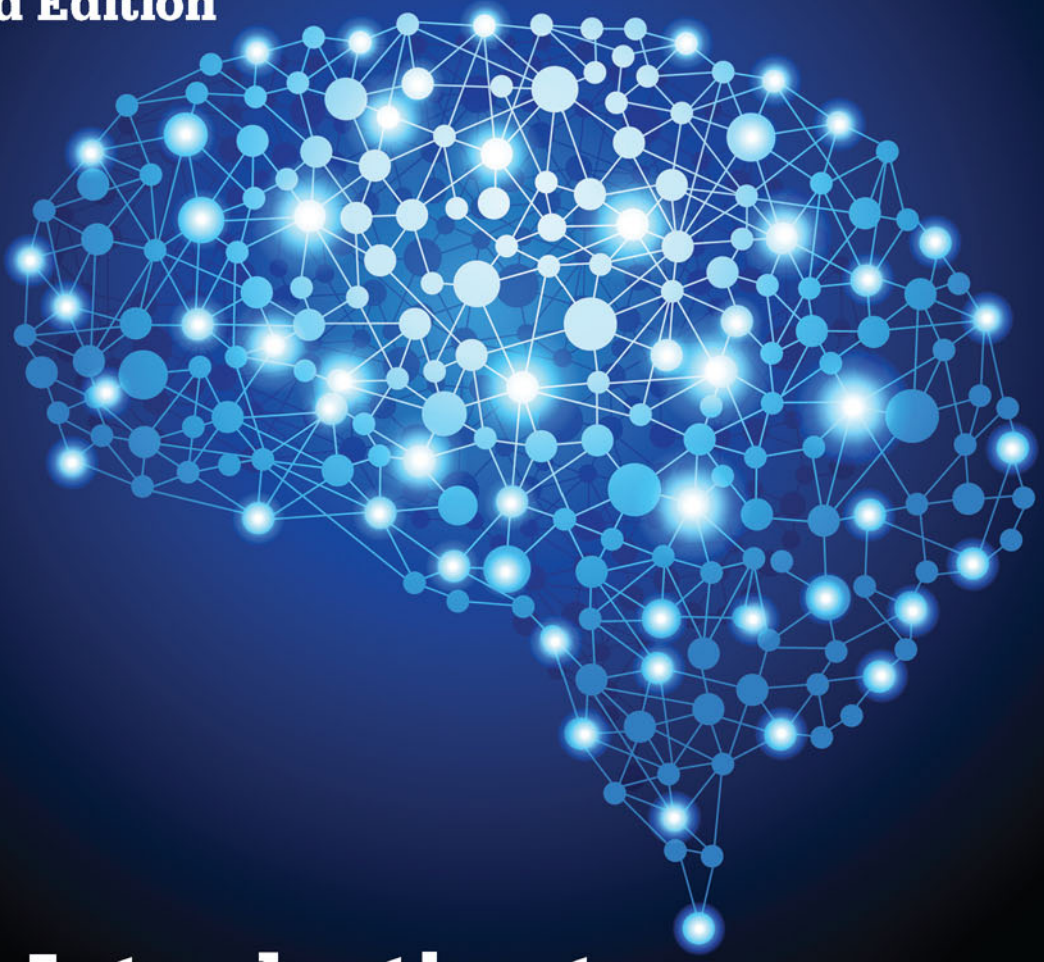
Third Edition



An Introduction to Cognitive Psychology

Processes and disorders

David Groome
with Nicola Brace, Graham Edgar, Helen Edgar, Michael Eysenck, Tom Manly, Hayley Ness, Graham Pike, Sophie Scott and Elizabeth Styles

Psychology Press

An Introduction to Cognitive Psychology

An Introduction to Cognitive Psychology: Processes and disorders is a comprehensive introductory textbook for undergraduate students. The third edition of this well-established text has been completely revised and updated to cover all the key areas of cognition, including perception, attention, memory, thinking and language. Uniquely, alongside chapters on normal cognitive function, there are chapters on related clinical disorders (agnosia, amnesia, thought disorder and aphasia) which help to provide a thorough insight into the nature of cognition.

