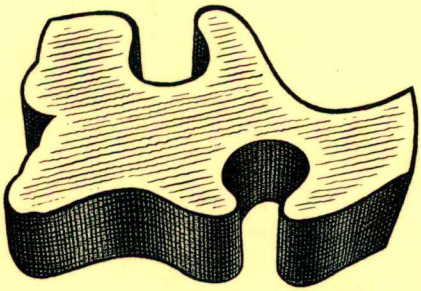
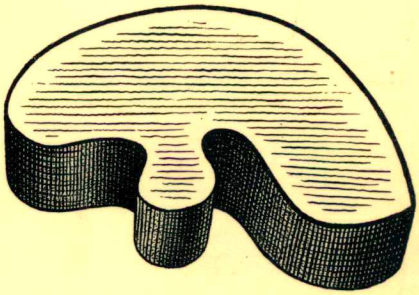
NEW ESSENTIAL PSYCHOLOGY

MEMORY, THINKING AND LANGUAGE





Topics in cognitive psychology

Judith Greene

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Memory, Thinking and Language

Topics in cognitive psychology

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To the 3 Js, Janet, John and Jonathan
from the 4th J

My grateful thanks to Pat Vasiliou for all the work she has put into typing the many drafts of this book.

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1

Introduction

There is a special difficulty about trying to write a book about memory, thinking and language, since these are just the processes which have gone into writing it. (At least one hopes some memory and thinking have gone into it and it is certainly presented in written language.) The equivalent volume to this in the earlier Essential Psychology series had the title *Thinking and Language*. The implication was that thinking and language could be treated as independent psychological activities. Interestingly there were many scattered references to the influence of memory on thought and language. Ten years on, the role of knowledge stored in memory has moved to the centre of the stage. Mental representations of knowledge based on past experiences, and the mental processes which exploit knowledge in order to interpret and act in the world, are seen as central issues in psychology.

This concern with representations and processes is a trademark of cognitive psychology. Over the past thirty years cognitive psychology has emerged as an identifiable theoretical standpoint for explaining human behaviour. There have been many

attempts to define cognitive psychology as a distinctive branch of psychology, comparable with social psychology, physiological psychology and abnormal psychology. Potentially the cognitive approach can be applied to any area of human activity. Children's development can be charted in terms of acquiring more and more complex mental representations, as implied in the work of Piaget. Social interactions depend on the way people represent the intentions and actions of other people. Perceiving the world through our senses results in mental representations of the environment. Indeed it has been claimed (Mandler, 1985) that cognitive psychology 'is well on its way to becoming mainstream psychology'.

Opposed to this is a much narrower definition of cognitive psychology as being concerned with cognition. Cognition is defined in the *Shorter Oxford Dictionary* as 'The action or faculty of knowing; knowledge, consciousness, a product of such an action'; in other words, knowing and being consciously aware. This limits the topic of cognitive psychology to conscious knowledge and those features of the environment we are aware of. In my own environment I am conscious of thinking what to say, writing these words, Handel playing on the radio, someone hammering outside, my unfinished coffee and the names of some people I am planning to ring up later. But there are many other aspects of my behaviour of which I am completely unaware, for instance the movements of the pen with which I wrote the individual letters on this page. A further contrast is between 'cold' rational cognition and two other 'hot' aspects of the mind: conation – which refers to the will – and emotion. Of course, in the real world which humans inhabit, reasoning is often coloured by emotion and thinking serves ulterior purposes. Nevertheless, cognitive psychologists have sometimes been described as being interested only in people as 'disembodied heads'.

The area of psychology covered in this book is not as wide as the empire-building definition of cognitive psychology; nor is it concerned solely with conscious cognition. Because of this ambiguity about the realm of cognitive psychology, I have preferred to retain for the title of this book the more traditional terms: memory, thinking and language. Another reason for my choice of title is that my treatment differs in emphasis from most

of the never-ending stream of books on cognitive psychology. It is a generally accepted view that cognitive psychology should be equated with an information processing model of human functioning. In this context information processing is defined as the processing of symbols which represent information. The significance of symbols is that they 'stand for' external events. Mental representations of knowledge are symbolic representations of the world. Processes like thinking, knowing and acting depend on manipulating internally represented symbols. But the information processing approach carries with it other connotations besides this neutral definition of symbol processing. Since the 1950s the guiding metaphor for developing theories of cognition has been the brain as a computer, an analogy which has had a profound effect on the development of cognitive psychology. The brain is thought of as a computer with input and output facilities and a program of instructions for carrying out operations on the data stored in its memory database. A crucial feature of computers is that they, too, are information processing systems. In human terms this means that information from the environment has to be internally represented so that various mental computations can be carried out. Traditionally information processing theories have been formulated as 'box and arrow' models in which information flows through a series of processing stages. The model in Figure 1 is a typical example of a psychological theory which implies that information input from the environment is encoded into different types of symbols as it is passed from one store to another.

