Making Everything Easier!™

Cognitive Psychology

FOR DUMMIES®

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Learn to:

- Grasp the fundamentals of cognitive psychology
- Apply key concepts concerning perception, memory, language and thought
- Write better research reports

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Introduction

The fact that you're reading this book implies that you have an interest in cognitive psychology or you're studying it for a course. In either case, you probably think that you know what cognitive psychology is: the study of all mental abilities and processes about knowing. Clearly, the subject covers a huge range whose contents would barely fit into 50 books the size of this one – with more being written every day!

We think that everybody should be interested in cognitive psychology, because it's fascinating. We know that all aficionados say that (from bell ringers to beer-mat collectors), but cognitive psychology really is! By scientifically studying how people see, remember, know, speak and think, you can truly understand what being human means and what makes all humans special.

About This Book

Cognitive Psychology For Dummies is designed as an introduction to the subject. We cover the historical perspective on cognitive psychology, but also draw on interesting, more recent work.

We adopt an informal writing style, but one that remains technically appropriate and scientifically accurate. We write in plain English (which is tricky, because cognitive psychologists love jargon!). Where we do use technical language you can assume that it's the only way to express something, but overall we make the tone as friendly as possible. We even include some jokes (if you don't spot any, it's because we're not very funny!). At no point are we making fun of anyone (except ourselves).

We endeavour to relate everything in this book to everyday reality, using real-world examples to anchor the more technical information. Nevertheless, cognitive psychologists like to create highly controlled, laboratory-based experiments that, on the surface, bear little resemblance to the real world. Don't fear though; everything cognitive psychologists study has some benefit to humanity.

Most chapters also cover instances of 'when things go wrong'. These discussions show how a particular cognitive ability can go haywire in healthy people (such as visual illusions) or those with brain damage.

This book is for people who need and want to know about cognitive psychology. For the former, we present all the information covered in school and the first year of a university course (anywhere in the world) in a highly accessible way. We map the content onto the most common courses of cognitive psychology. If you simply want to know about cognitive psychology, we present some of the most interesting and fun psychology here too. We pack the book with examples and exercises you can try out and demonstrate on your friends and family to amaze them!

Conventions Used in This Book

We use conventions to help you find your way around this book easily:

- *Italic* text highlights new, often specialist, terms that we always define nearby. These include elements of jargon we just can't escape, though we also use italics for emphasis.

- **Boldfaced** text indicates part of a list or numbered steps.

Unlike most textbooks in psychology, we don't include references or in-text citations. We mention the name of a researcher when we feel that the person's work is important and worth remembering.

We sometimes describe a few of the most important and influential studies, but not always. Be assured, however, that all the results and effects we describe in this book are based on empirical research – we simply don't want to get bogged down in such detail too often.

We also provide a number of sidebars, containing additional information with more detailed theories, methodologies or clinical examples. You can skip over these without missing anything essential, but we think they're interesting and add a lot to the text.

Foolish Assumptions

Hundreds of books on cognitive psychology exist. Many are technical, long, dry, specialised or cover a very narrow area of cognition. We wrote *Cognitive Psychology For Dummies* assuming the following:

- You want to understand how people think, see and remember things.
- You have questions about how the human mind works.
- You're starting a course in cognitive psychology and haven't studied it before.
- You've found other textbooks too complicated, dry or technical.
- You're simply interested in people.

- You have a basic understanding of psychology, probably from an introductory course or reading *Psychology For Dummies*.
- You want to discover a few tips on improving your own cognition.

Icons Used in This Book

Throughout this book, we use icons in the margins to help you find certain types of information. Here's a list of what they mean.

When you see this icon, we're giving you a bit of information that may come in handy someday.

Don't forget the information by this icon! It shows what you need to pick up from the particular paragraph.

Like most sciences, cognitive psychology has a lot of terms and particular usages. We highlight them with this icon so that you can join in the conversation wherever cognitive psychologists gather.

This icon flags text that rises above what you need for a basic understanding of the topic at hand. You can skip these paragraphs if you prefer without harming your comprehension of the main point. We often use this icon when describing studies in detail or the brain regions involved in cognition.

We use this icon to point out how the information under discussion has applications or is observed in reality.