Key features:

- Completely revised and updated throughout to provide a comprehensive overview of current thinking in the field
- Accessibly written and including new authors, including Sophie Scott, Tom Manly, Hayley Ness and Elizabeth Styles, all established experts in their field
- A new chapter on emotion and cognition, written by Michael Eysenck, the leading authority in the field
- Greater coverage of neuropsychological disorders, with additional material from the latest brain imaging research that has completely revolutionized neuropsychology
- Specially designed textbook features, chapter summaries, further reading and a glossary of key terms
- A companion website featuring an extensive range of online resources for both teachers and students.

An Introduction to Cognitive Psychology is written to cover all levels of ability and includes numerous figures and illustrations to assist learning. The book has sufficient depth to appeal to the most able students, while the clear and accessible writing style will help students who find the material difficult. It will appeal to all undergraduate students of psychology, and also medical students and those studying in related clinical professions such as nursing.

David Groome was formerly Principal Lecturer and Senior Academic in Psychology at the University of Westminster, where he worked from 1970 to 2011. He retired from teaching in August 2011 but continues to carry out research and write books. His research interests include cognition and memory, and their relationship with clinical disorders. He has published a number of research papers on these topics and is the co-author of four previous textbooks.

Advance praise for the new edition of *An Introduction to Cognitive Psychology*:

'A highly useful text which helpfully explains the associated disorders in all the key subject areas of cognitive psychology.' – *Parveen Bhatarah, School of Psychology, London Metropolitan University, UK*

'*An Introduction to Cognitive Psychology* comprehensively and exhaustively covers the basics and main topics of cognitive psychology. The authors are all experts in their research areas, and the overall content of the book is informative, up-to-date and clearly structured.' – *Wolfgang Minker, Institute of Communications Engineering, Ulm University, Germany*

'This book is a highly readable introduction to the major figures and studies in cognitive research. The visuals and summaries included throughout will help students process and understand all of the important information, whilst also provoking discussions surrounding controversial issues in psychology and learning.' – *Rosalind Horowitz, College of Education and Human Development, The University of Texas at San Antonio, USA*

'Any student wishing to understand basic principles in cognition alongside disorderly behaviour will find this a useful alternative to other introductory cognitive textbooks on the market today. The divergence in basic cognitive function will capture student attention while providing them with a solid foundation.' – *Karla A. Lassonde, Minnesota State University, Mankato, USA*

'I am very impressed with the distinctive approach taken to cognitive psychology in this textbook, where each topic is explored through the lenses of behavioral research, computer models, clinical neuropsychology and neuroscience. I appreciate the effort that the authors make to integrate neuroscience and neuropsychology, with intriguing case studies and the coverage of disorders skillfully integrated with the rest of the text.' – *Erik Nilsen, Department of Psychology, Lewis and Clark College, USA*

'*An Introduction to Cognitive Psychology* provides an up-to-date, topical and accessible overview of this core area of psychology. The coverage of topics is extensive and there is an excellent balance of theory, research and application in the treatment of each area. Three aspects of this text stand out: the multi-author approach that provides a variety of perspectives from a range of experts; a strong consideration of disorders in cognition, an important, often ignored, aspect of the discipline of great interest to students; and finally, the chapter on cognition and emotion, an important topic rarely covered in texts of this type, is a welcome addition.' – *John Reece, School of Health Sciences, RMIT University, Australia*

'With a unique blend of cognition and clinical (neuro)psychology, this book integrates a comprehensive introduction to the core areas of experimental cognitive psychology with a nuanced review of the cognitive aspects of clinical disorders. The clinical discussion avoids unhelpful syndrome pigeon-holing, and brings alive a topic that many students can find a bit dry.' – *Ullrich Ecker, The University of Western Australia, Australia*

