CENGAGE

second EMEA edition

cognitive psychology

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Johanna C. VAN HOOFF

Cognitive Psychology

2ND EMEA EDITION

E. BRUCE GOLDSTEIN AND JOHANNA C. VAN HOOFF

CENGAGE

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***Cognitive Psychology,* 2nd EMEA Edition**
US author: E. Bruce Goldstein
Adapter: Johanna C. van Hooff

Publisher: Annabel Ainscow

List Manager: Virginia Thorp

Marketing Manager: Laura Lichtensteiger

Senior Content Project Manager: Susan Povey

Manufacturing Manager: Eyvett Davis

Typesetter: KnowledgeWorks Global Ltd.

Cover Design: Jonathan Bargus Ltd

Cover Image(s): DrAfter123/Getty Images
sensationaldesign/istock

WCN: 02-300

British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library.

ISBN: 978-1-4737-7435-3

Cengage Learning, EMEA
Cheriton House, North Way
Andover, Hampshire, SP10 5BE
United Kingdom

Printed in China by RR Donnelley
Print Number: 01 Print Year: 2020

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CogLab experiments

Numbers in parentheses refer to the experiment numbers in CogLab 5.0. The first experiments in each chapter are "primary experiments." These experiments are directly or closely related to discussion in the text. Asterisks (*) indicate "related experiments." These experiments are relevant to the topic of the chapter but are not directly related to the discussion in the text.

CHAPTER 1

Simple Detection (2) A simple reaction time task that measures how fast you react to the appearance of a dot.

CHAPTER 2

Brain Asymmetry (15)* How speed of processing for shapes and words may be different in the left and right hemispheres.

CHAPTER 3

Apparent Motion (3) Determining how fast two dots have to be flashed, one after the other, to achieve an illusion of movement.

Statistical Learning (49) How learning can occur in response to exposure to sequences of forms.

Signal Detection (1)* Collecting data that demonstrate the principle behind the theory of signal detection, which explains the processes behind detecting hard-to-detect stimuli.

Garner Interference: Integral Dimensions (4)* Making light/dark judgments for a square. A one-dimensional task.

Garner Interference: Separable Dimensions (5)* Making light/dark judgments for squares of different sizes. A second dimension is added.

Müller-Lyer Illusion (6)* Measuring the size of a visual illusion.

Blind Spot (14)* Mapping the blind spot in your visual field that is caused by the fact that there are no receptors where the optic nerve leaves the eye.

Metacontrast Masking (16)* How presentation of a masking stimulus can impair perception of another stimulus.

Categorical Perception: Discrimination (39)* Demonstration of categorical perception based on the ability to discriminate between sounds.

Categorical Perception: Identification (40)* Demonstration of categorical perception based on the identification of different sound categories.

CHAPTER 4

Visual Search (7) Feature search experiment. Searching for a green circle among blue lines, with different numbers of blue lines.

Change Detection (9) A task involving detecting changes in alternating scenes.

Inhibition of Return (10) How presentation of a target away from fixation can cause a slowing of responding.

Spatial Cueing (12) How cueing attention affects reaction time to the cued area. Evidence for the spotlight model of attention.

Stroop Effect (13) How reaction time to naming font colours is affected by the presence of conflicting information from words.

Attentional Blink (8)* Testing your ability to detect stimuli that are presented in rapid succession.

Simon Effect (11)* How speed and accuracy of responding is affected by the location of the response to a stimulus.

Von Restorff Effect (32)* How the distinctiveness of a stimulus can influence memory.

CHAPTER 5

Partial Report (18) The partial report condition of Sperling's iconic memory experiment.

Brown-Peterson Task (20) How memory for trigrams fades.

Irrelevant Speech Effect (23) How recall for items on a list is affected by the presence of irrelevant speech.

Memory Span (24) Measuring memory span for numbers, letters and words.

Operation Span (25) Measuring the operation-word span, a measure of working memory.

Phonological Similarity Effect (26) How recall for items on a list is affected by how similar the items sound.

Word Length Effect (27) Measurement of the word length effect.

Modality Effect (17)* How memory for the last one or two items in a list depends on whether the list is heard or read.

Position Error (21)* Memory errors when trying to remember the order of a series of letters.

Sternberg Search (22)* A method to determine how information is retrieved from short-term memory.

Von Restorff Effect (32)* How the distinctiveness of a stimulus can influence memory.

Neighbourhood Size Effect (43)* How recall in a short-term memory task is affected by the size of a word's "neighbourhood" (how many words can be created by changing a letter or phoneme).

CHAPTER 6

Serial Position (31) How memory for a list depends on an item's position on the list.

