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Chapter 2
Developing and Evaluating Theories of Behavior

Questions to Ponder

1. What is the definition of a theory?
2. How does a theory differ from a hypothesis, a law, and a model?
3. What is a computer model, and what are the advantages of designing one?
4. How do mechanistic and functional theories differ? Which type is better, and why?
5. What are the defining characteristics of quantitative and qualitative theories?
6. What is a descriptive theory?
7. What is an analogical theory?
8. What is a fundamental theory?
9. How do descriptive, analogical, and fundamental theories differ? Which is preferred and why?
10. What roles do theories play in science? Describe each role in detail.
11. What are the defining characteristics of a "good" theory? Describe each characteristic in detail.
12. What is meant by confirmation and disconfirmation of a theory?
13. How are theories tested?
14. What is the difference between a confirmational and a disconfirmational strategy? How are they used to test a theory?
15. What is strong interference, and how is it used to test a theory?
16. How do theory-driven research and data-driven research differ?
17. What are the relative advantages and disadvantages of theory-driven and data-driven research?

Chapter Outline

I. What Is a Theory?
   A. Theory Versus Hypothesis
   B. Theory Versus Law
   C. Theory Versus Model
   D. Mechanistic Explanations Versus Functional Explanations

II. Classifying Theories

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A. Is the Theory Quantitative or Qualitative?
B. At What Level of Description Does the Theory Operate?
C. What Is the Theory's Domain?

III. Roles of Theory in Science
A. Understanding
B. Prediction
C. Organizing and Interpreting Research Results
D. Generating Research

IV. Characteristics of a Good Theory
A. Ability to Account for Data
B. Explanatory Relevance
C. Testability
D. Prediction of Novel Events
E. Parsimony

V. Strategies for Testing Theories
A. Following a Confirmational Strategy
B. Following a Disconfirmational Strategy
C. Using Confirmational and Disconfirmational Strategies Together
D. Using Strong Inference

VI. Theory-Driven Versus Data-Driven Research

VII. Summary

Key Terms

- Theory
- Hypothesis
- Law
- Model
- Mechanistic explanation
- Functional explanation
- Quantitative theory
- Qualitative theory
- Descriptive theory

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- Analogical theory
- Fundamental theory
- Domain
- Confirmational strategy
- Disconfirmational strategy
- Strong inference

Chapter Goals

The main goals of Chapter 2 are to explain what scientific theories are, to distinguish theories from laws and from hypotheses, to describe how theories differ, and to show students how to evaluate theories of behavior.

Students should understand that the phenomena one observes represents the superficial aspects of behavior, which, in turn, represent deeper processes. To adequately explain the processes that underlie behavior, one needs to know what those processes are, and how they interact. This deeper level of understanding is provided by theory. This chapter extensively discusses how theories fit into the research process. The student should understand what the different types of theories are, the role of theories in science, how theories are developed, what constitutes a good or bad theory, how theories are evaluated, and the relative merits of theory-driven versus data-driven research. The points emphasized in this chapter include the following:

1. Defining a theory: Students should understand what a theory is and how the scientific term differs from the more colloquial use of the term. Students should also be able to distinguish between a theory, hypothesis, and model.
2. The tentative nature of theories: Students should understand that even well-established theories can be overthrown if new evidence contradictory to the theory comes to light.
3. The fact that theories can be proven false but can never be proven true: Recently, a "creation scientist" stated that the creation theory had been proven true. The statement said more about the speaker's understanding of science than it did about the theory. Students need to be shown why theories cannot be proven true, and they need to understand why this does not weaken the force of scientific theories.
4. The different types of theory and how to distinguish them: descriptive, analogical, and what we term "fundamental" theories represent different levels of understanding. Descriptive theories merely propose a relationship without really explaining why the relationship exists; they are "surface" descriptions. Analogical theories attempt to relate the variables in the theory with known processes through analogy. Fundamental theories propose unobserved processes to explain observed relationships. The processes themselves give rise to observable effects that, if they are in fact observed, provide indirect evidence for the existence of the proposed processes.