'This new edition has been updated throughout to include the latest cutting-edge research. Its refreshing approach combines both neuropsychology and cognitive psychology in alternating chapters making it relevant to students of cognitive psychology, neuropsychology or medicine. The book is clearly organized and accessible despite the enormous breadth that it covers.' – *Michael D. Patterson, Nanyang Technological University, Singapore*

'This is a very comprehensive introduction to cognitive psychology with a particular focus on disorders of cognition. The book provides an integrated approach to illustrate how the human mind works through introductions to both normal and disordered cognitive functions. A wide range of topics with different approaches, including experimental and computational modelling approaches, alongside the inclusion of materials from cognitive neuroscience and neuropsychology, will enhance students' understanding of how the brain gives rise to the mind.' – *Janet H. Hsiao, Department of Psychology, University of Hong Kong, Hong Kong*

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Michael Eysenck is Professorial Fellow at Roehampton University and Emeritus Professor at Royal Holloway University of London. He has produced 46 books and about 160 book chapters and journal articles leading some to accuse him of following the adage, "Never mind the quality, feel the width!"

Nicola Brace is a Senior Lecturer in Psychology at The Open University. She has taught and researched cognitive psychology for over 25 years, and has come to the conclusion that when it comes to solving Sudoku puzzles understanding the brain is not nearly as useful as a good cup of tea.

Graham Edgar is currently employed as a Reader in Psychology at the University of Gloucestershire. He has spent most of his career coming to appreciate that, although psychology can be applied to pretty much everything, the difficult bit is working out how. He is presently researching situation awareness in the military, health, fire-fighting and driving domains and trying to see if neuroscience can explain it. He is an optimist.

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Elizabeth Styles is lecturer in psychology at St. Edmund Hall, University of Oxford. She has taught and examined cognitive psychology for many years and has previously written text books on the psychology of attention for Psychology Press. She has written a highly regarded book on attention, which was good practice for her contribution to the present book. When not working she likes to travel and study archaeology.

Preface

We wrote this book because we felt that it filled an important gap. As far as we know it is the first textbook to cover all of the main aspects of cognitive psychology and all of their associated disorders too. We believe that an understanding of the disorders of cognition is an essential requirement for understanding the processes of normal cognition, and in fact the two approaches are so obviously complimentary that we are quite surprised that nobody had put them together in one book before. There are books about normal cognition, and there are books about cognitive disorders (usually referred to as "cognitive neuropsychology"), but there do not seem to be any other books which cover both topics in full. We feel that this combined approach offers a number of advantages. In the first place, combining normal and abnormal cognition in one book makes it possible to take an integrated approach to these two related fields. References can be made directly between the normal and abnormal chapters, and theories which are introduced in the normal chapters can be reconsidered later from a clinical perspective. We chose to keep the normal and abnormal aspects in separate chapters, as this seems clearer and also makes it more straightforward for those teaching separate normal and abnormal cognitive psychology courses. There is also one further advantage of a combined textbook, which is that students can use the same textbook for two different courses of study, thus saving the cost of buying an extra book.

Another reason for writing this book was that we found the other available cognitive psychology texts were rather difficult to read. Our students found these books were heavy going, and so did we. So we set about writing a more interesting and accessible book, by deliberately making more connections with real life and everyday experience. We also cut out some of the unnecessary anatomical detail that we found in rival texts. For example, most neuropsychology books include a large amount of detail about the structure of the brain, but most psychology students do not really need this. So we decided to concentrate instead on the psychological aspects of cognitive disorders rather than the anatomical details. And finally, we decided to put in lots of illustrations, because we think it makes the book clearer and more fun to read. And also we just happen to like books which have lots of pictures.

So here then is our textbook of cognitive psychology and cognitive disorders, made as simple as possible, and with lots of pictures. We enjoyed writing it, and we hope you will enjoy reading it.

