Attention and Pattern Recognition

Attention and Pattern Recognition introduces the main psychological research on attention and the methods that have been used to study it. It also examines the subdivisions of focused and divided attention and explores how people recognise patterns and faces. The book is suitable for the AQA-A A2 level examination and students studying attention and pattern recognition for the first time at undergraduate level.

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To my parents
John and Cyn Lund

Attention and Pattern Recognition

Nick Lund

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Attention and pattern recognition

The subject of this book, *Attention and Pattern Recognition*, comes under the Routledge Modular Psychology series that deals with **cognitive psychology**. Solso (1998) defines cognitive psychology as 'the scientific study of the thinking mind' and points out that it is concerned with a variety of areas of research including perception, pattern recognition, attention, memory, language and thinking. These research areas are closely related and there is considerable overlap between them. This is particularly true of attention, pattern recognition and perception. As Greene and Hicks (1984) point out: 'We can only perceive things we are attending to; we can only attend to things we perceive.'

 Perception is concerned with how we interpret and experience information from our sense organs. Attention is largely the concentration

on, and response to, part of the available information. Pattern recognition is the ability to pick out and organise some aspects of our visual input. Attention and pattern recognition are therefore closely linked since both involve selecting or focusing on part of our perceptual experiences. Treisman and Schmidt (1982) have argued that we should regard attention as 'perceptual glue' since it binds the features we perceive into coherent percepts of objects.

What is 'attention'?

William James (1890) wrote: 'Everyone knows what attention is. It is the taking possession by the mind, in clear and vivid form, of one out of what may seem several simultaneously possible objects or trains of thought. Focalisation, concentration of consciousness are of its essence.' While it is true that the term 'attention' is one that we all recognise and one that is in common usage (as in 'pay attention' or 'attention to detail'), psychologists find that it is a difficult concept to define. The James definition emphasises the focusing of attention or the concentration on one stimulus. This is echoed by a more recent definition by Solso (1998) who suggests that attention is 'the concentration of mental effort on sensory or mental events'.

However, part of the problem of definition is that the term 'attention' seems to refer to several different but interrelated abilities. It is probably a mistake to view attention as one ability. Allport (1993) believes that there is no uniform function to which we can attribute everything that has been labelled 'attention'. There seem to be at least two different areas of attention:

- **Focused (or selective) attention** – this is the ability to pick out (or focus on) some information from a mass of data. For example, in a crowded room there may be a hundred people talking yet you are able to listen to just one voice. This topic is the subject of Chapter 2.
- **Divided attention** – this is the ability to allocate attention to two or more tasks simultaneously. For example, an experienced driver may be able to attend to his/her driving, observe the obstacles and hazards around them and attend to a debate on the car radio. This topic is the subject of Chapter 3.

This distinction is useful when studying attention; however, in reality the difference between focused and divided attention is not clear-cut.

Somebody who is focusing their attention on writing an essay may find that they are also listening to a favourite song on the radio – their attention is now divided. Somebody who is dividing their attention between driving a car and having a conversation with a passenger will focus their attention entirely on their driving if a tyre bursts.

In addition to focused and divided attention there has been great interest in the role of practice in attention. This has led to ideas about whether tasks can be so well practised that they require no attentional resources. This has been labelled **automatic processing** and this is the subject of Chapter 4.

How is attention studied?

Although there have been numerous studies of attention, Eysenck (1984) suggests they can be divided into two basic experimental techniques:

1. **Dichotic listening task**. These are studies of auditory attention in which the participant is presented with two stimuli simultaneously. Typically one message is played to one ear and the second to the other ear through headphones. The participant is asked to select one of the messages (e.g. Cherry, 1953). As the nature of the task is to select (or to focus on) one stimulus, this technique has been used mainly to study **focused attention**. A common way of ensuring that the participants concentrated on and responded to one stimulus was to ask them to repeat one of the messages as it was played, a process which has been called **shadowing**. Although the participants were asked to focus on one stimulus, much of the interest of the researchers using this technique centred around what was noticed or understood about the rest of the stimuli.

2. **Dual task**. In these experiments participants are presented with two or more stimuli and are asked to attend or respond to all of them. As in the dichotic listening experiments, participants may be presented with two messages simultaneously, but in the dual task experiment they are asked to attend to both of them. The dual task experiments require the participant to try to attend to two or more stimuli simultaneously and are therefore frequently used in the study of **divided attention**. The ability to divide attention is affected by variables such as task difficulty and task similarity. Dual task

experiments therefore often use a variety of stimuli and tasks. For example, participants may be asked to shadow an auditory message and to search a visual scene.