Remember-Know (36) Distinguishing between remembered items in which there is memory for learning the item and items that just seem familiar.

Implicit Learning (47) How we can learn something without being aware of the learning.

Suffix Effect (19)* How adding an irrelevant item to the end of a list affects recall for the final items on a list in a serial position experiment.

CHAPTER 7

Encoding Specificity (28) How memory is affected by conditions at both encoding and retrieval, and the relation between them

Levels of Processing (29) How memory is influenced by depth of processing.

Production Effect (30)* How memory depends on whether words are read out loud or silently.

Von Restorff Effect (32)* How the distinctiveness of a stimulus can influence memory.

CHAPTER 8

False Memory (33) How memory for words on a list sometimes occurs for words that were not presented.

Forgot It All Along (34) How it is possible to remember something and also have the experience of having previously forgotten it.

Memory Judgment (35) A test of how accurate people are at predicting their memory performance.

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Lexical Decision (42) Demonstration of the lexical decision task, which has been used to provide evidence for the concept of spreading activation.

Prototypes (48) A method for studying the effect of concepts on responding.

Absolute Identification (45)* Remembering levels that have been associated with a stimulus.

Concept Formation (46)* Investigate the properties of concepts that are learned by feedback.

CHAPTER 10

Link Word (37) A demonstration of how imagery can be used to help learn foreign vocabulary.

Mental Rotation (38) How a stimulus can be rotated in the mind to determine whether its shape matches another stimulus.

CHAPTER 11

Lexical Decision (42) Demonstration of the lexical decision task.

Word Superiority (44) Comparing speed of identifying a letter when the letter is isolated or in a word.

Categorical Perception: Discrimination (39)* Demonstration of categorical perception based on the ability to discriminate between sounds.

Categorical Perception: Identification (40)* Demonstration of categorical perception based on the identification of different sound categories.

Age of Acquisition (41)* Comparing response times of lexical decisions on a set of stimuli.

Neighbourhood Size Effect (43)* How recall in a short-term memory task is affected by the size of a word's "neighbourhood" (how many words can be created by changing a letter or phoneme).

CHAPTER 13

Decision Making (50) How decisions can be affected by the context within which the decision is made.

Risky Decisions (52) How decision making is influenced by framing effects.

Typical Reasoning (53) How the representativeness heuristic can lead to errors of judgment.

Wason Selection (54) Two versions of the Wason four-card problem.

Monty Hall (51)* A simulation of the Monty Hall three-door problem, which involves an understanding of probability.

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Preface for instructors

This second EMEA edition of Bruce Goldstein's bestselling textbook, *Cognitive Psychology* has been updated by Dr Johanna C. van Hooff of the University of Amsterdam who also adapted and contextualized the original content for the first edition to localize it for the European, Middle East and South African markets. Real-life examples are given from countries in these parts of the world and cross cultural differences are featured prominently. This more culturally diverse approach is supported by pictures, illustrations and photographs from across the world. All chapters have been revised and updated with the latest research, whilst also reflecting on how cognitive psychology ideas and theories have evolved over time.

The highly accessible writing style has been retained from the original edition, along with the approach and structure. Updated and new content in pedagogical features has been introduced whilst also retaining some of the strong features of the original, including:

- **Research boxes** highlight recent individual studies mainly from Europe and elsewhere internationally. These studies provide helpful levels of detail to increase and enhance students' understanding of experimental design and the interpretation of results.
- **Demonstrations,** easy-to-do mini-experiments provide students with firsthand experience with the phenomena of cognitive psychology.
- **Test Yourself** sections help students to review the material and aid self-study.
- **Think About It** questions ask students to critically consider questions that go beyond the presented material.
- **Methods** sections highlight the ingenious methods cognitive psychologists have devised to study the mind. They describe methods such as brain imaging, the lexical decision task and think-aloud protocols. This not only highlights the importance of the method, but makes it easier to return to its description when it is referred to later in the text.
- The end-of-chapter **Something to Consider** sections describe cutting-edge research, important issues, or applied research.
- Additionally, adopters of CogLab will have access to more than 50 online **experiments** that students can run themselves and then compare their data to the class average and to the results of the original experiments from the literature.

We want to note that at the time of this second EMEA edition going to press, the global COVID-19 pandemic is still at large worldwide. For the past few months governments across the world have introduced a range of social distancing, isolation and quarantine methods to help control the pandemic and it is too early to tell what the effects of this pandemic will be on topics related to cognitive psychology.

Cengage's peer reviewed content for higher education courses is accompanied by a range of tailored digital teaching and learning support resources.