David Groome

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We would like to offer our sincere thanks to the reviewers who provided valuable comments and suggestions about our manuscript, especially Julie Blackwell Young, Rosalind Horowitz, Sam Hutton, Wido La Heij, Karla Lassonde, Wolfgang Minker, Erik Nilsen, Jane Oakhill, Fenna Poletiek, and Gezinus Wolters. Also our heartfelt thanks to Richard Kemp and Hazel Dewart, who both made valuable contributions to chapters 4 and 10 respectively. Thanks also to those at Psychology Press, and in particular Rebekah Edmondson, Michael Fenton, Ceri Griffiths, and Natalie Larkin. And finally thanks to Richard Cook and Jef Boys at Book Now.

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Chapter 1

Contents

1

Introduction to cognitive psychology

David Groome

1.1 COGNITIVE PROCESSES

A DEFINITION OF COGNITIVE PSYCHOLOGY

Cognitive psychology has been defined as the psychology of mental processes. More specifically it has also been described as the study of understanding and knowing. However, these are rather vague terms, and whilst they do provide an indication of what cognition involves, they leave us asking exactly what is meant by 'knowing', 'understanding' and 'mental processes'. A more precise definition of cognitive psychology is that it is the study of the way in which the brain processes information. It concerns the way we take in information from the outside world, how we make sense of that information and what use we make of it. Cognition is thus a rather broad umbrella term, which includes many component processes, and this possibly explains why psychologists have found it so difficult to come up with a simple and unified definition of cognitive psychology. Clearly cognition involves various different kinds of information processing which occur at different stages.

Key Term

Cognitive psychology
The study of the way in which the brain processes information. It includes the mental processes involved in perception, learning and memory storage, thinking and language.

STAGES OF COGNITIVE PROCESSING

The main stages of cognitive processing are shown in Figure 1.1, arranged in the sequential order in which they would typically be applied to a new piece of incoming sensory input.

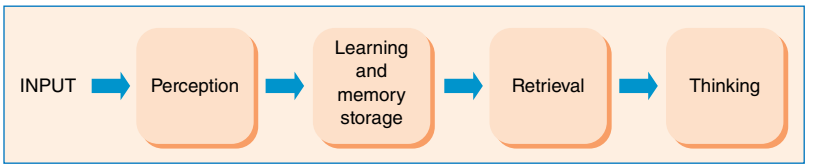

Figure 1.1 The main stages of cognitive processing.

Information taken in by the sense organs goes through an initial stage of **perception**, which involves the analysis of its content. Even at this early stage of processing the brain is already extracting meaning from the input, in an effort to make sense of the information it contains. The process of perception will often lead to the making of some kind of record of the input received, and this involves **learning** and **memory storage**. Once a memory has been created for some item of information, it can be retained for later use, to assist the individual in some other setting. This will normally require the **retrieval** of the information. Retrieval is sometimes carried out for its own sake, merely to access some information stored in the past. On the other hand, we sometimes retrieve information to provide the basis for further mental activities such as **thinking**. Thought processes often make use of memory retrieval, as for example when we use previous experience to help us deal with some new problem or situation. Sometimes this involves the rearrangement and manipulation of stored information to make it fit in with a new problem or task. Thinking is thus rather more than just the retrieval of old memories.

The cognitive processes shown in Figure 1.1 are in reality a good deal more complex and interactive than this simple diagram implies. The diagram suggests that the various stages of cognitive processing are clearly distinct from one another, each one in its own box. This is a drastic oversimplification, and it would be more accurate to show the different stages as merging and overlapping with one another. For example, there is no exact point at which perception ceases and memory storage begins, because the process of perception brings about learning and memory storage and thus in a sense these processes are continuous. In fact all of the stages of cognition shown in the diagram overlap and interact with one another, but a diagram showing all of these complex interactions would be far too confusing, and in any case a lot of the interactions would be speculative. Figure 1.1 should therefore be regarded as a greatly simplified representation of the general sequential order of the cognitive processes which typically occur, but it would be more realistic to think of cognition as a continuous flow of information from the input stage through to the output stage, undergoing different forms of processing along the way.

