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Human Memory

Theory, Research and Individual Differences

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HUMAN MEMORY: THEORY, RESEARCH AND INDIVIDUAL DIFFERENCES

by

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To Chris

PREFACE AND ACKNOWLEDGEMENTS

The commentator's classic remark on a football match that "It was a match of two halves" is applicable with slight modification to this book, for it basically comprises two halves. The main reason is that there are some psychologists who are interested in the processes of human learning and memory, and there are other psychologists who are interested in individual differences, but hitherto any attempt at communication between the two groups has resembled the dialogue of the deaf. My main aim in writing this book was to present the ideas and experimentation of both groups of workers, and to show the potential for cross-fertilization.

Part I of the book is largely concerned with current information-processing accounts of the various stages of processing involved in human learning and memory, whereas Part II deals primarily with individual differences. The work discussed in Part I has suffered from the prevalent assumptions that all individual differences can safely be relegated to the error term of the analysis of variance. The work discussed in Part II has suffered from a failure to utilize the conceptual and experimental advances that have transformed memory research over the past decade.

There have been some researchers who have successfully combined an interest in problems of learning and memory with an awareness of the importance of individual differences, and the work of three of them (Spence, Spielberger, and my father) is discussed in some detail in this book. Needless to say, my intellectual development owes much to each of them.

It is a pleasure for me to express my gratitude to several people who have in some way contributed to the book. Chris Cromarty provided expert assistance with the figures. My ideas on several points have been influenced by my students and friends, particularly Hilary Klee, Susan Bibby, Dave Riley, Chris Gillespie, Brian Clifford, and Harry Sacks, and by my colleagues, notably by David Legge and Vernon Gregg. I would also like to thank my parents, who have helped me in their very different ways. Above all, however, my greatest

debt of gratitude is to my wife, who has suffered patiently during the long months when the manuscript was in preparation, and who has been a source of inspiration. Finally, thanks are due to Jemima, who was an enthusiastic participator in the enterprise. May her involvement in psychology wax while her bird-catching proclivities wane.

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CHAPTER 1

INTRODUCTION

The research literature in psychology is enormous, and increasing at a very fast rate. The psychologist determined to read every article that is published each year would need to read one article every 15 minutes, 24 hours of the day, 365 days a year. He would also need to be a polyglot. When one considers in addition the proactive and retroactive interference to which our sleep-deprived obsessionalist would be exposed, and the almost impossible task of integrating the disparate findings, it becomes clear that we are all extremely selective samplers of the literature in psychology. Even within the more modest boundaries of work on human memory, it has become essential to focus one's attention on certain phenomena to the exclusion of others. This book deals primarily with long-term memory, although there is some coverage of short-term memory. Little is said about the modality-specific stores into which it has been argued that information goes initially. The research on such stores, labelled iconic and echoic memory by Neisser (1967), has been capably reviewed by others. The interested reader is directed to recent articles by Crowder (1975) on echoic memory and by Coltheart (1975) and Holding (1975) on iconic memory.

The reader should be warned that the enormous recent proliferation of articles and books on human memory does not necessarily imply a commensurate increase in knowledge. It is difficult to disagree with the following somewhat pessimistic statement from Tulving and Madigan (1970): "Many inventions and discoveries in other fields would bewilder and baffle Aristotle, but the most spectacular or counter-intuitive finding from psychological studies of memory would cause him to raise his eyebrows only for an instant" (p. 437).

A more detailed analysis of current experimentation on human memory has been provided by Newell (1973) and Allport (1975). Their first point is that research tends to be phenomenon-driven, i.e., some finding, closely tied to a

particular experimental paradigm, is exhaustively analyzed and investigated. Unfortunately, the usual consequence of this thorough investigation is total obfuscation or disappointment, or both. For example, consider the part-to-whole transfer paradigm introduced by Tulving (1966). Control and experimental groups of subjects learned two lists of words, the second of which was twice as long as the first. Retention was tested by free recall, with the subjects recalling the words in any order. For the control group, the two lists were unrelated, whereas, for the experimental group, all the first-list words were included in the second list. Counter-intuitively, the experimental subjects had more difficulty than the control subjects in learning the second list, in spite of the fact that the experimental subjects had previously learned half the words. Tulving argued that the experimental subjects had organized the first-list words in order to learn them, and that this organization was inappropriate to the second-list situation.