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Preface for students

In this book you will learn what we actually do and do not know about the mind, as determined from the results of controlled scientific research. You will learn that there is much more going on in your mind than you are conscious of. You are aware of experiences such as seeing something, remembering a past event, or thinking about how to solve a problem—but behind each of these experiences are a myriad of complex and largely invisible processes. Reading this book will help you appreciate some of the "behind the scenes" activity in your mind that is responsible for everyday experiences such as perceiving, remembering and thinking.

Another thing you will become aware of as you read this book is that there are many practical connections between the results of cognitive psychology research and everyday life. One especially important connection is how research in cognitive psychology can help you to improve the way you study. The following two principles are designed to help you get more out of this book.

Principle 1: It is important to know what you know

Have you ever experienced an exam that you thought went well, but when your results came back found that you hadn't done as well as you expected? If so, the problem may be that you didn't have a good awareness of what you knew about the material and what you didn't know. If you think you know the material but actually don't, you might stop studying or might continue studying in an ineffective way, with the result being a poor understanding of the material and an inability to remember it accurately for exams. You can help to ensure a good understanding of the material by testing yourself on it using the Test Yourself questions in each chapter.

Principle 2: Don't mistake ease and familiarity for knowing

One of the main reasons that you may think you know the material, even when you don't, is that you can mistake familiarity for understanding. You read the chapter once when you first study a topic, and when you come back to read it again for revision the material is familiar because you remember it from the first time. This might lead you to think that you know the material and can move on to the next section. However, this feeling of familiarity is not necessarily equivalent to knowing the material and may not help you to answer questions on it in an exam. In fact, it may even lead you to choose a wrong answer to a multiple choice question just because it is familiar, rather than the best answer.

This brings us back again to the idea of testing yourself. One finding of cognitive psychology research is that the very act of *trying* to answer a question increases the chances that you will be able to answer it when you try again later. Another related finding is that testing yourself is a more effective way of learning than simply re-reading, because *generating* material is a more effective way of getting information into memory than simply *reviewing* it. Bear these two principles in mind as you read through the book and remember to keep testing yourself on what you have read.

Acknowledgments

The authors and publisher would like to thank the following people for their valuable input in the development of this book:

Donna Rose Addes
University of Auckland, New Zealand
Jessica Alderman
Tim Andrews
University of York
Anna Babarczy
McDaniel College Budapest
Karl G. D. Bailey
Andrews University
Jeff Bane
Miriam Bassok
University of Washington
Linda Becker
University of Erlangen-Nuremberg
Sian Beilock
University of Chicago
Deon Benton
Carnegie-Mellon University
Dharanivel Bhasker
Jeanine Blumenau
University of Witwatersrand
Laura Boubert
University of Westminster
Sarah Brown-Schmidt
University of Illinois
Ruth Byrne
University of Dublin
Roberto Cabeza
Duke University
Fernando Calamante
Florey Institute, Heidelberg, Australia
Francesca Carota
University of Cambridge
Charlene Carpentier
Jason C. K. Chan
Iowa State University
Christie Chung
Mills College
Marlene Cohen
University of Pittsburgh
Anne Draus
Kenneth Drinkwater
Manchester Metropolitan University, UK
Stephen Emrich
Brock University
Christine Feeley
Adelphi University
Alex Fine
University of Illinois
Stephani Foraker
Buffalo State College, SUNY
Jack Gallant
University of California, Berkeley
Giorgio Ganis
University of Plymouth
Martha Ghent
Daniel Goldreich
McMaster University
Robert Goldstone
University of Indiana
Christopher Gore
Newham College
Ralf Greenwald
Central Washington University
Paul G. Helton
Freed-Hardeman University
Pernille Hemmer
Rutgers University
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Keith Holyoak
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Daniel Kersten
University of Minnesota
Daniël Knobel
University of Mpumalanga, South Africa
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Shannon Lemay-Finn
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Indiana University–Purdue University Columbus
Timothy Rogers
University of Wisconsin
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University of Erlangen-Nuremberg
Christopher Schunn
University of Pittsburgh
Enid Schutte
University of the Witwatersrand
Stacie Shaw
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A hiker looks down over a fjord and anticipates her journey through an amazing and varied landscape. Now you, the reader of this book, are about to embark on an intellectual journey that will take you through the remarkable inner workings of the mind. This chapter sets the stage for this journey, by tracing the history of the scientific study of the mind from its beginnings in a few laboratories in Europe in the late 19th century, to today's widespread scientific study of what the mind is and what it does.

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Chapter summary

Think about it

Key terms

CogLab experiment

CHAPTER 1

Introduction to Cognitive Psychology

Some questions we will consider

- How is cognitive psychology relevant to everyday experience?
- How is it possible to study the inner workings of the mind when we can't really see the mind directly?
- How are models used in cognitive psychology?
- What are the practical applications of cognitive psychology?