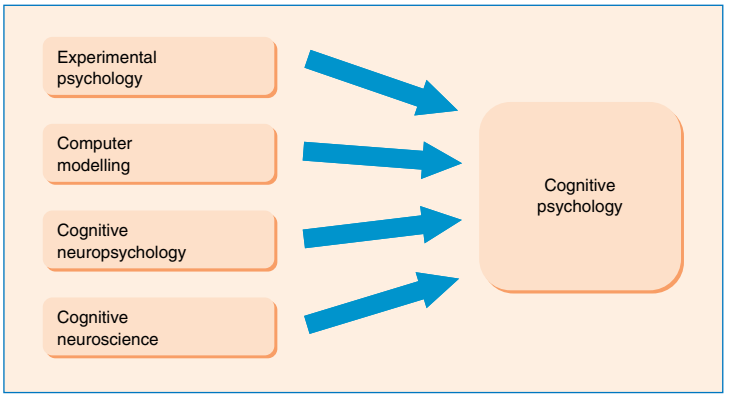

Figure 1.2 The four main approaches to studying cognitive psychology.

APPROACHES TO THE STUDY OF COGNITION

There have been four main approaches to the study of cognitive psychology (see Figure 1.2).

In the first place there is the approach known as **experimental cognitive psychology**, which involves the use of psychological experiments on human subjects to investigate the ways in which they perceive, learn, remember or think. A second approach to cognitive psychology is the use of **computer modelling** of cognitive processes. Typically this approach involves the simulation of certain aspects of human cognitive function by writing computer programs, in order to test out the feasibility of a model of possible brain function. The third approach is known as **cognitive neuropsychology,** which involves the study of individuals who have suffered some form of brain injury. We can discover a great deal about the working of the normal brain by studying the types of cognitive impairment which result from lesions (i.e. damage) in certain regions of the brain. Brain damage can impair information processing by disrupting one or more stages of cognition, or in some cases by breaking the links between different stages. The fourth approach to cognition is known as **cognitive neuroscience**, and this involves the use of techniques such as brain imaging (i.e. brain scans) to investigate the brain activities that underlie cognitive processing. The two most widely used brain-imaging techniques are PET scans (Positron Emission Tomography) and MRI scans (Magnetic Resonance Imaging, Figure 1.3). PET scans involve the detection of positrons emitted by radioactive chemicals injected into the bloodstream, whereas MRI scans detect responses to a powerful magnetic field. Both techniques can provide accurate images of brain structures, but MRI is better at detecting changes over a period of time, as for example in measuring the effect of applying a stimulus of some kind.

Figure 1.3 An MRI scanner.

Source: Science Photo Library.

Key Term

Experimental psychology
The scientific testing of psychological processes in human and animal subjects.

Computer modelling
The simulation of human cognitive processes by computer. Often used as a method of testing the feasibility of an information-processing mechanism.

Cognitive neuropsychology
The study of the brain activities underlying cognitive processes, often by investigating cognitive impairment in brain-damaged patients.

Cognitive neuroscience
The investigation of human cognition by relating it to brain structure and function, normally obtained from brain-imaging techniques.

These four approaches to cognition have all proved to be valuable, especially when it has been possible to combine different approaches to the same cognitive process. The rest of this chapter deals with these approaches to cognitive psychology, starting with experimental cognitive psychology (Section 1.2), then computer modelling (Section 1.3), and finally cognitive neuroscience and neuropsychology (Section 1.4). Subsequent chapters of the book will continue to apply the same basic approaches in a more detailed study of each of the main areas of cognition.

1.2 EXPERIMENTAL COGNITIVE PSYCHOLOGY

THE FIRST COGNITIVE PSYCHOLOGISTS

The scientific study of psychology began towards the end of the nineteenth century. Wilhelm Wundt set up the first psychology laboratory at Leipzig in 1879, where he carried out research on perception, including some of the earliest studies of visual illusions. In 1885 Hermann Ebbinghaus published the first experimental research on memory, and many subsequent researchers were to adopt his methods over the years that followed. Perhaps the most lasting work of this early period was a remarkable book written by William James (Figure 1.4) in 1890, entitled *Principles of Psychology*. In that book James proposed a number of theories which are still broadly accepted today, including (to give just one example) a theory distinguishing between short-term and long-term memory.