In subsequent work, Wood and Clark (1969) and Novinski (1972) found that informing subjects in the experimental group that the second list included all the first-list words eliminated the slower learning of the experimental subjects obtained by Tulving (1966). Slamecka, Moore, and Carey (1972) argued that the experimental subjects would notice that some of the words on the second list had come from the first list, but they would not be certain that they had all been included. Thus the experimental subjects might be cautious in their recall in order to avoid possible intrusion errors. In support of this contention, Slamecka et al. found that inferior performance by the experimental group was obtained with neutral instructions, but not with instructions asking the subjects to adopt a lenient criterion for response. The initial part-to-whole transfer phenomenon, which was at first thought to provide strong evidence for organizational processes in memory, is thus now seen as a somewhat fragile and complex effect. Furthermore, its relevance to important theoretical issues is now in doubt.

The concentration of effort on phenomena derived from specific experimental paradigms carries with it the danger of paradigm-specific theorizing. For example, theories have been proposed on the basis of data collected solely or primarily from a single experimental paradigm, such as free recall, serial learning, or paired-associate learning. This tendency is so strong that Murdock (1974), in his recent book,

discusses theories of association, serial order, and free recall in separate chapters. The danger, of course, is that theories formed on a narrow data base will have extremely limited applicability to the findings from other paradigms. Even in those cases where the same theoretical concept has been applied to data from various experimental situations, there have been remarkably few attempts to establish the identicality of the concept across situations. For example, as Watkins (1974) has pointed out, the concept of 'primary memory' has been applied to data from several paradigms, including free recall and probe experiments. A necessary but not sufficient test of the assumption that the same concept is applicable cross-situationally would be the demonstration that those with a relatively large (or small) primary-memory store in one situation should also have a relatively large (or small) store in other situations. This cross-situational generality has not as yet been systematically studied.

A further difficulty is that theoretical approaches have frequently involved the postulation of binary oppositions, such as the following: all-or-none versus incremental; serial versus parallel; peripheral versus central; continuous versus discontinuous; heredity versus environment; and so on. While it is surely true that many of these conceptual dichotomies relate to important theoretical issues, the actual consequence of these theses and antitheses has rarely been the desired Hegelian synthesis. Instead, it usually transpires that the dichotomy is either misleading or that one cannot safely favour either side of the opposition. If we continue our current practice of studying limited phenomena and proposing unhelpful binary oppositions, Newell (1973) argues, the future is unpromising:

> Another hundred phenomena, give or take a few dozen, will have been discovered and explored. Another forty oppositions will have been posited, and their resolution initiated. Will psychology then come of age? How will the transformation be accomplished by this succession of phenomena and oppositions?...It seems to me that clarity is never achieved. Matters simply become muddier and muddier as we go down through time (pp. 287-289).

A further, related, problem is the plethora of theoretical

concepts in recent work on human memory. In the last decade or so there has been an enormous increase in the number of terms used to describe the workings of memory. Although those who wield Occam's razor too recklessly are liable to slit their own throats, more regard for Lloyd Morgan's (1894) canon regarding parsimony would be appropriate. According to the literature, we have iconic, echoic, active, working, acoustic, articulatory, primary, secondary, episodic, semantic, short-term, intermediate-term, and long-term memories, and these memories contain tags, traces, images, attributes, markers, concepts, cognitive maps, natural-language mediators, kernel sentences, relational rules, nodes, associations, propositions, higher-order memory units, and features. While it is true that many of these concepts have explanatory power in interpreting the experimental data, it is also true that they are frequently used in senses other than the rigorously scientific. The reader is warned that we are far from having an established taxonomy of memorial processes and structures.