This icon indicates a task or exercise to perform on yourself or someone you know. The exercises are based on examples we provide in the text or on an Internet resource.

Beyond the Book

The area of cognitive psychology is so vast that its contents would fill far more than this book. Given that it's really interesting and exciting, we want to give you as much chance to learn about it as possible, and so we put some extras on the Internet. In addition to the printed chapters, you can find loads more (free!) *Cognitive Psychology For Dummies* information at www.dummies.com/extras/cognitivepsychology.

In an online cheat sheet found at www.dummies.com/cheatsheet/cognitivepsychology, we include a quick guide to some central cognitive psychology ideas on memory, language and problem solving, among other topics.

Where to Go from Here

We organise this book in a logical representation of how the human brain works (information comes in, is remembered, spoken and thought about), but each chapter is self-contained so that you can dip in and out at your leisure. Except for the first and last parts, each part

deals with a different element of cognitive psychology, so you can pick out the sections that you're most interested in or are struggling with the most.

Use the table of contents and index to find what's most relevant to you. If you're new to the subject, you may want to start with Chapter 1 and read the book in sequence, but you don't have to read it cover to cover.

We hope that you find the book educational, informative and entertaining. We think that you'll like it and learn a lot about yourself as you go. If you do, tell your friends about it!

Part I

Getting Started with Cognitive Psychology

web extras Go to www.dummies.com for bonus information about cognitive psychology and almost any other topic that

interests you.

In this part …

- Understand what cognitive psychology is and why it’s so darn important.
- Realise how cognitive psychology influences every aspect of the human experience that involves thinking.
- Find useful tips on how cognitive psychology can improve your cognitive skills in school, college, university and almost all walks of life.

Chapter 1

Understanding Cognition: How You Think, See, Speak and Are!

In This Chapter

- Defining cognitive psychology
- Detailing the discipline's research methods
- Looking at some limitations

How do you know that what you see is real? Would you notice if someone changed her identity in front of you? How can you be sure that when you remember what you saw, you're remembering it accurately? Plus, how can you be sure that when you tell someone something that the person understands it in the same way as you do? What's more fascinating than looking for answers to such questions, which lie at the heart of what it means to be … well … you!

Cognitive psychology is the study of all mental abilities and processes about knowing. Despite the huge area of concern that this description implies, the breadth of the subject's focus still sometimes surprises people. Here, we introduce you to cognitive psychology, suggesting that it's fundamentally a science. We show how cognitive psychologists view the subject from an information-processing account and how we use this view to structure this book.

We also describe the plethora of research methods that psychologists employ to study cognitive psychology. The rest of this book uses the philosophies and methods that we describe here, and so this chapter works as an introduction to the book as well.

Introducing Cognitive Psychology

Cognitive psychologists, like psychologists in general, consider themselves to be *empirical* scientists – which means that they use carefully designed experiments to investigate thinking and knowing. Cognitive psychologists (including us!) are interested in all the seemingly basic things that people take for granted every day: perceiving, attending to, remembering, reasoning, problem solving, decision-making, reading and speaking.

To help define cognitive psychology and demonstrate its 'scientificness', we need to define what we mean by a science and then look at the history of cognitive psychology within this context.

Hypothesising about science

Although many philosophers spend hours arguing about the definition of science, one thing that's central is a systematic understanding of something in order to make a reliable prediction. The *scientific method* commonly follows this fairly strict pattern:

1. **Devise a testable hypothesis or theory that explains something.**

   An example may be: how do people store information in their memory? Sometimes this is called a *model* (you encounter many models in this book).

2. **Design an experiment or a method of observation to test the hypothesis.**

   Create a situation to see whether the hypothesis is true: that is, manipulate something and see what it affects.

3. **Compare the results obtained with what was predicted.**

4. **Correct or extend the theory.**

Philosopher Karl Popper suggested that science progresses faster when people devise tests to prove hypotheses wrong: called *falsification*. After you prove all but one hypothesis wrong about something, you have the answer (the Sherlock Holmes approach – if you exclude the impossible, whatever remains must be true!). This is also called *deductive reasoning* (see Chapter 18 for the psychology of deduction).