As Ruben is walking across campus, talking to Susan on his mobile phone about meeting at the student union later this afternoon, he remembers that he left the book she had lent him at home (Figure 1.1). "I can't believe it," he thinks, "I can see it sitting there on my desk, where I left it. I should have put it in my backpack last night when I was thinking about it."

As he finishes his call with Susan, and after making a mental note to be on time for their appointment, his thoughts shift to how he is going to deal with the fact that his bicycle still has a flat tyre. Renting a bicycle from the campus shop offers the most mobility, but is expensive. Borrowing one from his friend wouldn't cost anything, but is more difficult to coordinate. "Maybe I'll try to catch the bus from the student union," he thinks, as he puts his mobile phone in his pocket.

Entering his psychology class, he remembers that an exam is coming up soon. Unfortunately, he still has a lot of reading to do, so he decides that he won't be able to go to the movies with Susan tonight as they had planned. As the lecture begins, Ruben is anticipating, with some anxiety, his meeting with Susan.

FIGURE 1.1
What's happening in Ruben's mind as he walks across campus? Each of the thought bubbles corresponds to something in the story in the text.

This brief slice of Ruben's life is noteworthy because it is ordinary, while at the same time so much is happening. Within a short span of time, Ruben does the following things that are related to material covered in chapters in this book:

- *Perceives* his environment—seeing people on campus and hearing Susan talking on the phone (Chapter 3: Perception)
- *Pays attention* to one thing after another—the people on his right, what Susan is saying, how much time he has to get to his class (Chapter 4: Attention)
- *Remembers* something from the past—that he had told Susan he was going to return her book today (Chapters 5–8: Memory)

- *Distinguishes items in a category*, when he thinks about different possible forms of transportation—rental bicycle, friend's bicycle, bus (Chapter 9: Knowledge)
- *Visualizes* the book on his desk the night before (Chapter 10: Visual Imagery)
- *Understands and produces language* as he talks to Susan (Chapter 11: Language)
- Works to *solve a problem*, as he thinks about how to get places while his bicycle has a flat tyre (Chapter 12: Problem Solving)
- *Makes a decision*, when he decides to postpone going to the movies with Susan so he can study (Chapter 13: Judgment, Reasoning and Decisions)

The things Ruben is doing have something very important in common: They all involve the mind. **Cognitive psychology** is *the branch of psychology concerned with the scientific study of the mind*. In this book, you will learn what the mind is, how it has been examined, and what study results tell us about how the mind works. In this chapter we will first describe the mind in more detail, then consider some of the history behind the field of cognitive psychology, and finally begin considering how modern cognitive psychologists have gone about studying the mind.

Cognitive psychology: Studying the mind

You may have noticed that we have been using the term **mind** without precisely defining it. Mind, like many other concepts in psychology, such as intelligence or emotion, can be thought of in a number of different ways.

What is the mind?

One way to approach the question "What is the mind?" is to consider how the word "mind" is used in everyday conversation. Here are a few examples:

1. "He was able to call to mind what he was doing on the day of the accident." (The mind as involved in memory.)
2. "If you put your mind to it, I'm sure you can solve that maths problem." (The mind as problem-solver.)
3. "I haven't made up my mind yet" or "I'm in two minds about this." (The mind as used to make decisions or consider possibilities.)
4. "He is of sound mind and body," or "When he talks about his encounter with aliens, it sounds like he is out of his mind." (A healthy mind being associated with normal functioning, a non-functioning mind with abnormal functioning.)
5. "A mind is a terrible thing to waste." (The mind as valuable, something that should be used.)
6. "He has a brilliant mind." (Used to describe people who are particularly intelligent or creative.)

These statements tell us some important things about what the mind is. Statements 1, 2 and 3, which highlight the mind's role in memory, problem solving and making decisions, are related to the following definition of the mind: *The mind creates and controls mental functions such as perception, attention, memory, emotions, language, deciding, thinking and reasoning*. This definition reflects the mind's central role in determining our various mental abilities, which are reflected in the titles of the chapters in this book. It is important to realize that cognition does not only reflect our higher "thinking" functions and that many of the processes involved (the basic as well as the more complex ones) operate outside conscious control.

Another definition, which focuses on how the mind operates, is: *The mind is a system that creates representations of the world so that we can act within it to achieve our goals*. This definition reflects the mind's importance for functioning and survival, and also provides the beginnings

of a description of how the mind achieves these ends. The idea of creating representations is something we will return to throughout this book.