This notion of memory stores has had an enormous influence on models of cognition. In textbooks on cognitive psychology theories are usually presented in the order of the stores shown in the 'multi-store' model in Figure 1, beginning with theories of perception, moving on to theories of short-term memory and

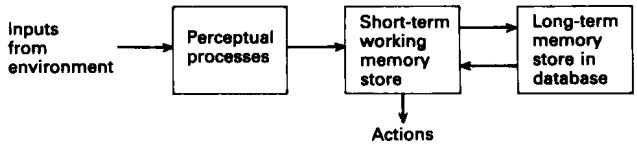


Figure 1 Information processing 'multi-store' model.

finally to theories of long-term memory. I have preferred to take as my starting-point the central role of knowledge representations in long-term memory, working outwards to demonstrate their influence on interpretations of inputs and on the planning and execution of actions. While everyone acknowledges the importance of interactions between knowledge and input information, there is a tendency to look at each stage in isolation. My aim in starting with knowledge is to draw attention to central issues concerning the selection of relevant information and actions to achieve perceived needs. Formulating questions like this emphasizes the integrated nature of cognitive activities, which is reflected in the three major themes listed below.

1 The central role of knowledge in interpreting the environment.
2 The processes by which knowledge gets translated into speech and action.
3 The principles underlying the learning of facts and acts, strategies and procedures for action.

In fact a possible title for this book could have been *Knowledge, Action and Learning*, to emphasize that knowledge informs all thinking, learning, speech and action.

The intertwined nature of human cognitive activities has certainly not made the planning of this book an easy task. The first difficulty is how to parcel out topics under neat chapter headings. A further problem is that, despite the formal distinction between scientific theories and the experiments designed to test them, psychological theories of memory, thinking and language often stem from preconceived ideas about human capabilities. If a psychologist believes that there is no essential difference between human thought and the way a rat learns to run down a maze, then he or she will be likely to design experiments in which human beings are hard put to display anything but rat-like behaviour. On the other hand, a belief in the complexity of human mental processes encourages experiments in which people are given the opportunity to solve complicated problems requiring goal-directed reasoning and creative thinking.

My principle has been to group areas of research together according to the theories and methodologies most commonly used to investigate memory, thinking and language. As will

become all too clear, there is no single theoretical framework capable of explaining all human thought and action. However, in the final two chapters, I have attempted my own synthesis of some implications of cognitive psychology for learning and teaching. A linking theme throughout is to characterize the knowledge and problem-solving strategies of those recognized as experts and to identify procedures which may succeed in transforming novices into experts.

Clearly in a book of this size it is impossible to cover all the psychological research which has been done on memory, thinking and language. Rather than attempting to sample the full range of evidence, I have preferred to concentrate on a representative selection of experiments, describing them in sufficient detail to get over the flavour of cognitive research. This has inevitably meant that some very important areas have been mentioned only in passing, for instance cognitive development, individual differences, nonverbal communication, theories of word recognition and models of reading (but see other volumes in the New Essential Psychology series: Turner, 1984; Shackleton and Fletcher, 1984; Gahagan, 1984; Barber, 1987).

2

Thinking and knowledge

It may seem obvious to the layman that thinking, knowledge and intelligence are interconnected. Indeed, they are often defined in terms of each other, intelligence being defined as knowing how to think constructively. Yet, almost from the first emergence of psychology as a subject for study, there has been a division between psychometricians, whose aim is to devise tests of intelligent thinking, and experimental psychologists who study the general characteristics of human thinking and knowledge. I shall be referring to both these traditions and their implications for theories designed to explain intelligent behaviour.

What is thinking?

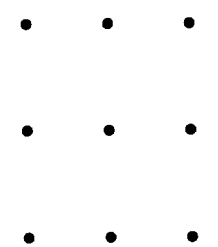
If asked to define thinking, most people would probably agree on a list of mental activities, including some of the following: day-dreams, wishes, having ideas, philosophical theorizing, making decisions, planning a holiday, working out a problem. How do we arrive at such a list? Essentially by scanning the thoughts

which pass through our conscious minds. Clearly there is some quality which enables us to distinguish between the mental activity we call thinking and other more physically overt kinds of behaviour. For one thing, thinking seems to be private and internal to ourselves, in the sense that we are free to conjure up the world – and try out various courses of action in our minds without necessarily telling other people what we are thinking or committing ourselves to action. It has been argued that it is this property of being able to run through actions symbolically rather than in actuality that constitutes human thinking, in the same way that a bridge-builder will create models to try out stresses and strains without going to the expense of building a full-scale bridge. Yet, if we are totally honest, perhaps the most conspicuous quality of moment-to-moment thinking is its fragmentary nature, attention flitting around from topic to topic. It sometimes seems as if our minds are a stage and that we have no control over the entries and exits of random thoughts, images and conjectures.