The scientific method has some clear and obvious limitations (or strengths, depending on the way you look at it):

- **You can hypothesise and test only observable things.** For this reason, many cognitive psychologists don't see Sigmund Freud, Carl Rogers and others as scientists.
- **You must conduct experiments to test a theory.** You can't do research just to find out something new.

Cognitive psychology employs the scientific method vigorously. Everything we describe in this book comes from experiments that have been conducted following this method. Although this does sometimes limit the questions you can ask, it establishes standards that all research must follow.

Describing the rise of cognitive psychology

Before cognitive psychology, people used a variety of approaches (or *paradigms*) to study psychology, including behaviourism, psychophysics and psychodynamics. The year 1956, however, saw the start of a cognitive renaissance, which challenged, in particular, behaviourism. For more background on how cognitive psychology emerged from other scientific disciplines, chiefly behaviourism, check out the nearby sidebar '1956: The year cognitive psychology was born'.

We don't intend to minimise the importance of behaviourism: it ensured that the scientific method was applied to psychology and that experiments were conducted in a controlled way. Cognitive psychology took this strength and carried it into more ingenious scientific studies of cognition.

1956: The year cognitive psychology was born

The behaviourist approach dominated psychology until 1956, when enough people found that it was insufficient to understand human behaviour. Specifically, behaviourism couldn't explain cognition. Part of the issue was that virtually all behaviourist research was conducted on animals (usually rats and pigeons), and perhaps humans are different to animals. Interest in new areas also proved difficult for the behaviourist model to deal with.

Imagery, short-term memory, attention and the organisation of knowledge can't be easily interpreted within the behaviourist model, because behaviourists are only interested in observable behaviour.

The attack on behaviourism became venomous, with American linguist Noam Chomsky leading the charge. He claimed that the behaviourist analysis for language learning was wrong (for reasons we discuss in the chapters in Part IV). His attack coincided with a series of other key papers that showed behaviourism was waning and cognitive science was the way forward: George Miller's paper on the magic number seven (see Chapter 8), Allen Newell and Herb Simon's problem-solving model (Chapter 17), and the birth of artificial intelligence. All this happened in 1956. This *cognitive renaissance* culminated in the first textbook on cognitive psychology in 1967 by Ulric Neisser, a German-American cognitive psychologist. He described this book as an attack on behaviourism.

Looking at the structure of cognition (and of this book)

Fittingly, we're writing this book to bring cognitive psychology to a wider audience around the 50th anniversary of the first published cognitive psychology textbook (in 1967).

Applications

In Part I, we review the applications of cognitive psychology and why studying it is important. Cognitive psychology has produced some incredibly exciting and interesting findings that have changed how people view psychology and themselves (as you can discover in Chapter 2). But also, people have learnt a great deal about how best to teach, learn and improve themselves from cognitive psychology, something we address in Chapter 3. The applications of cognitive psychology are so wide that studies are used in such disparate fields as computing, social work, education, media technology, human resources and much more besides.

Information-processing framework

In this book, we follow the *information-processing* model of human cognition. In many ways, this approach to cognition is based on the computer. The idea is that human cognition is based on a series of processing stages. In 1958, Donald Broadbent, a British psychologist, argued that the majority of cognition follows the processing stages we depict in Figure 1-1. The boxes represent stages of cognition and the arrows represent processes within it.

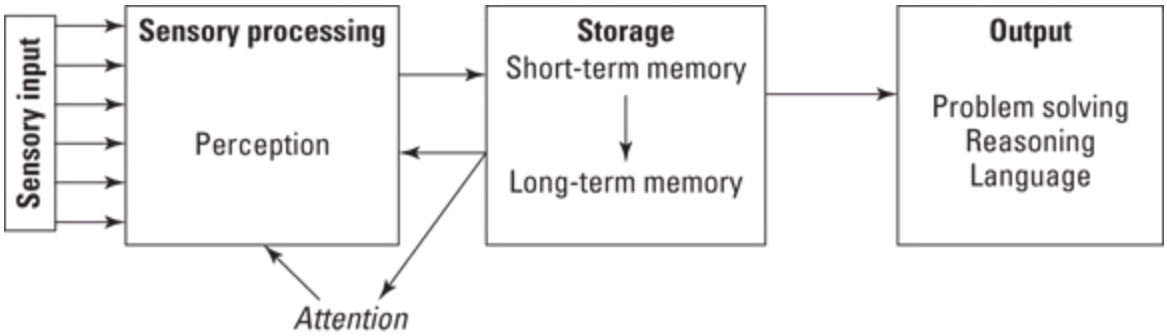

Figure 1-1: Basic processes in cognition according to information processing.