These two definitions of the mind are not incompatible. The first one indicates different types of **cognition**—the mental processes, such as perception, attention and memory, that are what the mind does. The second definition indicates something about how the mind operates (it creates representations) and its function (it enables us to act and to achieve goals). It is no coincidence that all of the cognitions in the first definition play important roles in acting to achieve goals.

Statements 4, 5 and 6 emphasize the mind's importance for normal functioning, and the amazing abilities of the mind. The mind is incredible in all its facets and forms, and not just in whiz kids and masterminds. Even the most "routine" things—like recognizing a person or having a conversation, involve many sophisticated qualities and complex operations of the mind. What exactly are the properties of the mind? What are its characteristics? How does it operate and how is it related to brain processes? Stating that the mind creates cognition and is important for functioning and survival tells us *what the mind does*, but not *how it achieves what it does*. The question of how the mind achieves what it does is what cognitive psychology is about. Our goals in the rest of this chapter are to describe how the field of cognitive psychology evolved from its early beginnings to where it is today, and to begin describing how cognitive psychologists approach the scientific study of the mind.

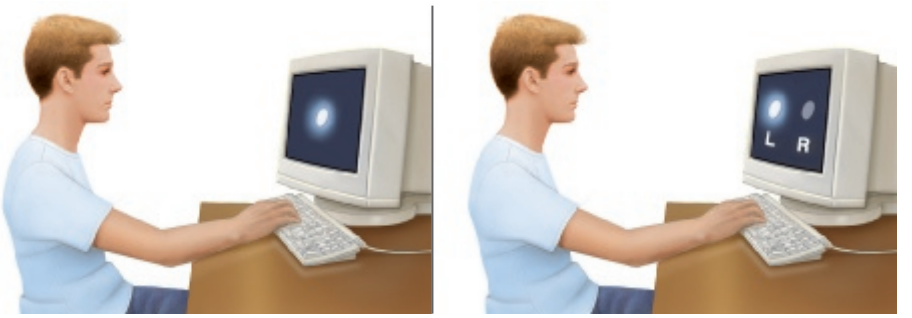
Studying the mind: Early work in cognitive psychology

In the 1800s, ideas about the mind were dominated by the belief that it is not possible to study the mind. One reason given was that it is not possible for the mind to study itself, but there were other reasons as well, including the idea that the properties of the mind simply cannot be measured. Nonetheless, some researchers defied the common wisdom and decided to study the mind anyway. One of these people was the Dutch physiologist, Franciscus Donders, who in 1868, 11 years before the founding of the first laboratory of scientific psychology, did one of the first experiments that today would be called a cognitive psychology experiment. (It is important to note that the term "cognitive psychology" was not coined until 1967, but the early experiments we are going to describe next, would today qualify as cognitive psychology experiments.)

1868: Donders' pioneering experiment: How long does it take to make a decision?

Donders was interested in determining how long it takes for a person to make a decision. He determined this by measuring **reaction time**—how long it takes to respond to the presentation of a stimulus (a stimulus is a sound, a light, a touch, a smell, etc). He used two measures of reaction time. First, he measured **simple reaction time** by asking his participants to push a button as rapidly as possible when they saw a light go on (Figure 1.2a). In addition, he measured **choice reaction time** by using two lights and asking his participants to push the left button when they saw the left light go on, and the right button when they saw the right light go on (Figure 1.2b).

The steps that occur in the simple reaction time task are shown in Figure 1.3a. Presenting the stimulus (the light) causes a mental response (perceiving the light), which leads to a behavioural response (pushing the button). The reaction time (dashed line) is the time between the presentation of the stimulus and the behavioural response. The steps that occur in the choice reaction time task are indicated in Figure 1.3b. In this task, an extra step (or mental response) is required, asking participants to determine whether the left or right light was illuminated and then to decide which button to push. As expected, reaction times in this choice task were longer than those in the simple task. Donders reasoned that the difference in reaction time between these tasks would indicate how long it took participants to make the decision that led to pushing the correct button. Because in this example the choice reaction time took around 100 milliseconds (ms) longer than the simple reaction time, it could therefore be concluded that the decision-making process took around 100 ms.



(a) Press J when light goes on. (b) Press J for left light, K for right.

FIGURE 1.2
A contemporary version of Donders' (1868) reaction time experiment: (a) the simple reaction time task and (b) the choice reaction time task. In the simple reaction time task, the participant pushes the J key when the light goes on. In the choice reaction time task, the participant pushes the J key if the left light goes on and the K key if the right light goes on. The purpose of Donders' experiment was to determine how much time it took to decide which key to press in the choice reaction time task.