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5. The distinction between a qualitative theory and a quantitative one
6. The roles theories play in science
7. The difference between following a confirmational versus disconfirmational strategy when testing a theory
8. The role theory plays in guiding scientific research
9. Why theories known to be inadequate often continue to be used (useful, no replacement in sight)
10. The dangers of letting theory drive research rather than the data, and vice versa, and the advantage of combining the two approaches

Ideas for Class Activities

Identifying Theories, Hypotheses, and Models

Have students find an example of a theory in psychology and summarize its major ideas and characteristics. Have them determine the following points:

1. Whether the theory is quantitative or qualitative
2. The level of description at which the theory operates
3. The scope or domain of the theory
4. How the theory differs from a hypothesis or a model

Some ideas that students can use for psychological theories are: terror management theory, equity theory, cognitive dissonance theory, attachment theory, cognitive–developmental theory (e.g., Piaget), Clark Hull's theory of learning, Maslow's hierarchical theory of personality, and Gibbon's scalar expectancy theory of reinforcement.

Are Theories Necessary?

Have students read B. F. Skinner's article "Are Theories of Learning Necessary?" (the reference appears in the back of the text), and ask them to debate the issue raised by the article in class. The instructor can note the conditions that existed at the time the article was written (failure of the Hullian theory to adequately account for all forms of learning, etc.) and use Skinner's argument to raise the question of when it is appropriate to attempt theory construction. Was Skinner too severe in his criticism? Is a science without theory really a science? What does Skinner propose to substitute in place of theory?

Strong Inference

Discuss Platt's suggestion that all we need to make progress in any science is to follow his

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program of "strong inference" or systematic elimination of rival hypotheses until only one (presumably the correct one) is left. What happens to strong inference when extraneous variables cannot be as rigorously controlled as they are in molecular biology? Is the apparent lack of progress in theoretical development within many fields of psychology due to a failure to follow Platt's methods, or might the complexity of relationships and lack of adequate control over the relevant variables have more to do with it?

Platt suggests that people tried to develop several theories to account for their data and then rigorously pitted the alternative theories against one another. Discuss the advantage of this approach over simply developing a theory and then testing its predictions.

The "competing theories" approach can be found in many studies on the "Observing Response" in the operant conditioning literature. An excellent example is:

Wilton, R. N., & Clements, R. O. (1971). The role of information in the emission of observing responses: A test of two hypotheses. *Journal of the Experimental Analysis of Behavior, 16,* 1–166.

