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memory systems This term denotes putative brain/behavior and brain/cognition systems concerned with different forms of learning and memory. "Memory" is a general label for different forms of acquisition, retention, and utilization of information, skills, and knowledge. These different forms of learning and memory constitute a hierarchy in which forms that emerged early in evolution represent the lower levels, and forms evolving later represent the higher levels. Because evidence exists showing that the operations of different forms are related to different neuro-anatomical substrates, the different forms of learning and memory have been increasingly thought of as constituting different memory systems (Weiskrantz, 1987). All systems have in common the ability to retain, and to make available for use in ongoing behavior and cognitive functioning, effects of earlier behavior and experiences. They differ in the kind of information they handle, and in the nature of their operations.

Separate neural systems are believed to underlie simple forms of learning, such as sensitization and habituation. Some evidence also exists for separable neural bases for SHORT-TERM MEMORY and LONG-TERM MEMORY. However, most of the research concerned with the classification of forms of learning and memory has revolved around three hypothetical systems: EPISODIC MEMORY, SEMANTIC MEMORY, and procedural memory (see DECLARATIVE AND PROCEDURAL KNOWLEDGE) (Tulving, 1985). These systems are considered here.

Episodic memory is the memory system that makes it possible for a person to remember concrete personal episodes or events dated in the subjective past - that is, to remember that he or she did or witnessed something on a particular occasion at a particular time. This ability to remember personal experiences is possessed by all normal individuals, but it is

absent in very young children, and absent or less well developed in lower organisms. Episodic remembering is, in its essence, a *mental* phenomenon. It entails a conscious experience of a unique kind, one that every normal human can readily tell apart from other kinds of mental experiences, such as perceiving, imagining, dreaming, daydreaming, and hallucinating. The nature of the conscious experience of remembering a past event also differs qualitatively from the nature of the conscious experience resulting from the actualization of general knowledge about the world. The hallmark of episodic-memory capability is the rememberer's strong belief that the remembered event did in fact occur and that he or she was present when it occurred. JAMES (WILLIAM) (1890) described the difference between "remembering" one's own past states and experiences, and "conceiving" someone else's as follows: "Remembrance is like direct feeling; its object is suffused with a warmth and intimacy to which no object of mere conception ever attains."

At the next level of the classificatory scheme is semantic memory. It is concerned with what William James called "conception," or what today can be described as "general knowledge of the world." The term was introduced into the literature by Quillian in 1966, and the distinction between episodic and semantic memory, as "two parallel and partially overlapping information processing systems," was proposed by Tulving in 1972. Semantic memory was initially defined in close reference to knowledge expressible in language, but is now conceptualized much more broadly, consisting of a number of hypothetical subdivisions. The information that the semantic system handles need not have any personal relevance to the individual. Neither need it refer to the past, or any other particular time in the individual's existence. The semantic-memory system allows the individual to construct mental models of both concrete and abstract parts and aspects of the world. It makes possible the cognitive representation of stimuli, objects, situations, facts, and events, and the utilization of information thus represented in the absence of original stimuli and events.

Episodic and semantic memory have sometimes been grouped together as *declarative*, or *propositional*, or *factual* memory, since both entail acquisition, retention, and utilization (retrieval) of *factual knowledge* about objects, situations, and events, and about real or imaginable states of the world external to the individual. This knowledge can be introspectively contemplated by the individual in the absence of any overt behavior. The feasibility of such introspective contemplation is one of the important features that renders factual memory different from procedural memory (see DECLARATIVE AND PROCEDURAL KNOWLEDGE).

Procedural memory represents a lower, more general level of the classificatory hierarchy (Cohen, 1984). It is thought to be a large system that appeared early in evolution and that is shared in various forms by most living organisms. Procedural memory enables organisms to retain learned connections between stimuli and responses, including complex stimulus-response patterns and sequences. Learning in procedural memory is nonsymbolic; it can be expressed only in terms of specific *responses* or *behaviors*. This expression can occur "automatically," in the absence of directed attention (see AUTOMATIC PROCESSING). The stimuli controlling responding in the procedural system do not refer to, or represent, anything outside a given present situation. Thus, behavior mediated by procedural memory does not reflect any acquired "knowledge" about the world. This means that, unlike the information in episodic and semantic memory which may be true or false, what is learned procedurally has no truth value. Unlike episodic and semantic information that can be acquired very quickly, acquisition of most procedural-memory responses or skills occurs slowly.

The distinction between procedural and propositional (declarative) memory is now widely accepted not only in its psychological aspects but also with respect to the underlying neurophysiological mechanisms. The nature of the concepts of episodic and semantic memory, on the other hand, is still a subject of intense debate. Although most cognitive psychologists accept the distinction as a useful

heuristic, many doubt that episodic memory is a distinct system. The issues are complex and involved, with the debate revolving around the interpretation of relevant evidence, the perceived usefulness and validity of neuropsychological findings, and even matters such as the proper appreciation of the principle of parsimony.

An open problem has to do with the relation between the various systems. Two different specific proposals have been made. One holds that procedural and declarative memory constitute two *parallel* subsystems of memory, with a further subdivision of declarative memory into the *parallel* classification of episodic and semantic memory. Another view is that episodic memory is embedded in and supported by semantic memory, and that semantic memory is embedded in and supported by procedural memory. It is not yet clear which of the two, or whether some other scheme altogether, describes Nature more adequately. The relevant empirical evidence includes the existence of single and double dissociations between, as well as the order of development of, memory functions reflecting the operations of different systems.

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ENDEL TULVING

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COGNITIVE
PSYCHOLOGY

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BLACKWELL REFERENCE

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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