Donders' experiment is important, both because it was one of the first cognitive psychology experiments and because it illustrates something extremely significant about studying the mind: Mental responses (perceiving the light and deciding which button to push, in this example) cannot be measured directly, but must be *inferred* from behaviour. We can appreciate this by recognizing that the dashed lines in Figure 1.3 indicate that the measured reaction times represent the relationship between the presentation of the stimulus (the light flashes) and the participant's response (button presses). He did not measure mental responses directly, but *inferred* how long they took from the reaction times. The fact that mental responses cannot be measured directly, but must be inferred from observing behaviour, is a principle that holds not only for Donders' experiment but for *all* research in cognitive psychology.

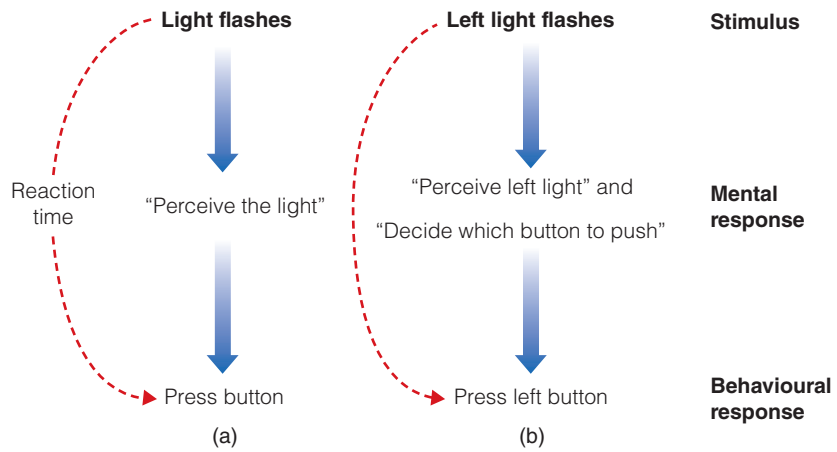


FIGURE 1.3
Sequence of events between presentation of the stimulus and the behavioural response in Donders' experiments: (a) simple reaction time task and (b) choice reaction time task. The dashed line indicates that Donders measured reaction time—the time between presentation of the light and the participant's response.

1879: Wundt's psychology laboratory: Structuralism and analytic introspection

Eleven years after Donders' reaction time experiment, Wilhelm Wundt founded the first laboratory of scientific psychology at the University of Leipzig in Germany. Wundt's approach, which dominated psychology in the late 1800s and early 1900s, was called **structuralism**. According to structuralism, our overall experience is determined by combining basic elements of experience which

were called *sensations*. Thus, just as chemistry developed a periodic table of the elements, which combine to form molecules, Wundt wanted to create a "periodic table of the mind," which would include all of the basic sensations involved in creating complex experiences.

Wundt thought he could achieve this scientific description of the components of experience by using **analytic introspection**, a technique in which trained participants described their sensations, feelings and thought processes in response to stimuli. Analytic introspection (intro = inside, spectare = to look) required extensive training because it is difficult to describe an experience in terms of basic, fundamental elements, such as the sensations of "redness," "sweetness" and "crispiness" when viewing an apple. In one experiment, Wundt asked participants to describe their experience of hearing a five-note chord played on the piano. One of the questions he then hoped to answer was whether his participants were able to hear each of the individual notes that made up the chord. As we will see when we consider perception in Chapter 3, structuralism was not a fruitful approach and was therefore abandoned in the early 1900s. Nonetheless, Wundt made a substantial contribution to psychology by his commitment to studying behaviour and the mind under controlled conditions. Indeed, Wundt is seen by many as leading the shift in the study of the mind from the rationalist approach to the **empiricist approach**, emphasizing the pivotal role of experiments in gaining knowledge about the human mind. In addition, he trained many doctoral students who later established psychology departments at other universities in Europe and the United States. To see for yourself how experiments were carried out in Wundt's time, you can still visit his laboratory in Leipzig (see Figure 1.4).

FIGURE 1.4
Wundt's laboratory.

1885: Ebbinghaus' memory experiment: What is the time course of forgetting?

Meanwhile, 120 miles from Leipzig, at the University of Berlin, German psychologist Hermann Ebbinghaus (1885/1913) was using another approach to measuring the properties of the mind. Ebbinghaus was interested in determining the nature of memory and forgetting—specifically, how rapidly information that is learned is lost over time. Rather than using Wundt's method of analytic introspection, Ebbinghaus used a quantitative method for measuring memory. Using himself as the participant, he repeated lists of 13 nonsense syllables such as DAX, QEH, LUH and ZIF to himself one at a time at a constant rate. He used nonsense syllables so that his memory would not be influenced by the meaning of a particular word.

