corresponds to recognition of a stimulus as familiar. Next, and most important in the theory, is "referential meaning." A word can arouse an image; an image can arouse a word. Finally there is "associative meaning," in which chains or hierarchies of associations among either words or images are activated. Verbal stimuli, whether words or sentences, can be either *concrete* or *abstract*: the distinction is important for Paivio because concrete words easily arouse images at the referential level whereas abstract words do not. Thus the former have access to two symbolic modes rather than one, with a corresponding advantage in many memory tasks. Picture stimuli, of course, are always concrete.

After setting out this framework in the first three chapters, Paivio goes on to survey a wide range of material. Separate chapters review the literature on tachistoscopic recognition, encoding and priming studies, associative memory, other kinds of memory, verbal mediation, image mediation, and so on. This is very useful work: the accounts of experiments are usually detailed and clear, and many familiar effects (for example visual fragmentation, perceptual set, associative symmetry) are given new and interesting interpretations. He gives particularly detailed consideration to the effects of abstractness/concreteness, as compared with such other traditional variables as familiarity or number of verbal associations, because his theory suggests that familiarity should be more important at the representational level and concreteness at the referential level. The data support him handsomely on this point. Among these chapters is also one devoted to the ancient mnemonic systems, whose importance for the psychology of memory is now generally admitted.

Though he is in his element when he reviews experimental results, Paivio is less surefooted when it comes to theories. Somehow the important questions slip unanswered through the cracks. For example, no consistent definition of "image" is ever offered. Images are described on page 12 simply as "*nonverbal* memory representations"; they are later assigned various specific properties (such as parallel processing); by page 439, they have become the psychological correlate of linguistic deep structure. This casual attitude toward definition means that he need never ask whether words and images exhaust the repertory of the mind, that

630
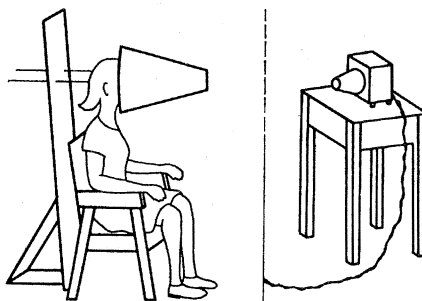
Hood used in imagery experiments by Segal. The subject is asked to form a visual image of something as if it were on the translucent screen, while the experimenter projects a real stimulus onto the screen from the other side. (The projector is usually in a separate room.) In general, imaging reduces the subject's ability to detect the projected stimuli. [From *Imagery: Current Cognitive Approaches*]

is, whether there are "imageless" concepts or thoughts. And indeed, he never does. In general, Paivio seems to take rational argument much less seriously than experimental data: thus he can adopt an imagist theory of meaning after carefully listing several objections to it which are never answered. The basic difficulty confronting this and all mediation theories—how the subject knows just what an image (or word) means in a particular instance—is never

faced. There is a rather undifferentiated acceptance of most contemporary theoretical concepts; the only harsh criticism in the book is directed at Chomsky's linguistic theory, which (predictably) is considered largely on the merits of the "psycholinguistic" experiments popular in recent years. Several chapters are devoted to such matters, and Paivio ends by endorsing the orthodox behavioristic view of language:

The present view, therefore, is that the associationistic model is essentially correct with respect to the intra-verbal contextual aspects of abstract language in particular [p. 439].

He is not worried about Chomsky's well-known criticisms of this "model" because they have all been answered in a recent paper by someone else!

Cognitive psychology cannot afford to ignore images, and cognitive psychologists cannot afford to ignore this book; it is too full of data. But data are not enough; we also need to understand what images are, and what they do, and what goes on when they are used. To these questions, we still have no adequate answers.

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Complexities of the Mind at Work

What Computers Can't Do. A Critique of Artificial Reason. HUBERT L. DREYFUS. Harper and Row, New York, 1972. xxxvi, 260 pp. $8.95.

The dominant theoretical paradigm of American experimental psychology, behaviorism, is recurrently decried for its mechanical conception of man. One of the most persistent critics has been Gestalt psychology, which offers examples of human abilities claimed to be beyond the explanatory power of the behaviorists' concept of stimulus-response associations. Gestaltists note, for example, the sudden appearance in consciousness of recognition, as in perception, and of understanding, as in insightful problem solving. Such phenomena, they claim, must have significant behavioral repercussions for which a behaviorist account is not possible. Though the Gestalt position has not been vigorously pursued for some time, the doubts it raised have never been quelled.

A recent challenger to behaviorism is cognitive simulation (CS), which attempts to define a level of analysis distinct from the matter-moving level of body, the phenomena-experiencing level of mind, and the energy-transforming level of brain. The function of this level is information processing, precisely defined by and simulatable on a digital computer. Though still limited by lack of a theory of programming, the computer is in an exact sense a universal symbol-manipulating device. CS is thus the most powerful precisely specifiable conception of cognitive processes so far proposed.

CS is sometimes seen as offering a rapprochement between behaviorism and Gestalt psychology by maintaining the objectivity of the former without being bound by its limited conceptual tools. For example, in behavioristic analysis problem solving amounts to blind search, and there is thus no plausible account of the success of intelligence applied to difficult tasks. CS proposes selective search to explain how great numbers of possibilities are dealt

with to produce recognition and understanding. Indeed, the key concept of CS thus far is selectivity, mediated by any well-specified, computationally based strategy.