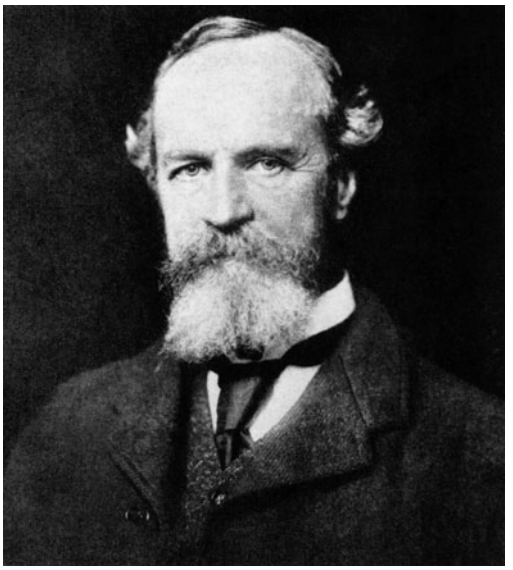

Figure 1.4 William James.

Source: Science Photo Library.

THE RISE AND FALL OF BEHAVIOURISM

Cognitive psychology made slow progress in the early years due to the growing influence of **behaviourism**, an approach which constrained psychologists to the investigation of externally observable behaviour. The behaviourist position was clearly stated by Watson (1913), who maintained that psychologists should consider only events that were observable, such as the stimulus presented and any consequent behavioural response to that stimulus. Watson argued that psychologists should not concern themselves with processes such as thought and other inner mental processes which could not be observed in a scientific manner. The behaviourists were essentially trying to establish psychology as a true science, comparable in status with other sciences such as physics or chemistry. This was a worthy aim, but like many

worthy aims it was taken too far. The refusal to consider inner mental processes had the effect of restricting experimental psychology to the recording of observable responses, which were often of a rather trivial nature. Indeed, some behaviourists were so keen to eliminate inner mental processes from their studies that they preferred to work on rats rather than on human subjects. A human being brings a whole lifetime of personal experience to the laboratory, which cannot be observed or controlled by the experimenter. A rat presents rather fewer of these unknown and uncontrolled variables (Figure 1.5). A good example of the behaviourist approach is the classic work carried out on learning by B.F. Skinner (1938), who trained rats to press a lever in order to obtain a food pellet as a reward (or 'reinforcement'). The work of Skinner and other behaviourists undoubtedly generated some important findings, but they completely disregarded the cognitive processes underlying the responses they were studying.

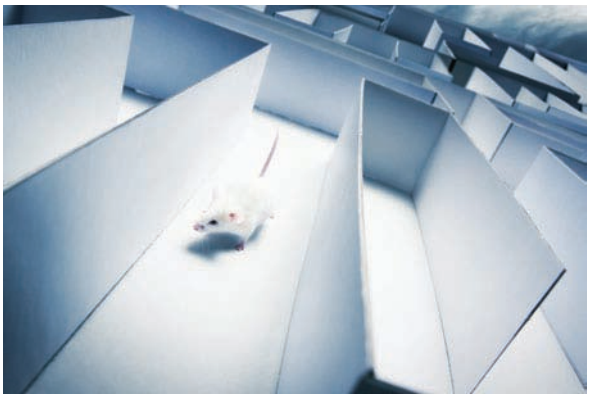

Figure 1.5 A rat learning to run through a maze.
Source: Shutterstock.

GESTALT AND SCHEMA THEORIES

Despite these restrictions on mainstream psychological research, some psychologists began to realise that a proper understanding of human cognition could only be achieved by investigating the mental processes which the behaviourists were so determined to eliminate from their studies. Among the first of these pioneers were the **Gestalt** psychologists in Germany, and the British psychologist Frederick Bartlett. Their work returned to the study of cognitive processes and it helped to lay the foundations of modern cognitive psychology.