A final difficulty with contemporary approaches to human memory is what Reitman (1970) referred to as the decoupling problem. In order to simplify experimental work on memory, laboratory tasks are frequently chosen in order to decouple the memory system from the large system of cognitive processes and problem-solving strategies. There is also an attempt, implicit or explicit, to utilize experimental paradigms in which individual differences in personality and motivation will be minimized. The decoupling problem has several aspects to it:-

(1) It may not be possible to study memorial processes separately from other cognitive processes.

(2) Since the memory system usually operates in interaction with other functional systems, we may well obtain non-representative data in our attempt to decouple the memory system.

(3) Research questions involving the interaction of the memory system with other processes are of importance and require investigation. At the present time, fewer than five per cent of all the studies on human memory include any consideration of either motivational factors of relevance or individual differences in personality.

In spite of the various methodological and theoretical problems associated with research on memory, there is no

doubt that much genuine progress has occurred over the past ten to fifteen years. It is hoped that this discussion of the problems will provide a critical framework for evaluating the work considered in the following chapters. The first part of the book deals with data and theory on the major memorial processes, and the second part deals with the relationship between memorial processes and ageing, motivation, intelligence, and personality.

Summary

While our knowledge of the functioning of human memory has increased considerably in recent years, there remain a number of problems which beset research in this area. Among the more consequential of such problems appear to be the following:-

(1) Paradigm specificity - the tendency for generalizations and theoretical statements to be based exclusively on findings obtained from a single, limited, experimental situation.

(2) Binary oppositions - the tendency for theorists to assume that performance is determined by one or other of two mutually exclusive processes, a tendency which is limiting conceptually.

(3) A plethora of concepts - several dozen new concepts have been introduced into the research literature over the past few years. Many of these concepts overlap substantially with previous concepts, and several of them have no unequivocal scientific meaning.

(4) The decoupling problem - it is usually tacitly assumed that experimentation on memory should attempt to isolate the memory system from other systems. The author doubts whether this is either possible or desirable.

CHAPTER 2

INFORMATION STORAGE

Over the past twenty years, several attempts have been made to describe what happens when people perceive and retain information from the external environment. Two different aspects of information processing have been emphasized in recent theories: structure and process. Those who emphasize structure have usually suggested that the nature of the information-processing system imposes limitations on the rate of flow of information through it. It has commonly been assumed that there is a temporal sequence to the flow of information, which passes from modality-specific stores through a short-term store (STS) to a long-term store (LTS). On the other hand, those theorists stressing the importance of process have concentrated more on the richness and variety of encoding and processing strategies which can be applied to incoming information. While it is convenient to distinguish between process and structure for expository purposes, they undoubtedly interact and depend on one another in a variety of complex ways.

Structural Theories: Boxology

The best and most detailed information-processing theories of human memory put forward during the 1950s and 1960s were of the structural variety. The theories in question were those of Broadbent (1958), Waugh and Norman (1965), and Atkinson and Shiffrin (1968). While these theories differ in points of detail, it is nevertheless possible to construct from them a 'modal model' (Murdock, 1967, 1972) incorporating the substantial overlap among them (see Fig. 2.1). It is assumed that information is initially held in a modality-specific sensory store, but that information is rapidly lost through decay unless attention is paid to it. Attended items are passed on to a limited-capacity STS, where they are rehearsed or displaced by further items. Rehearsal is used both to maintain items in STS and to transfer (or copy) information about the items to a semi-permanent LTS. Any items in STS at the time of test can be recalled. The