These experimental techniques have been influential in the development of theories of attention. Other techniques have been used to study the application of attention research (or how attention affects everyday life). This includes the use of the **diary method** to record everyday mistakes caused by attention errors.

What are pattern and face recognition?

A vital aspect of both attention and perception is the ability to recognise and identify objects from the world around us. These objects range in complexity from a simple two-dimensional object on a page to the complex combination of features that constitute a face. Pattern recognition has been defined as 'the ability to abstract and integrate certain elements of a stimulus into an organised scheme for memory storage and retrieval' (Solso, 1998). Although the ability to recognise a letter on a page seems effortless and simple, it is a very difficult process to explain or understand. For example, the letter '**N**' can be presented in hundreds of different ways, yet no matter what font is used in print everyone can recognise it as the same letter. Examiners see essays in hundreds of different types of handwriting but can decipher most of them. This poses the question of how these very different stimuli can be identified as the same object. Pattern recognition is the subject of Chapter 5.

Recognition and identification become more complex problems when we consider face recognition. When we think of a friend's face we tend to picture a stable image. However, in reality we do not receive a stable image to our eyes. For example, as your friend approaches you, the image of his/her face grows from a small dot when they are in the distance to an image which fills your field of view when they are close. As your friend moves around, sits down, stands up, etc., you will receive very different images of his/her face from different angles. Faces are mobile and vary in expression; a happy face is different from a sad face. Despite the huge variety of images we are presented with, the faces of friends seem to remain constant (see the topics of size and shape constancy in the book in this series on perception, by Rookes

and Willson, 2000). Of course it does not have to be a friend's face; we can also recognise that several pictures of a stranger, which are taken from different angles, are of the same person. Face recognition is the subject of Chapter 6.

How are pattern and face recognition studied?

The complex processes involved in pattern and face recognition have been studied in a variety of ways:

1. **Behavioural studies**. In behavioural studies participants are typically presented with a pattern and the speed or accuracy of recognition is measured. The pattern to be detected is usually presented amongst a background of distracter stimuli. Face recognition is often studied by investigating how manipulation of an image of a face affects recognition. These types of experiment typically use human participants in a laboratory setting.
2. **Neurophysiological studies**. Another way of studying pattern recognition is to study the responses of the visual system to patterned visual stimuli. These studies usually look at the activities of the cells in the visual cortex. The firing rate of individual cells in response to different stimuli is recorded. Since this technique uses invasive surgery, this type of study uses non-human animals (primarily cats and monkeys) as participants. This type of technique is one method used in **cognitive neuroscience**. Cognitive neuroscience is the study of the structure and functioning of the brain to try to explain cognitive processes. In addition to recording the activity of single cells, cognitive neuroscientists study the general activity of the brain using techniques such as positron emission tomography (PET) and magnetic resonance imaging (MRI).
3. **Cognitive neuropsychology**. Cognitive neuropsychology is the study of the cognitive functioning of brain-injured patients. The aim is to investigate the patterns of impaired and normal performance to find the components of a model of normal functioning. For example, the condition **prosopagnosia** impairs the ability to recognise faces. However, prosopagnosia does not always affect people in the same way. Some people have problems in recognising familiar faces (including their own) but can recognise two different photographs of a stranger as the same person. Some people are

affected in completely the reverse fashion: they cannot match unfamiliar faces but can recognise familiar ones. These types of findings have very important implications for models of both pattern and face recognition.

One important distinction between pattern and face recognition is that the study of pattern recognition typically uses letters or numbers. These types of pattern are static and two-dimensional. Faces, on the other hand, are mobile and three-dimensional and we rarely see the same image of a face for long (people move, they talk, they show emotions, etc.). Therefore, although the study of face recognition does use drawings, any theory has to account for how this malleable and mobile 'pattern' is recognised.

The information processing approach

Information processing is one of the central concepts of all cognitive psychology. The information processing approach lies at the heart of the study of memory, language, thought, perception, pattern recognition and attention. This approach uses analogies from computer science to try to explain cognitive processes. It assumes that perception, memory, attention, etc. are not immediate results of stimulation but that they occur as a result of processing information over time. The cognitive psychologists' aims are to study and explain these processes. The processes involved in, for example, attention and memory may be different, but the information processing approach suggests that all cognitive abilities have three main stages:

- input – this is the reception or recording of information
- translation – this is the manipulation of information and may involve categorising data, storing data, interpreting data, etc.
- output – this is the response to the information

Each of these stages could involve a number of processes. Part of the translation process in attention, for example, might involve physical analysis followed by semantic analysis of data. Early cognitive models, which were based on the computer technology of the time, tend to be based on the idea of **serial processing**. This assumes that information has to be processed in sequence in a step-by-step fashion. If there are

several sets of information to be processed – for example, when there are two messages – serial processing assumes that they will be dealt with one at a time. A good example of a serial processing theory is Broadbent's filter model of attention (see p. 12). As computer programs became more complex, and, more recently, with the development of neural networks, cognitive psychologists began to develop models based on **parallel processing**. This assumes that two or more inputs can be dealt with at the same time. Allport's module model of attention is a good example of the use of parallel processing (see p. 32).