Surprisingly, the CS analysis and method may have more difficulty meeting the concerns of the Gestaltists than does behaviorism. Behaviorists frequently rely upon phenomenological descriptions of stimulus and response, as can most readily be seen when we leave the laboratory and discuss human behavior in clinical and educational settings. The definitions of stimuli and responses needed to give plausible characterizations of these settings are not given in machine-recognizable form, but require a human observer for their identification. Cognitive simulators, however, set themselves the task of constructing a completely self-contained model which can interact directly with the world. Thus, though they allow themselves the full power of all forms of computation, a healthy advance over association alone, the task they set themselves is far greater than that undertaken by behaviorism.

Too great, claims Dreyfus, a philosopher who advances a view with roots in Gestalt psychology, ordinary language philosophy, and phenomenology. His book is a partly sober, partly angry attempt to say what man can do that computers can't, and to say why. It is no simple panegyric to humankind, but attempts to meet CS on its own ground, without appeal to will, affect, or entelechy. The question raised is, Can a *digital computer* simulate the full *cognitive* abilities of man? In Dreyfus's view, selection among predefined alternatives is *all* the computer can do, but this plays a minor role in cognition. What we do in those brief moments preceding recognition and understanding is not an unconscious sorting-through of possibilities. From an indefinite welter of stimulation, the mind structures situations so that only the essential aspects are considered; the inessential are paid no heed whatsoever. Further, that to which attention is paid is not generally, if ever, a specific feature with definite meaning and significance, but is characteristically vague, as word and sentence meanings are. Perhaps most tellingly, there are no such things as immutable facts sitting about the world waiting to be processed. Facts are in the *Weltanschauung* of the beholder. If all of this is so, argues the author, we must not only

give up hope of digitally simulating the cognitive processes of humans but must also dismiss the possibility of the more modest goal of devising a computationally based theory of artificial intelligence (AI) which exhibits the range and complexity of human cognition without attempting to model the same processes used by man.

Dreyfus does not resort to mysticism to explain the lawful regularities of human behavior and mental life. Thus rejecting the only characterizations of reasoning familiar to Western science—logic and magic—this view will have to many the distressing appearance of mere nay-saying. Dreyfus attempts to dispel this impression, not altogether successfully. What he offers as an explanation is not soul but body. Though realized within the realm of physics and chemistry, the Dreyfus body's parallel, analog, and "wholistic" processing cannot be mimicked by a serial, digital machine. It is more than the mind's analog-to-digital converter; it provides the means by which man sees himself in *situations* in a sense not capturable by representing potential environments as *states* of the world. The body is an integral part of our knowledge and language systems.

Though these conceptions of carnal knowledge and body English may appear foreign and vague to the programmer, the Dreyfus thesis should not be dismissed easily. He makes clear that CS and AI research faces possibly insurmountable problems, an observation which may strike some with the force of a new idea. It should come as no surprise that the book contains no knockdown arguments; the Gestalt position still awaits its definitive programmatic statement. But coming as it does as a critique of a field short on self-analysis, Dreyfus's effort could be enormously important if taken as a challenge and responded to dispassionately.

Unfortunately, it may not be, for Dreyfus has been made crotchety by the excesses of optimism and immodesty of prediction which accompanied the early promise of computer metaphors. He has responded with a lengthy polemic against CS and AI research and researchers which concludes that no progress has been or will be made toward their avowed goals. To a reader with this book as his only guide, the field will appear to be based solely on puffery and blind faith, supported at best by a philosophical analysis of the depth one might expect to read on

a tee shirt. Such blatant bias can only lead to a blunting of the book's impact, particularly since the "empirical evidence," as Dreyfus somewhat grandly calls his survey, is too often called upon to shore up his case.

The hypotheses which have been explored in the 15 years of research which this book criticizes hardly cover all possibilities. Neither this research nor Dreyfus's critique has settled the issue of whether the mind's work is done by computation alone, for while we surely do not know the nature of the mind, we do not know the full power of the computational model either. In the modeler's world, the ambient conception of man may be artless; but it is still not clear to what extent it must so remain.

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Memory Transfer

Chemical Transfer of Learned Information. EJNAR J. FJERDINGSTAD, Ed. North-Holland, Amsterdam, and Elsevier, New York, 1971. xxviii, 268 pp., illus.

The wish to educate oneself or one's children by taking pills or injections is both deeply embedded in folklore and consonant with our modern view of inexorable progress. In the past decade a literature has developed which claims not only that this is possible but that something like it has already been achieved. In various circles this literature has been met with exultant enthusiasm or passionate skepticism, but in most instances the response has been indifference in the face of what appears to be an implausible claim. In this book a number of investigators present their evidence that memory transfer has been accomplished. Some studies that have failed to confirm these claims are evaluated and there is much discussion of the present state of the art. This is the best summary that I have seen of this field and is a good starting point for those who may wish to examine it in some detail.

I should point out at once that studies of memory transfer should not be confused with the more general study of the effects of biological compounds on behavior. That behavior can be specifically influenced by chemicals derived from animals or plants has been conclusively shown. For example, thy-