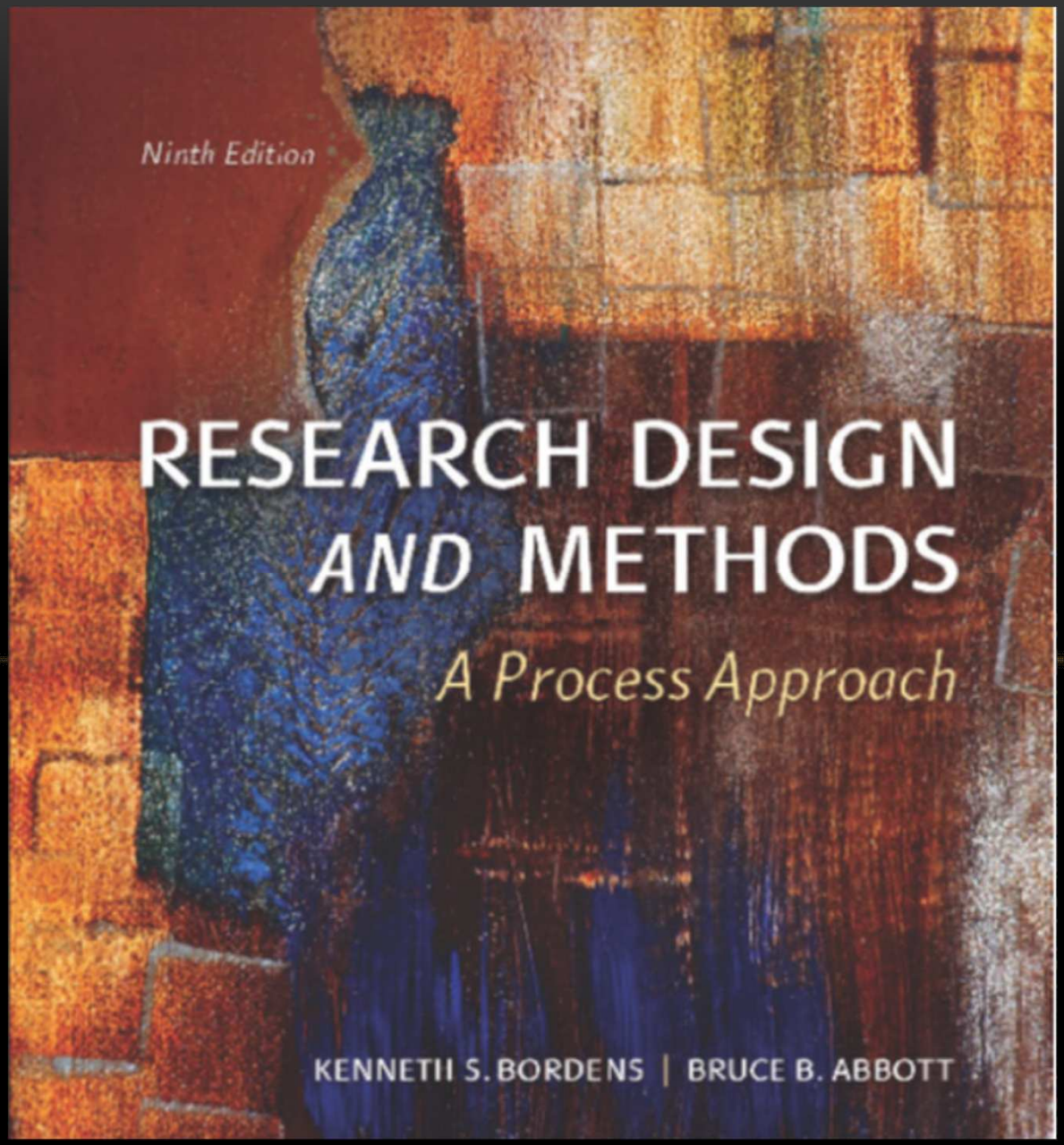
Paradigm Shift?

Kuhn (1964) suggested that scientists conduct their research under a set of implicit assumptions that constitute, in effect, a theory of the phenomena they study. This theory determines which research questions are important. When the theory is overthrown by a new view, a paradigm shift is said to occur. Under the new paradigm, new research questions become important, and many issues that were important under the old view become irrelevant.

Many now claim that American psychology is currently undergoing a paradigm shift from the purely associationistic view that predominated under behaviorism to a view that emphasizes mental processes. Discuss this "cognitive revolution" with the class. Does it represent a true paradigm shift as Kuhn would define? In what ways does the cognitive view change one's approach to conducting research?

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CHAPTER 2

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DEFINITION OF A THEORY

- In everyday language, the term *theory* is used loosely to refer to a wide range of concepts
- A **theory** is a plausible or scientifically acceptable, well-substantiated explanation of some aspect of the natural world; an organized system of accepted knowledge that applies in a variety of circumstances to explain a specific set of phenomena and predict the characteristics of as yet unobserved phenomena (U.S. Academy of Sciences, 2013)

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THEORY VERSUS RELATED CONCEPTS

- Theory versus hypothesis
  - Two concepts are often confused
  - In contrast to a theory, a **hypothesis** is:
    - Not well substantiated
    - More simple and lacks a complex set of assumptions
  - Like a theory, a hypothesis is testable
- Theory versus law
  - A **law** is an empirically verified, quantitative relationship between two or more variables

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THEORY VERSUS RELATED CONCEPTS (CONTINUED)