Despite this everyday experience, most definitions of intelligence stress sheer 'brain power', meaning the ability to think things through in a logical way and to adapt thinking to the problem in hand. Within the psychometric tradition of intelligence testing, the aim has been to measure 'pure' intelligence, as demonstrated by the ability to reason and to follow a consistent train of logical deductions. In conventional IQ tests, tasks are selected which (a) have one right answer and (b) produce large differences in scores to discriminate between individuals with supposedly different levels of intelligence. A full account of the development of IQ tests is given in another book in this series (Shackleton and Fletcher, 1984).

Insight and creativity

Emphasis on the reasoning required to solve well-defined logical problems masks another aspect of human thinking. This is the ability to tackle novel and open-ended problems. One well-known example is the nine dot problem. The task is to draw four straight lines (without raising your pencil from the paper) which will pass through all nine dots.



If you try this for yourself you may find that, like most people, you have represented the problem to yourself as having to draw straight lines which keep within the boundaries of the square. But this particular problem can be solved only by taking an imaginative leap which allows you to draw lines that go outside the square (see solution in Figure 3 at the end of this chapter). The sudden reformulation of a problem which makes a solution obvious is often called insight.

During the 1920s and 1930s the Gestalt group of psychologists, Kohler, Koffka and Wertheimer, argued strongly that thinking depends on the overall structure of the perceptual field. The problems worked on by the Gestalt psychologists tended to have a strong perceptual bias, such as the classic experiments by Kohler, in which he claimed that apes could show insight into the perceptual relations necessary to use one stick to reach another longer stick in order to reach a banana. In a case like this it is easy to see how Gestalt laws about restructuring the perceptual field could affect the way a problem-solver gains 'insight' – a perceptual metaphor – into a possible solution. It is more difficult to see how one would specify the perceptual factors involved in solving a purely abstract logical problem for which there is no perceptual representation (yet notice my unconscious use of the metaphor 'see' in this sentence). Psychologists working in the Gestalt tradition have used a wide variety of problems, ranging from those most clearly dependent on perceptual restructuring, for example Katona's (1940) matchstick problems, to abstract problems which require a grasp of underlying principles. What they all have in common is that they are complex rather than simple and that their solutions are by no means obvious. A famous example is Duncker's (1945) classic radiation problem: 'Given a human being with an

inoperable stomach tumour, and rays which destroy organic tissue at sufficient intensity, by what procedure can one free him of the tumour by these rays and at the same time avoid destroying the healthy tissue which surrounds it?' Duncker was one of the first experimenters to use the method of getting the people taking parts as subjects in his experiment to talk aloud while trying to solve the problem, producing what are now called verbal protocols.

Duncker analysed the various suggestions made by his subjects as attempts to solve the main goal by setting up subgoals, for example avoiding contact between the rays and healthy tissue, desensitizing or immunizing the healthy tissue, reducing the intensity of the rays on the way. The point Duncker is making is that these proposals are not just trial and error stabs at solving the problem but are geared to a prior analysis of functional types of solution. The proposed methods result from a reformulation of the overall structure of the problem, from which certain kinds of solutions naturally follow. A breakdown of the suggestions made by one of Duncker's most creative solvers is shown in Figure 2.

In case you are wondering, Duncker's preferred solution was to disperse the rays by sending a lot of weak rays from different directions so that they would meet in sufficient intensity at the tumour. Certainly this 'dispersion' solution requires 'insight'; but reading records of his subjects' thinking aloud protocols, one gets the distinct impression that Duncker as experimenter was rejecting certain suggestions and leading his subjects by hints to a more appropriate solution. The whole thrust of the Gestalt tradition was to help people to restructure a perceptual problem space so as to achieve a novel although, of course, also an appropriate solution. The Gestalt psychologists were more interested in the general principles underlying creative problem-solving than in the question of why some subjects produced several solutions, while other subjects never solved Duncker's problem despite all the hints they were given.

In contrast, the whole issue about what makes some people more creative than others attracted a lot of attention in the early 1960s in the wake of American worries about the USSR winning the race to put up the first sputnik into space. Guilford (1959), in a comprehensive analysis of the components of intelligence,