Ebbinghaus determined how long it took him to learn a list for the first time (i.e., recall correctly). He then waited for a specific amount of time (the *delay*) and then determined how long it took him to re-learn the list for the second time. Because forgetting had occurred during the delay, Ebbinghaus did not perform perfectly in his first attempt after the delay, but he was able to achieve correct recall quicker and with fewer attempts than before. In other words, he re-learned the list more rapidly than when he had learned it for the first time. Thus, something from the original learning period must have been saved in memory to achieve this quicker learning.

To determine how much information was retained after a particular delay, Ebbinghaus proposed a measure called **savings**, calculated as follows: Savings = (Original time to learn the list) – (Time to re-learn the list after the delay). Thus, if it took 1,000 seconds to learn the list the first time and 400 seconds to re-learn the list after the delay, the savings would be 1,000 – 400 = 600 seconds. Figure 1.5, which represents original learning and re-learning after three different delays, shows that longer delays result in smaller savings.

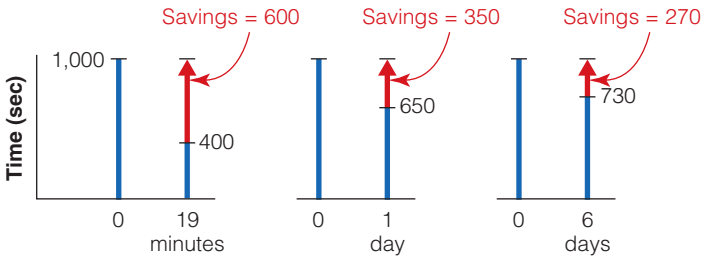


FIGURE 1.5

Calculating the savings score in Ebbinghaus' experiment. In this example, it took 1,000 seconds to learn the list of nonsense syllables for the first time. This is indicated by the lines at 0. The time needed to re-learn the list at delays of (a) 19 minutes, (b) one day, and (c) six days are indicated by the line to the right of the 0 line. The red line indicates the savings score for each delay. Notice that savings decrease for longer delays. This decrease in savings provides a measure of forgetting.

According to Ebbinghaus, this reduction in savings provided a measure of forgetting, with smaller savings meaning more forgetting. Thus, the plot of per cent savings versus time in Figure 1.6, called a **savings curve**, shows that memory drops rapidly for the first two days after the initial learning and then levels off. This curve was important because it demonstrated that memory could be quantified and that functions like the savings curve could be used to describe a property of the mind—in this case, the ability to retain information. Interestingly, this 130-year-old experiment was recently replicated and an almost exactly similar forgetting curve was found (Murre & Dros, 2015). Notice that although Ebbinghaus' savings method was very different from Donders' reaction time method, both measured *behaviour* to determine a property of the *mind*.

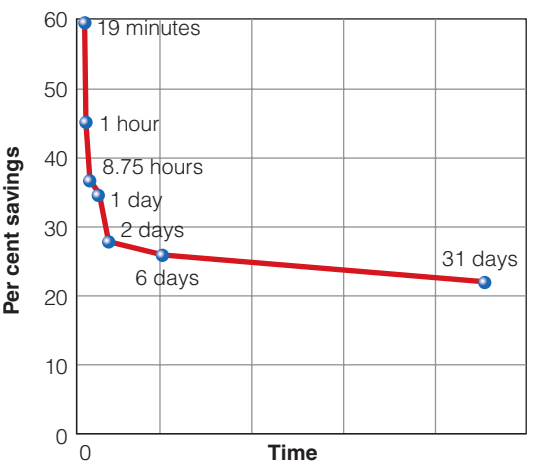


FIGURE 1.6

Ebbinghaus' savings curve. Ebbinghaus considered the per cent savings to be a measure of the amount remembered, so he plotted this versus the time between initial learning and testing. The decrease in savings (remembering) with increasing delays indicates that forgetting occurs rapidly over the first two days and then occurs more slowly after that.

Based on: Ebbinghaus, H. (1885/1913). *Memory: A contribution to experimental psychology*, H. A. Ruger & C. E. Bussenius, Trans., New York: Teachers College, Columbia University.

1890: William James' *Principles of Psychology*

William James, one of the early American psychologists, described significant observations about the mind in his famous textbook, *Principles of Psychology* (1890). James' observations were based not on the results of experiments but on observations about the operation of his own mind. One of the best known of James' observations is the following, on the nature of attention:

> *Millions of items . . . are present to my senses which never properly enter my experience. Why? Because they have no interest for me. My experience is what I agree to attend to. . . . Everyone knows what attention is. It is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. . . . It implies withdrawal from some things in order to deal effectively with others.*

The observation that paying attention to one thing involves withdrawing from other things still rings true today and has been the topic of many modern studies of attention. As impressive as the accuracy of James' observations, so too was the range of cognitive topics he considered, which included thinking, consciousness, attention, memory, perception, imagination and reasoning.