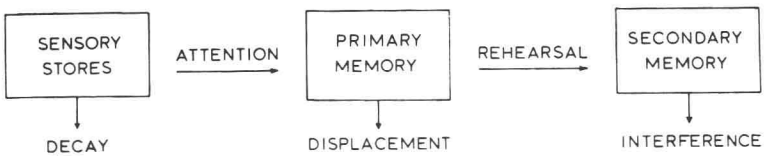

Fig. 2.1. The basic structural model of memory.

capacity of LTS is essentially unlimited, with forgetting being determined by interference. Waugh and Norman (1965) used the term 'primary memory' to refer to STS, and 'secondary memory' to refer to LTS. It has been suggested (e.g., Baddeley, 1972a) that an important distinction between STS and LTS is that information processing is primarily phonemic (i.e., acoustic and/or articulatory) in STS, but predominantly semantic in LTS.

In order to distinguish between STS and LTS at an experimental level, a much-used task has been that of free recall. The subject is presented with a list of words, and then has to recall as many as possible in any order. It is usually found that the subject recalls well from the beginning (the primacy effect) and the end (the recency effect) of the list, with recall leveling out in the middle of the list (the asymptote). Several variables affect the asymptote, but have no discernible effect on the recency portion of the recall curve. For example, the more items in the list, the lower the asymptote (Postman & Phillips, 1965); the less frequent the words presented are in the language, the poorer the recall of the middle-of-the-list items (Raymond, 1969); and the faster the rate of presentation, the lower the asymptote (Glanzer & Cunitz, 1966). The fact that none of these variables affects the recency effect suggests that different structures are involved in different parts of the list. More specifically, the assumption has been that recall from the initial and middle portions of the list is from LTS, whereas recall from the last few serial positions is predominantly from STS (see Fig. 2.2). This assumption is supported by the finding that

a distracting task interpolated between the end of list presentation and recall eliminates the recency effect, but has little effect on recall from the earlier parts of the list (Glanzer & Cunitz, 1966). Frequently, the discrepancy between immediate and delayed free recall has been taken as an estimate of the capacity of STS.

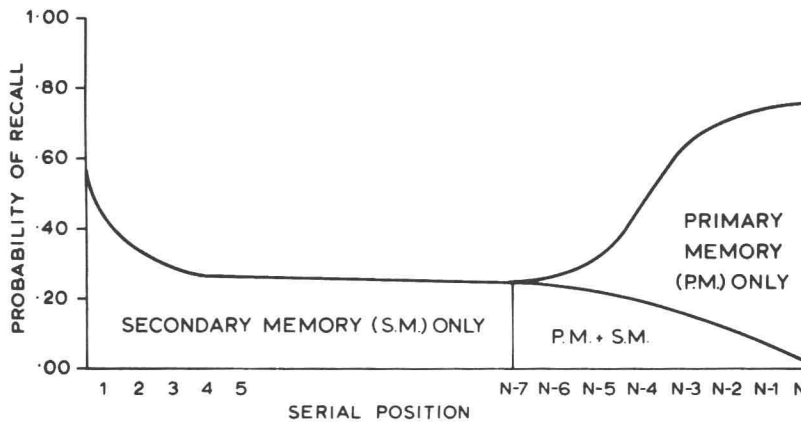

Fig. 2.2. The theoretical involvement of primary memory and secondary memory in immediate free recall as a function of serial position.

Since the structural models of human memory regard the extremely limited capacity of STS as one of its prime characteristics, several attempts have been made to provide accurate estimates of its capacity (cf., Watkins, 1974). Craik (1971a) discussed some of the methods which have been used, most of which are based upon the free-recall paradigm. Glanzer and Razel (1974) collated data from 21 free-recall studies, and found that the mean estimate of STS capacity was 2.2 words. As Glanzer and Razel pointed out, the capacity of STS seems so small that it would appear to be of extremely limited value in the processing of conversation.

It has usually been assumed that the capacity of STS is appropriately measured in terms of the number of words stored. For example, Craik (1968a) varied the number of