All cognition fits within this framework. Cognitive psychologists research each box (stage) and each arrow (process) in Figure 1-1 in many different domains. In other words, this framework provides a good structure for how to think about and learn about cognitive psychology (and oddly matches the framework of this book).

Your leg bone's connected to your knee bone

Cognitive psychology's favoured information-processing framework corresponds well with how the brain seems to process information. People

have sensory organs that detect the world. These connect to parts of the brain devoted to perception (in the case of vision, the *occipital lobe* in the back of the head). The information then passes forward from the perception centres to the attention centres (*the parietal cortex*, just in front of the occipital lobe) and then to the memory centres (the *temporal lobe*, in the middle of the head). Higher-level reasoning and thinking are primarily processed in the *frontal lobes* at the front of the head. Although a gross oversimplification, this description is a nice fit with the information-processing account of cognition.

Information processing may not be as simple as Figure 1-1, progressing in perfect sequence from the sensory input to long-term storage. Existing knowledge and experience may cause some processing to be in reverse. These two patterns of processing are often referred to as follows:

- **Bottom-up processing:** Physical environment and sensation drive brain processing.
- **Top-down processing:** Existing knowledge and abilities drive responses.

All forms of cognitive psychology are based on the interaction between bottom-up and top-down processing. No processing is strictly driven by the stimulus or by knowledge.

Cognitive psychologists like the information-processing framework, because people's interactions with the world are guided by internal mental representations (such as language) that can be revealed by measuring the processing time. Neuroscientists have also found parts of the brain responsible for different cognitive behaviours.

Input

In Part II of this book, we look at the first stage of cognition: input of information. In the computer analogy,

this would be a camera recording information or the keyboard receiving key presses.

Cognitive psychologists call the input of information *perception*: how the brain interprets the information from the senses. Perception is different from *sensation*, which is exactly what physical information your senses record. Your brain then immediately changes and interprets this information so that it's easy to process. This process highlights a linear progression from sensation (Chapter 4) to perception (Chapters 5 and 6).

Attention follows information input (see Chapter 7). *Attention* is the first distinct process of the information-processing account, and it's what links perception with higher-level cognition. Without it, people would simply react to the world in an involuntary manner.

Storage

After you attend to information, it enters your brain's storage system (see the chapters in Part III). The brain has a number of mechanisms for storing and using information, collectively called *memory*. We cover short-term memory in Chapter 8 and long-term memory in Chapter 9. You also have stored knowledge and skills (Chapter 10). Although all this knowledge is highly useful, we can't forget(!) to consider forgetting (Chapter 11), as well as how memory works in everyday life and some of the applications of memory research (Chapter 12).

In the computer analogy of cognition, short-term memory is the RAM: it has limited capacity and simply keeps the information you're currently using available to you. Just as you can't have too many applications or windows open on a computer simultaneously without slowing it down, the same applies to human short-term memory. Long-term memory and knowledge is the hard-disk space – a vast store of information.

Language and thought

Sensation and perception are quite low-level cognitive functions: they're fairly simple processes that many animals can do. Memory is a slightly higher-level cognitive function, but the highest-level functions are the ones that animals can't do, according to some psychologists – language and thought (see Parts IV and V):

- **Language:** The first output stage of information processing. Some psychologists describe it as a human form of communication and it's typically the vocal form of exchanging ideas with other people. We describe language and its relation to other forms of communication in Chapter 13. We cover its structure and the steps needed to produce it in Chapters 14 and 15. We discuss how language relates to other parts of cognition and perception in Chapter 16.
- **Thought:** The second output stage of information processing. Problem solving, reasoning and decision-making (Chapters 17, 18 and 19, respectively) are

complex, highly evolved abilities that are an accumulation of extensive experience, knowledge and skill. Plus, don't forget how cognition is affected by emotions (Chapter 20).