One consequence of the information processing approach has been the development of computer models of cognitive abilities. This is particularly true of pattern and face recognition where computer models not only have scientific interest but also have important applications (e.g. the computer recognition of postcodes on letters).

Summary

Attention and pattern recognition are two cognitive processes which have close links with memory and perception. Attention is the concentration of mental effort on either external stimuli or thoughts. One aspect of attention is focused attention. This is the ability to select some information from a mass of stimuli, and it has been studied using dichotic listening task experiments. Divided attention is the ability to attend to two or more tasks at the same time and has largely been studied using dual task experiments. Studies of the effect of practice on attention have led to theories of automatic processing. This is the idea that some tasks become so well practised that they require no attention. The study of pattern recognition looks at the ability to pick out certain stimuli and match them with information stored in memory. Although faces might be regarded as complex patterns, the study of face recognition has become a separate field of study, partly because faces are very significant in our social interactions. Pattern and face recognition have been studied using behavioural studies, neurophysiological studies and cognitive neuropsychology. The theories of attention and pattern recognition have been greatly influenced by the information processing approach which uses analogies from computer science to explain cognitive processes.

Briefly differentiate between the following pairs of terms:

Focused attention and divided attention
Dichotic listening task and dual task
Neurophysiological studies and cognitive neuropsychology
Serial processing and parallel processing

Further reading

Solso, R.L. (1998) *Cognitive Psychology* (5th edn). Boston: Allyn and Bacon. This is a good cognitive psychology textbook which has a chapter on pattern recognition and another on attention. Although primarily aimed at undergraduate level it is very easy to read.

Further reading

Eysenck, M.W. and Keane, M.T. (1995) *Cognitive Psychology – A Student's Handbook* (3rd edn). Hove, UK: Lawrence Erlbaum Associates Ltd. This is a standard cognitive psychology textbook for many undergraduate courses. Chapter 5 provides a very clear discussion of most aspects of attention, including focused attention.

Hampson, P.J. and Morris, P.E. (1996) *Understanding Cognition*. Oxford: Blackwell. Chapter 5 has a good discussion of attention and has a section on focused attention.

Further reading

Allport, D.A. (1993) Attention and control. Have we been asking the wrong questions? A critical review of twenty-five years. In D.E. Meyer and S.M. Kornblum (eds) *Attention and Performance*, vol. XIV. London: MIT Press. This review of attention is complex but provides an excellent overview of the topic and is written by one of the foremost researchers in the field.

Payne, D.G. and Wenger, M.J. (1998) *Cognitive Psychology*. Boston: Houghton Mifflin. This cognitive psychology textbook is aimed at American undergraduates. It has a good section on divided attention in Chapter 5.

Further reading

Eysenck, M.W. and Keane, M.T. (1995) *Cognitive Psychology – A Student's Handbook* (3rd edn). Hove, UK: Lawrence Erlbaum Associates Ltd. The end of Chapter 5 has a very good discussion of automatic processing and action slips.

Styles, E.A. (1997) *The Psychology of Attention*. Hove, UK: Psychology Press. This book is not aimed at A level standard and can be difficult to understand at first. However, it does have a very detailed discussion of automatic processing in Chapter 8.

Further reading

Solso, R.L. (1998) *Cognitive Psychology* (5th edn). Boston: Allyn and Bacon. This is a good textbook on cognitive psychology which is aimed at American undergraduates. It is written in a clear style and Chapter 4 provides an interesting and informative discussion of pattern recognition.

Payne, D.G. and Wenger, M.J. (1998) *Cognitive Psychology*. Boston: Houghton Mifflin. This is another advanced textbook but again it is very clear. Chapter 4 has a good section on pattern recognition which takes a slightly different perspective from that of Solso.

Further reading

Eysenck, M.W. and Keane, M.T. (2000) *Cognitive Psychology – A Student's Handbook* (4th edn). Hove, UK: Psychology Press. This is one of the few cognitive psychology textbooks that has a good section on face recognition.

Young, A. and Bruce, V. (1998). *Face and Mind*. Oxford: Oxford University Press. This is an advanced textbook written by two of the foremost researchers in this area. It has too much detail for A level work but is excellent for anyone with a particular interest in the topic.

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