

respond to each question either affirmatively or negatively.

The results of such experiments show that both recall and recognition of the studied items vary with the type of encoding operation and response category at the time of study. Semantic judgements are more effective than phonemic judgements which in turn are more effective than graphemic ones; also for the first two kinds of judgements, encoding questions requiring affirmative responses are more effective than those requiring negative ones. The superiority of semantic encoding is regularly found in most situations. But the fact that recognition is higher for semantic questions answered affirmatively than for those answered negatively suggests that semantic encoding operations can be further analyzed into differentially effective classes.

Such further analysis shows that different kinds of semantic encoding operations can also vary in effectiveness. In one experiment, for example (Mathews, 1977), people were presented with word triplets (e.g. "lion," "whale," "mammal"; or "lion," "whale," "circus"; or "lion," "whale," "metal") and were asked to judge whether both, one, or none of the first *two* words were semantically related to the third. All subjects were subsequently given one of the two first words from the triplet as a cue (e.g. "lion") and asked to recall the other one (here, "whale"). The results showed that the probability of such cued recall varied greatly – over a range of 0.10 to 0.68 – with the number of semantic relations in the study triplet.

The effects of many different encoding operations have been reliably documented in the literature, using such standard measures of memory performance as free recall and recognition. It is generally assumed that encoding operations play an important role in memory even when they are not specifically manipulated, and even when the rememberer is not consciously aware of how any particular event has been encoded. It is also known that the exact effects of any encoding operation depend on the nature of retrieval information available to the learner at the time of retrieval. These effects are subsumed under the rubric of the ENCODING SPECIFICITY PRINCIPLE.

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encoding specificity principle A general statement regarding the relation between encoding and retrieval conditions necessary for the remembering of an item or event: the effectiveness of encoding operations depends on retrieval cues, and the potency of the cues varies with encoding operations.

How well a person remembers an event or a fact depends on two critical factors: (1) the initial encoding operations and the resulting memory trace, and (2) the subsequent retrieval environment or retrieval cues (see ENCODING OPERATIONS IN MEMORY; FORGETTING; RECALL; RECOGNITION MEMORY). The encoding specificity principle is a general theoretical statement regarding the relation of these two determinants of remembering. It holds that the specific encoding operations performed on what is perceived determine what is stored in memory, and what is stored determines what retrieval cues are effective in providing access to what is stored (Tulving & Thomson, 1973, p. 369).

It has been known for a long time that the recall and recognition of items of presented information depend greatly on the *properties* of these items in the "permanent memory store," properties such as meaningfulness, concreteness, imaginability, and general familiarity. Another important class of determinants of memorability has also been known for a long time, namely conditions of learning and retention. It comprises variables such as the inten-

tion to learn on the part of the learner, the frequency and recency of presentation of the to-be-remembered material, the length of the retention interval, and the amount of proactive and retroactive interference present in the situation (see PROACTIVE INTERFERENCE; RETROACTIVE INTERFERENCE). Finally, it is commonplace that memory performance may vary greatly with the conditions of retrieval, defined by variables such as the presence or absence of retrieval cues and their characteristics. A good deal of experimental evidence has been accumulated since Hermann Ebbinghaus in support of all of these ideas.

More recent research, however, has shown that it is quite possible to hold constant all of these "classical" learning and retention variables, and still observe large differences in how well the studied material is recalled or recognized. Such differences in memory performance come about as a consequence of differences in the *relation* between the encoding operations performed at study and the cues available at retrieval. Thus, how effective a given encoding operation is depends on the nature of the cues given to the rememberer later on. Conversely, the effectiveness of a cue depends on the nature of encoding operations performed earlier, at the time of study.

Consider two illustrative experimental facts. First, it can be readily shown that a strong semantic association exists between the words "king" and "queen." But whether or not "king" as a cue word facilitates recall of the previously studied target word "queen" depends greatly on the specific encoding operations performed on the word "queen" at the time of study. For instance, if the subject sees the target word "queen" as a member of a pair of words, such as "lady"-"queen," and encodes "queen" in relation to "lady," the presentation of the cue word "king" at time of retrieval does not facilitate recall of "queen" when compared with recall in the absence of any specific cues. Second, when a person has heard a sentence such as "The man tuned the piano," the cue "nice sound" is quite effective in helping him to recall "piano" whereas the cue "something heavy" helps little. Conversely, when the originally heard sentence is "The men lifted the piano," "something

heavy" is an excellent cue whereas "nice sound" is not (Barclay, Bransford, Franks, McCarrell, & Nitsch, 1974). This interaction between encoding and retrieval conditions occurs despite the fact that in the learner's semantic memory the "piano" that can be tuned and the "piano" that can be lifted are believed to be represented by the same code (see SEMANTIC MEMORY).

These kinds of experimental facts – showing that the specific form of encoding affects the potency of cues, and that the potency of cues depends on the specific encoding operations performed on the item at time of study – are subsumed under the general concept of the encoding specificity principle.