Researching Cognitive Psychology

People have devised a number of methods for researching cognitive psychology. Plus, technological advances allow psychologists to explore how the brain functions. In this section, we describe how experiments, computational models, work with patients and brain scanning helped psychologists to understand how the cognitive system works.

Testing in the laboratory

The tightly controlled laboratory experiment is one of the most commonly used techniques for researching cognitive psychology. Psychologists take normal people (like those exist!) – usually university students (narrowing the definition of normal to those generally well-educated and intelligent) – place these *participants* in small cubicles and show them things on a computer. Each person is tested in exactly the same way and the experimenters have complete control over what the person sees (as long as the computers follow the given instructions!).

Participants are usually unaware of exactly what they're going to do. They're given instructions to follow a set of tasks on the computer, often in the form of a game. (Indeed, a few years ago Nintendo

released a brain game that included several cognitive psychological tasks, such as the Stroop effect task we describe in Chapter 7.) Participants make responses on the keyboard, mouse or other specially designed equipment.

The experimenters take the participants' responses, usually in terms of measures of response speed and their accuracy, and use statistics to work out whether the hypothesis and cognitive psychological model is correct or not. These statistics allow researchers to see whether the sample tested reflects the whole population of people that could've been tested. Then the psychologists tell the world!

Crucially, experimenters must test lots of people to get reliable results. If you only test a few people, you may get very odd results, because the world contains lots of odd individuals and they usually turn up for experiments! After testing enough people, you can see the average of lots of people, which tells you whether to trust your hypothesis or not.

Being ethical in research

Cognitive psychologists have to conduct all their research following the appropriate ethical standards, as guided by the Helsinki Principle (an internationally recognised standard for ethics). The key issue is getting *informed consent* during experiments: participants must know what's going to happen to them and permit it to happen. Experimenters don't need to tell participants everything (for example, if you want to test implicit learning or memory [Chapter 9] you wouldn't tell participants about a later memory test), but they need to know enough about what they're going to do.

Informed consent is more difficult to obtain from children and people with a brain injury. In all cases, the person responsible for the participant must give consent. Psychologists then ensure that the participant wants to take part. If a person can't say, the psychologists look for cues to indicate whether the person wants to take part (say, a baby looking away from a computer).

Other ethical concerns exist (such as maintaining participants' health and wellbeing), but they come up less frequently in cognitive psychology. Download the British Psychological Society's guidance (www.bps.org.uk/system/files/documents/code_of_ethics_and_conduct.pdf).

Modelling with computers

One approach to testing cognitive psychology doesn't use people at all! Researchers can employ computers to mimic human cognition in what's called *computational modelling*. A good computational model is specific enough to predict human behaviour. These kinds of theories are more precise than the often vague verbal theories that earlier cognitive psychologists used.

Computational models are based around different types of structure (or *architecture*). *Connectionist models* are by far the most common of cognitive models. They work by having layers of nodes connected to each other by links that either promote or stop activity. Nodes in the same layer are usually *inhibitory* to each other (they prevent other nodes in the same layer from activating). We draw out a simple connectionist model in Figure 1-2, representing concepts and knowledge as a pattern of activation within the model. We go into much more detail in Chapter 10.