It is very easy to demonstrate the importance of inner mental processes in human cognition. For example, a glance at Figure 1.6 will evoke the same clear response in almost any observer. It is a human face. However, a more objective analysis of the components of the figure reveals that it actually consists of a semi-circle and two straight lines. There is really no 'face' as such in the figure itself. If you see a face in this simple figure, then it is you, the observer, who has *added* the face from your own store of knowledge.

The idea that we contribute something to our perceptual input from our own knowledge and experience was actually proposed by a number of early theorists, notably the Gestalt group (Gestalt is German for 'shape' or 'form'). They suggested that we add something to what we perceive, so that the perception of a whole object will be something more than just the sum of its component parts (Wertheimer, 1912; Kohler, 1925). They argued that the perception of a figure depended on its 'pragnanz' (i.e. its meaningful content), which favoured the selection of the simplest and best interpretation available (Koffka,

Key Term

Behaviourism
An approach to psychology which constrains psychologists to the investigation of externally observable behaviour, and rejects any consideration of inner mental processes.

Gestalt psychology
An approach to psychology which emphasised the way in which the components of perceptual input became grouped and integrated into patterns and whole figures.

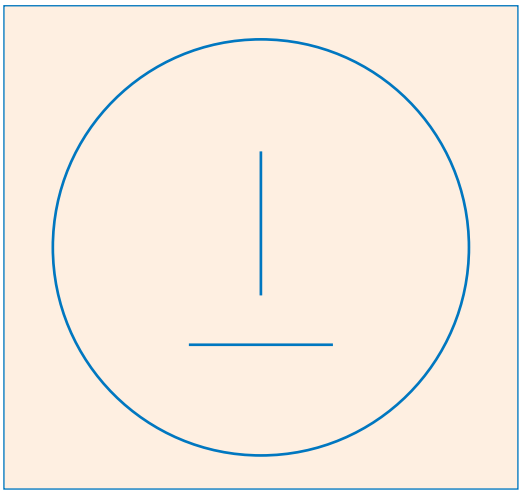

Figure 1.6 A shape recognised by most observers.

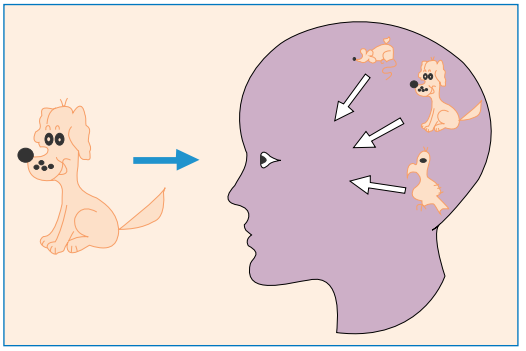

Figure 1.7 Schemas generated for comparison with new input.

Source: Drawing by David Groome.

1935). These theories were perhaps rather vague, but they did at least make an attempt to explain the perception of complex figures such as faces. The behaviourist approach, which refused to consider any influence other than the stimulus itself, could not offer any explanation at all for such phenomena.

The **schema** theory proposed by Bartlett (1932) was another early attempt to provide a plausible explanation for a person's ability to make sense of their perceptual input. The schema theory proposes that all new perceptual input is analysed by comparing it with items which are already in our memory store, such as shapes and sounds which are familiar from past experience. These items are referred to as 'schemas', and they include a huge variety of sensory patterns and concepts. Figure 1.7 illustrates the process of selection of an appropriate schema to match the incoming stimulus. (NB: This is purely diagrammatic. In reality there are probably millions of schemas available, but there was not enough space for me to draw the rest of them.)

