, prey animals become faster, predators become more formidable. Some changes, such as the movement of continents, take place over eons; others, such as the advance of glaciers, take thousands of years; still others, such as the rising and setting of the sun or the appearance and disappearance of hungry predators, occur daily. The one constant is change. Any individual or species must be able to cope with change if it is to survive. But how? By what mechanisms can we and other organisms deal with such a fickle world?

NATURE: ADAPTATION THROUGH EVOLUTION

One mechanism for coping with change is evolution. In *On the Origin of Species*, published in 1859, the English naturalist Charles Darwin proposed that species arise through the process of natural selection. There is, he argued, tremendous variation among the members of any species. Some of these variations are relevant to features in the environment; others are not. Relevant features may be either beneficial to the species or harmful. Not only are individuals with favorable variations more likely to survive, and hence to reproduce, but their offspring are more likely to show this helpful variation. Characteristics that contribute to survival are selected by the environment, so future generations will increasingly display these characteristics. Evolution is therefore the inevitable product of variation and natural selection.

Query: *Why is variation important in evolution?*[1]

Although Darwin did not understand the genetic basis for variation (the work of Gregor Mendel was not then widely known), he knew from direct observation that variation among the members of a species was common. He also knew that selective breeding of farm animals with a specific variation often resulted in offspring that resembled their parents in that characteristic. And he knew that selective breeding of individuals with a given characteristic would, over several generations, result in a high proportion of animals with that characteristic.

Darwin went beyond the animal breeders, however, by proposing that this same sort of selection process takes place throughout nature.

[1] Try answering each query as it appears, and immediately check the answers at the end of the chapter.

A characteristic such as the thickness of a mammal's fur varies widely among the members of the species. If the climate turns gradually colder, individuals with thicker coats will have an advantage over those with thinner coats, so they will live longer and produce more thick-coated offspring. With each succeeding generation, there will be proportionally more animals with thick coats.

Darwin's theory does not require the involvement of any intelligent agent; we need not, for example, imagine God as animal husbandry expert. The slow-witted and the slow afoot are culled by natural predators. Those that are not suited to a change in climate, a change in the food supply, a change in predators, perish. The environment selects desirable characteristics, and selects out undesirable characteristics.

It is often difficult for people to see how natural selection could produce the complex systems we call plants and animals. Richard Dawkins (1986), in a book called *The Blind Watchmaker*, offers this analogy:

> If you walk up and down a pebbly beach, you will notice that the pebbles are not arranged at random. The smaller pebbles typically tend to be found in segregated zones running along the length of the beach, the larger ones in different zones or stripes. The pebbles have been sorted, arranged, selected. (p. 43)

What has sorted, arranged, and selected the stones, Dawkins notes, is the mechanical, unthinking force of the waves. Big stones are affected differently by the waves than small stones, so they end up in different places. Order has evolved from disorder as the inevitable product of natural forces.

Another analogy is the sieve. If you pour gravel into a sieve, the finer material will pass through while the larger material will not. The sieve selects objects of a certain size, and selects out objects of a different size. The characteristics selected depend upon the characteristics of the sieve, yet we do not attribute intelligence to the sieve.

Research on *Biston betularia*, one of the many large moths found on the British Isles, illustrates natural selection nicely. *Betularia* feeds at night and rests during the day on the trunks and limbs of trees. Its survival depends in large part on its ability to escape detection by the birds that find it an appetizing food. Several decades ago, nearly all *betularia* were a mottled light gray color, closely resembling the lichen-covered trees on which they rested. A rare black variation of the moth stood out against this background like coal against snow. But when pollutants in certain industrial areas killed the lichen and darkened the bark, the light-colored moths increasingly fell prey to birds, while the dark moths tended to survive and reproduce. An examination of *betularia* collections reveals that in forests near industrial centers, where pollution is common, the black *betularia* has increased and the light-colored variety has declined. In some areas, 90% of the *betularia* are of the once-rare black variety (Kettlewell, 1959).

It is possible that the same sort of process that affected the coloration of *betularia* has affected the skin color of humans living in very different climates. A natural substance in the skin, melanin, screens out the sun's rays. The more melanin, the darker the skin, and the more sunlight is screened out. The people of Scandinavia and Northern Europe, where there is relatively little sunlight, are characteristically fair-skinned, which allows them to absorb the sunlight needed to produce vitamin D. People who live near the equator, where there is an abundance of sunlight, are characteristically dark-skinned, which provides them with protection against the hazards of too much sun. Like *betularia*, the human species takes on the coloration that survival in a given environment requires.

Genetic variation and natural selection account for most of the differences within a species from one geographic region to another and from one time to another. However, genetic diversity is also affected by abrupt changes in the genes. These **mutations,**[2] as they are called, can occur in any of the body's cells and are sometimes the cause of life-threatening diseases. If a mutation occurs in the genes of reproductive cells (sperm or ova), the mutation will be passed along to the next generation.

Offspring with mutated genes may or may not display a new characteristic, just as a person who carries the gene for blue eyes may or may not have blue eyes. But the mutated gene will be passed on, unseen or not, to future generations.

Most mutations produce changes that are not helpful to survival. Many of these changes are simply of no consequence. People who have alligator green or navy blue eyes as a result of a mutation may experience some ostracism (or, given the fickleness of fashion, increased popularity) but their chances of surviving and reproducing are not likely to be strongly affected. Other mutations put the individual at risk. Gene mutations can result in two-headed snakes, for example. Since two heads are not, in fact, better than one, such animals seldom live long enough to reproduce their kind. Thus, harmful mutations are selected out.

On very rare occasions, mutations result in adaptive changes. A mutation might, for instance, provide an animal with a horn that proves useful in defense. Or it might provide resistance against certain diseases. When mutations are useful, they can mean rapid changes in the defining characteristics of a species because the offspring of individuals carrying the useful gene will be more likely to survive and reproduce.

[2] Glossary terms appear in boldface when introduced.