The founding of the first laboratory of psychology by Wundt, the quantitative experiments of Donders and Ebbinghaus, and the perceptive observations of James provided what seemed to be a promising start to the study of the mind (Table 1.1). However, research on the mind was soon to be curtailed, largely because of events early in the 20th century that shifted the focus of psychology away from the study of the mind and mental processes. One of the major forces that caused psychology to reject the study of (invisible) mental processes was a negative reaction to the analytic introspection technique.

TABLE 1.1 Early pioneers in cognitive psychology

Person	Procedure	Results and Conclusions	Contribution
Donders (1868)	Simple reaction time vs choice reaction time	Choice reaction time takes 100 milliseconds longer; therefore, it takes 100 milliseconds to make a decision	First cognitive psychology experiment
Wundt (1879)	Analytic introspection	No reliable results	Established the first laboratory of scientific psychology
Ebbinghaus (1885)	Savings method to measure forgetting	Forgetting occurs rapidly in the first one to two days after original learning	Quantitative measurement of mental processes
James (1890)	No experiments; reported observations of his own experience	Descriptions of a wide range of experiences	First psychology textbook; some of his observations are still valid today

Abandoning the study of the mind

Many early departments of psychology conducted research in the tradition of Wundt's laboratory, using analytic introspection to analyze mental processes. This emphasis on studying the mind was to change, however, being largely replaced by a focus on "pure" observable behaviour. This approach became known as behaviourism, devoting its efforts to the strict study of stimulus–response or input–output relationships.

1913: Watson founds behaviourism

The account of how John Watson founded behaviourism is probably known to most introductory psychology students. We will briefly review it here because of its importance to the history of cognitive psychology. Around 1913, Watson became dissatisfied with the method of analytic introspection because (1) it produced extremely variable results from person to person, and (2) these results were difficult to verify. In response to what he perceived to be deficiencies in analytic introspection, Watson proposed a new approach called **behaviourism**. The goals of this approach are expressed clearly in this famous quote:

> *Psychology as the behaviourist sees it is a purely objective, experimental branch of natural science. Its theoretical goal is the prediction and control of behaviour. Introspection forms no essential part of its methods, nor is the scientific value of its data dependent upon the readiness with which they lend themselves to interpretation in terms of consciousness. . . . What we need to do is start work upon psychology making behaviour, not consciousness, the objective point of our attack. (Watson, 1913, pp. 158, 176; emphasis added)*

This passage makes two key points: (1) Watson rejects introspection as a method, and (2) observable behaviour, not consciousness (which would involve unobservable processes such as thinking, emotions and reasoning), is the main topic of study. In other words, Watson wanted to restrict psychology to observable behavioural data and rejected the idea of going beyond those data to draw conclusions about unobservable mental events. As a consequence of these ideas, psychologists' attention shifted from asking "What does behaviour tell us about the mind?" to "What is the relation between stimuli in the environment and behaviour?"

Watson's ideas are closely associated with **classical conditioning** as originally studied by Ivan Pavlov from around 1890. Pavlov (1927) demonstrated that dogs could be made to salivate to the sound of a bell, when this (neutral) sound was previously paired to the arrival of food. Watson showed that the same principles applied to human behaviour and he used the idea of classical conditioning to argue that behaviour can be analyzed without any reference to the mind. For Watson, what is going on inside our head (or inside the head of Pavlov's dog), either physiologically or mentally, is irrelevant. The only thing he cared about was how pairing one stimulus with another stimulus affected behaviour.

1938: Skinner's operant conditioning

Twenty-five years later, B. F. Skinner provided another tool for studying the relationship between stimulus and response, which ensured that this approach would dominate psychology for decades to come. Skinner introduced **operant conditioning**, which focused on how behaviour is strengthened by the presentation of positive reinforcers, such as food or social approval (or withdrawal of negative reinforcers, such as a shock or social rejection). For example, Skinner showed that reinforcing a rat with food for pressing a bar maintained or increased the rat's rate of bar pressing. Like Watson, Skinner was not interested in what was happening in the mind, but focused solely on determining how behaviour was controlled by stimuli (Skinner, 1938).

The idea that behaviour can be understood by studying stimulus–response relationships influenced an entire generation of psychologists from the 1940s through to the 1960s. Psychologists applied the techniques of classical and operant conditioning to classroom teaching, treating psychological disorders and testing the effects of drugs on animals. Figure 1.7 is a time line showing the initial studies of the mind and the rise of behaviourism. But even as behaviourism was dominating psychology, events were occurring that eventually led to the rebirth of the study of the mind.