A particularly striking manifestation of the encoding specificity principle is given by the fact that under certain conditions people cannot identify previously seen words as such, although they can produce the same words when the retrieval cues previously associated with the words are provided. Relevant research is known under the rubric of "recognition failure of recallable words" (Tulving & Thomson, 1973; Flexser & Tulving, 1978). It has also been shown (Nilsson, Law, & Tulving, 1987) that even unique names of famous people – such as George Washington, Sigmund Freud, and Florence Nightingale – exhibit recognition failure. Subjects do not recognize some of these names as those they had seen in a previously presented list, but they can recall them in response to the descriptive phrases that had accompanied the to-be-remembered names at study (e.g. "He was the first of a long line, but the only one on horseback" – George Washington). Thus, under special conditions the typical superiority of recognition over recall can be reversed: recall can succeed where recognition fails (see RECALL; RECOGNITION MEMORY). Such a reversal can be explained in terms of the encoding specificity principle.

Although initially the encoding specificity principle was assumed to hold only for EPISODIC MEMORY tasks (Tulving & Thomson, 1973), subsequent research has suggested that it also characterizes the relation between what is stored and what can be retrieved from semantic memory. The domain of research on

encoding specificity has also been referred to as research on "encoding/retrieval interactions." An early version of the same general idea that is represented by encoding specificity was known as the "principle of reinstatement of stimulating conditions." It held that retrieval succeeds to the extent that stimulating conditions present at study are reinstated at the time of attempted retrieval (Hollingworth, 1928). An idea essentially identical with encoding specificity has been proposed and is known under the label of "transfer appropriate processing" (Morris, Bransford, & Franks, 1977). Like encoding specificity, it emphasizes the importance of active processing and processes at study and test, rather than stimulating conditions.

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episodic memory The kind of memory that renders possible the conscious recollection of personal happenings and events dated in the rememberer's past. The concept has undergone considerable changes since its introduction (Tulving, 1972) and is now used in

different senses by different writers and in different contexts. Two principal senses of the term are discussed here.

The first one, almost universally accepted now, is that of episodic memory as a type of memory performance. Episodic memory in this sense refers to the acquisition of symbolically representable information on one occasion and its reproduction on a subsequent occasion. The prototypical laboratory experiment, in which subjects are exposed to a collection of verbal items and then tested for their knowledge of some aspect of what they perceived, can be regarded an episodic memory experiment in this first sense of the term: the subjects' recollection of miniature laboratory events from their personal past is the object of interest.

In an episodic memory experiment, the subject is given a task consisting of two parts: (1) she or he observes or studies a set of materials presented by the experimenter, and (2) takes a test for her or his knowledge of the studied material. A large number of different test questions has been used, including the following: (1) What were the items in the study set or list? (free recall task). (2) In what order were they presented? (serial recall, or serial reproduction, task). (3) What item appeared together with Item X? (paired-associate task). (4) What item in the study list was the name of a four-legged animal? (cued recall task). (5) Did Item X appear in the study set? (yes/no recognition task). (6) Which of these two items, X or Y, appeared in the study set? (two-alternative forced choice recognition). (7) Which of these two items, X or Y, appeared earlier in the study list? (relative recency judgement) (see RECALL; RECOGNITION MEMORY). Each of these questions is designed to elicit the subject's recollection of an event that the subject has personally observed or witnessed. Each question, therefore, can be paraphrased in these terms; for example: Which items do *you* remember *seeing* in the list? Do *you* remember *hearing* Word X in the list? Which of these two items, X or Y, did *you* encounter earlier in the list? - hence the designation of these tasks as episodic memory tasks.

In the first sense, much of the research on verbal learning and memory that has been

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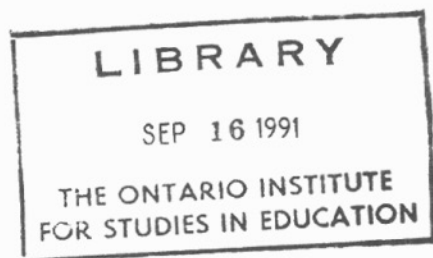
Edited by

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Editorial organization © Michael W. Eysenck 1990

First published 1990
First published in USA 1991

Basil Blackwell Ltd
108 Cowley Road, Oxford, OX4 1JF, UK

Basil Blackwell, Inc.
3 Cambridge Center
Cambridge, Massachusetts 02142, USA

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British Library Cataloguing in Publication Data

The Blackwell dictionary of cognitive psychology.

1. Cognitive psychology

I. Eysenck, Michael W. II. Ellis, Andrew III. Hunt, E.
B. (Earl B) IV. Johnson-Laird, Philip

153

ISBN 0-631-15682-8

Library of Congress Cataloging-in-Publication Data

The Blackwell dictionary of cognitive psychology/edited by Michael W. Eysenck; advisory editors, Andrew Ellis, Earl Hunt, Philip Johnson-Laird.

p. cm.

Includes bibliographical references.

ISBN 0-631-15682-8

1. Cognitive psychology - Dictionaries. I. Eysenck, Michael W.
II. Ellis, Andrew W. III. Hunt, Earl B. IV. Johnson-Laird, P. N.

(Philip Nicholas), 1936-

BF311.B535 1990

153'.03 - dc20 90-34225 CIP

Typeset in 9.5 on 11pt Ehrhardt
by Wyvern Typesetting Ltd
Printed in Great Britain by Butler & Tanner Ltd,
Frome, Somerset