The schema theory has some interesting implications, because it suggests that our perception and memory of an input may sometimes be changed and distorted to fit our existing schemas. Since our schemas are partly acquired from our personal experience, it follows that our perception and memory of any given stimulus will be unique to each individual person. Different people will therefore perceive the same input in different ways, depending on their own unique store of experience. Both of these phenomena were demonstrated by Bartlett's experiments (see Chapter 6 for more details), so the schema theory can be seen to have considerable explanatory value. The schema approach has much in common with the old saying that 'beauty lies in the eye of the beholder'. Perhaps we could adapt that saying to fit the more general requirements of schema theory by suggesting that 'perception lies in the brain of the perceiver'. As a summary of schema theory this is possibly an improvement, but I would concede that it possibly lacks the poetry of the original saying.

Schema and Gestalt theory had a major influence on the development of cognitive psychology, by emphasising the role played by inner mental processes and stored knowledge, rather than considering only stimulus and response. However, it would take many years for this viewpoint to take over from behaviourism as the mainstream approach to cognition.

Key Term

Schema
A mental pattern, usually derived from past experience, which is used to assist with the interpretation of subsequent cognitions, for example by identifying familiar shapes and sounds in a new perceptual input.

TOP-DOWN AND BOTTOM-UP PROCESSING

Inspired by the schema theory, Neisser (1967) identified two main types of input processing, known as **top-down** and **bottom-up** processing. **Top-down processing** involves the generation of schemas by the higher cortical structures, and these schemas are sent down the nervous system for comparison with the incoming stimulus. Top-down processing is also sometimes referred to as **schema-driven** or **conceptually driven** processing.

Bottom-up processing is initiated by stimulation at the 'bottom end' of the nervous system (i.e. the sense organs), which then progresses up towards the higher cortical areas. Bottom-up processing is also known as **stimulus-driven** or **data-driven** processing, because it is the incoming stimulus which sets off some appropriate form of processing. One obvious difference between 'top-down' and 'bottom-up' processing is that their information flows in opposite directions, as shown in Figure 1.8.

Bottom-up processing theories can help to explain the fact that processing is often determined by the nature of the stimulus (Gibson, 1979). However, bottom-up theories have difficulty explaining the perception of complex stimuli, which can be more easily explained by top-down theories.

Although there have been disputes in the past about the relative importance of 'top-down' and 'bottom-up' processing, Neisser (1967) argues that both types of processing probably play a part in the analysis of perceptual input and that in most cases information processing will involve a combination of the two. We can thus think of input processing in terms of stimulus information coming up the system, where it meets and interacts with schemas travelling down in the opposite direction.

Key Term

Top-down (or schema-driven) processing
Processing which makes use of stored knowledge and schemas to interpret an incoming stimulus (contrasts with bottom-up processing).

Bottom-up (or stimulus-driven) processing
Processing which is directed by information contained within the stimulus (contrasts with top-down processing).

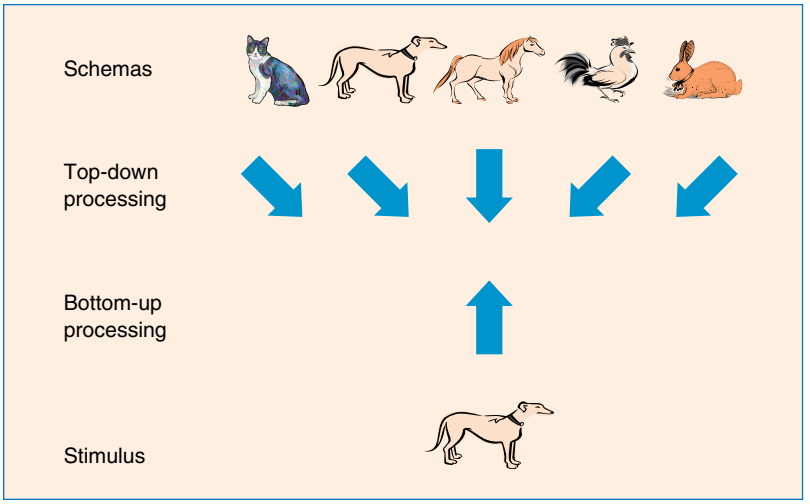

Figure 1.8 Top-down and bottom-up processing.