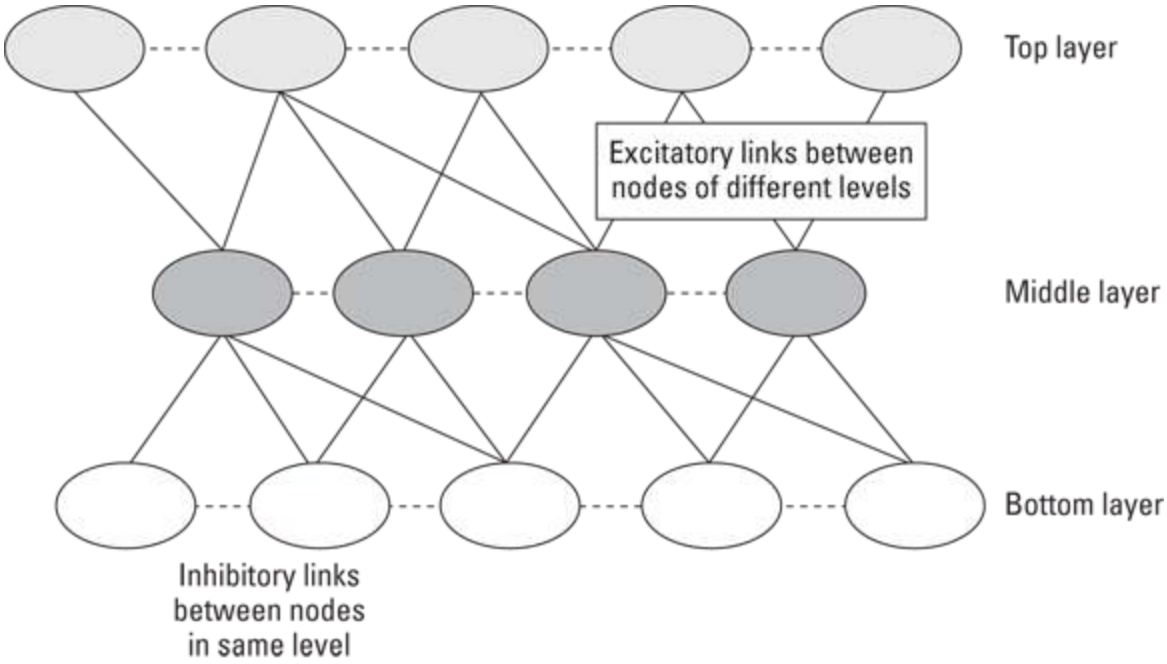

Figure 1-2: A basic connectionist model. Usually the top layer is the output, the middle layer is hidden processing and the bottom layer is the input.

Production models are based around formal logic (Chapter 18). They rely on a series of 'if … then' statements. The idea is that stored knowledge exists in terms of 'if this happens, then this will'. Another technique – *artificial intelligence* – involves constructing a computer to produce intelligent outcomes, though it doesn't have to reflect human processing.

Computational modelling can be hugely successful at explaining human behaviour, but the models created often run the risk of being incredibly complex and difficult to understand. Also, they can be modified too easily to account for a very limited set of data, making them not very useful.

Working with brain-damaged people

Cognitive neuropsychology is the study of brain-damaged patients in an attempt to understand normal cognition. Often the ingenious studies that cognitive psychologists devise are run on people with various types of brain damage to see whether they perform differently. The aim is to identify what processes take place where in the brain, and what groups of tasks are related in terms of cognitive functioning.

The neuropsychological approach has been around since the end of the nineteenth century. It has several key assumptions, as Max Coltheart, a noted Australian neuropsychologist, indicated:

- **Modularity:** The cognitive system contains separate parts that operate largely on their own.
- **Domain specificity:** Modules only work for one type of stimulus.
- **Anatomical modularity:** Each cognitive module is located in a specific part of the brain.
- **Uniformity of functional architecture across people:** Every brain in the world is the same.
- **Subtractivity:** Damage to the brain only removes abilities, but doesn't add to or change the brain in any other way. This assumption is largely wrong, especially in children, whereas the other points are at least defendable.

Neuropsychologists are always looking for dissociations or even double dissociations as the best form of evidence:

- **Dissociation:** Where they find a group of patients who perform poorly on one task but normally on others.
- **Double dissociation:** Where they have two groups of patients who show complementary patterns of impairment (so that one group is impaired on task A but not B, and the other group is impaired on B but not A). This approach shows that the two tasks are functionally different (and based on different brain structures).

Often, neuropsychologists use case studies. They look at individuals with a certain type of brain damage to understand what different parts of the brain do to a wide range of tasks. Certain people have been extensively researched and so have contributed to the knowledge of the brain more than many researchers! Chapter 21 has ten case studies for you to read.

Analysing the brain

Cognitive neuroscience is where researchers use expensive equipment to measure the brain when it's doing something. The brain consists of 100 billion neurons and each neuron is connected to up to 10,000 other neurons (that's a complex lump of goo inside your head). Yet researchers using neuroimaging have done a wonderful job of shedding light on it.

The German neurologist, Korbinian Brodmann, was the first to map the brain directly. He named 52 different brain areas and his descriptions are still used today. The assumption is that each area does a slightly different thing (based on the modularity assumption of the cognitive neuropsychologists we describe in the preceding section).