- Theory versus model
  - The word **model** is often used as a synonym for theory
  - A model may be a specific implementation of a general theoretical view
  - A model may represent an application of a general theory to a specific situation
  - A computer model is a set of program statements that define variables and how they change over time or trials

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LEVELS OF EXPLANATION

- **Mechanistic explanation**
  - Describes the mechanism and the chain of cause and effect through which conditions act on the mechanism to produce its behavior
  - Describes *how* something works
- **Functional explanation**
  - Describes an attribute in terms of its function
    - E.g., beauty functions to attract a mate
  - Describes *why* behavior exists
- Mechanistic explanations are preferred

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CLASSIFYING THEORIES

- ***Quantitative theory***
  - Defines the relationships between variables and constants in a set of mathematical formulas
  - Relates numerical values of variables to one another
- ***Qualitative theory***
  - States the relationships between variables in verbal rather than mathematical terms

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LEVEL OF DESCRIPTION OF A THEORY

- ***Descriptive theory***
  - Merely describes a relationship
  - Weakest form of explanation
- ***Analogical theory***
  - Explains the relationships among variables through an analogy of well-understood models
  - Can provide conceptual organization for data and predict unexpected relationships

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LEVEL OF DESCRIPTION OF A THEORY (CONTINUED)

- ***Fundamental theory***
  - Proposes a new structure to explain the relationships among variables
  - Highest level of theory
  - Uncommon in psychology

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DOMAIN OF A THEORY

- The ***domain*** (scope) of a theory is the range of situations to which the theory may be legitimately applied
  - Can be wide or narrow
  - Chances of dealing adequately with a range of phenomena are better for a small area of behavior than for a large area
  - Concepts invented to deal with one area may have no relationship to those invented to deal with others

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ROLES OF THEORY IN SCIENCE

- Understanding
  - Highest role in science
  - Theory helps you understand phenomena better
- Prediction
  - Theory provides predictions about behavior under varying circumstances
  - Predictions are tested empirically

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ROLES OF THEORY IN SCIENCE
(CONTINUED)

- Organizing and interpreting research results
  - A theory can provide a framework for understanding research
  - Research results can be interpreted based on a theory
- Generating research
  - A theory is a source for new research ideas
    - Known as the *heuristic value* of a theory
  - A theory can be wrong but can still have heuristic value

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CHARACTERISTICS OF A GOOD THEORY

- *Ability to account for data*
  - Theory must account for existing data and well-established facts within its domain
- *Explanatory relevance*
  - Theoretical explanation must offer good grounds for believing that the phenomenon would occur under specified conditions
- *Testability*
  - A theory must be testable
    - Must be capable of failing some empirical test

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CHARACTERISTICS OF A GOOD THEORY (CONTINUED)

- *Prediction of novel events*
  - A good theory should predict phenomena beyond those for which it was originally designed
- *Parsimony*
  - A theory should explain phenomena within its domain with the fewest possible assumptions

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STRATEGIES FOR TESTING THEORIES

- *Following a **confirmational strategy***
  - Look for evidence to confirm predictions from a theory
    - Important part of theory testing but it has its limitations
      - Confirmation does not prove a theory is correct
      - Confirmation may occur when predictions are too loosely defined
- *Following a **disconfirmational strategy***
  - Using a positive research result to disconfirm a theory's predictions
- The two strategies should be used together to test theories

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STRATEGIES FOR TESTING THEORIES (CONTINUED)

- *Using strong inference*
  - Theory is tested and modified based on the outcome of research and then tested again
    - Cycle of testing and modification continues until the theory adequately accounts for behavior
  - Several alternative explanations can be tested with an experiment
    - Some alternatives will be ruled out
    - New experiments should test the remaining alternatives
  - **Strong inference** works only when alternative explanations generate well-defined predictions

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THEORY-DRIVEN VERSUS DATA-DRIVEN RESEARCH

- The quest for theories of learning once drove psychological research
- Learning theories became very complex
- Researchers began to question whether the time was right for grand theories
- Some researchers (e.g., Skinner) argued for an atheoretical approach to research
  - Research should focus on functional relationships among variables

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