Neuroscientists use a number of ways to study cognitive psychology:

- **Single cell recording:** An electrode records the activity of single cells, which usually requires drilling into the skull and brain (so not something to undergo while eating lunch).
- **Electroencephalography (EEG):** Electrodes placed on the surface of the scalp measure the electrical activity of the brain. Electrical spikes occur due to the presentation of certain stimuli, called *event-related potentials* (ERPs). This technique records brain activity quickly but isn't good at finding the source of the activity.
- **Positron emission tomography (PET):** Radioactive substances are absorbed into the blood and a scanner picks them up when the blood enters the brain.
- **Functional magnetic resonance imaging (fMRI):** A large (and noisy) scanner detects the level of oxygen in the blood as it enters the brain. The more blood in certain areas, the more it's assumed to be active. This technique isn't good at measuring the speed of brain processing, but it can localise the source quite accurately.

- **Magneto-encephalography (MEG):** Similar to EEG, this method measures magnetic fields produced by the brain's electrical activity.
- **Transcranial magnetic stimulation (TMS):** A large magnetic pulse is sent into part of the brain, which stops that part working for a brief period.
- **Transcranial direct current stimulation (TDCS):** This method involves sending a small electrical current through parts of the brain to see how enhanced or reduced activity to a particular region affects performance on certain cognitive tasks.

These techniques can be useful in establishing which part of the brain is responsible for processing certain things, although none of them are completely accurate. To use neuroimaging techniques appropriately, you need to run a good, well-controlled cognitive test that really measures only one ability (to pinpoint which part of the brain is responsible for that ability – see the next section).

These methods also suffer from the fact that completing research while having your brain measured is an odd experience. In the case of fMRI, it involves lying down inside a big magnet – hardly the typical position when completing any form of cognition. Therefore, these techniques may change participants' behaviour.

Acknowledging the Limitations of Cognitive

Psychology

Cognitive psychologists' clever experiments (refer to the preceding section) have produced exciting findings that can help society greatly. We even use evidence from cognitive psychological research in Chapter 3 to help you in your studies!

But although cognitive psychology is generally awesome, we have to acknowledge two (minor) weaknesses to this approach:

- **Task impurity:** Many tasks that cognitive psychologists devise may not measure only the one intended aspect. For example, a researcher may be interested in response inhibition and use the Go/No-Go test (see Chapter 8), but this task also involves response conflict (a related, but subtly different cognitive process). The researcher's results may therefore reflect two different types of cognition, which is called task impurity.

  Furthermore, results from one task are sometimes not repeated in a similar task. This *paradigm specificity* reflects the problem that some cognitive psychological effects are limited to the very precise experimental procedures used to find them.

- **Lack of ecological validity:** In the attempt to be highly scientific, psychologists take people out of the real world and create artificial environments where they control every aspect of their behaviour. This is unrealistic, and so results may not occur in the real world.

Cognitive psychologists are interested in the internal mental processes that occur during cognition, but these processes aren’t directly observable. As a result, the evidence they collect is only indirect. Indeed, many cognitive psychologists’ theories are limited in scope and only focus on a small aspect of the human experience. Therefore, many areas of cognitive psychology don’t relate to other areas of cognitive psychology.

Chapter 2

Studying Cognitive Psychology Means Studying the Everyday

In This Chapter

- Seeing the central areas of cognitive psychology
- Understanding that cognition can go wrong
- Appreciating that the point lies in the journey

When people think of psychology they tend to focus on the more unusual cases and findings, such as explaining unusual behaviour. But psychology is concerned with every aspect of people's mental life, not just the extremes. The contents of most cognitive psychology books feature apparently mundane topics – such as seeing, remembering, using language and thinking – things that people do all the time without a second thought.

This focus on everyday behaviour is useful, because when you're studying any subject you improve best when it's relevant to you. Therefore, a good way to get to grips with cognitive psychology's topics is to think about how they relate to your everyday life and how you can use the knowledge to improve the way you do things.

Fortunately, cognitive psychologists have come up with a whole range of fascinating findings that alter how people view themselves. In this chapter, you read about just some of the many ways in which cognitive psychology