15
Go for the skill

DAVID C. RUBIN

There are a few people who think and write so clearly that their work is almost always influential. They can shape a whole field. What they say has to be taken very seriously. Failure to do so can waste a lot of time either because valuable insights are lost or because less-than-valuable insights are followed. Professor Neisser has shown himself to be such a person.

There are some problems that have "garden-path" solutions that are so seductive that psychologists repeatedly take them. Professor Neisser has warned us about many of these, including the reappearance hypothesis and the fact that the physical onset and offset of stimuli are not the psychological onset and offset of stimuli (Neisser, 1967). I think nesting is such a garden path, partly because it contains a kernel of truth and partly because we have been misled by similar concepts in the past. In Gibsonian ecological terms, nesting is a garden path because it makes a structure out of a process.

In what follows, Gibson's use of the word *ecological* is taken specifically to include the following principle: Although we should always start by making a very good description of the environment before wondering how the animal interacts with the environment, we should not copy that description of the environment into the mind. If there is a ringing bell, we should not put an image or other structure to represent the ringing bell in the mind and then study that internal representation (Bransford, McCarrell, Franks, & Nitsch, 1977; Gibson, 1966, 1979; Kolers & Roediger, 1984; Kolers & Smythe, 1984; Kvale, 1977; Skinner, 1974; cf. Shepard, 1984). Although it is theoretically possible to develop a Gibsonian theory of memory that would satisfy this tenet of ecological psychology, Neisser has demonstrated in chapter 14 that such a theory probably cannot be achieved.

From a Gibsonian perspective, Professor Neisser is making a structure out of a process, and when he makes a structure out of a process, he uses a different metaphor, a metaphor that adds much that is not wanted or needed. Mental structures, like other structures, tend (a) to

Table 15.1. *Things to put in the mind*

Associations	Nets and nests
Augmented transition networks	Pictures, sometimes moving
Codes, both verbal and imagery	Propositions
Holograms and hierarchies	Schemas, scripts, and similarity spaces
Grammars, story and otherwise	Trees and traces
Maps, MOPs, and mental models	Wax tablets, often brittle

be spatial, (b) to be rigid, (c) to be slow to change, (d) to have boundaries that include and exclude smaller components, and (e) to have specific locations in a more general organization and sometimes even in the brain. None of these properties is necessary, but they nonetheless are part of the metaphor.

In order to state the objection more clearly, two metaphors, or approaches, or ways to look at the world, need to be contrasted. The first is the complex-structure metaphor of which nesting is one example. The second is the skill, or complex-process, metaphor. Anything that can be understood using one metaphor can be understood using the other. A Gibsonian approach, however, strongly favors the latter.

In the complex-structure metaphor, which is the dominant metaphor in cognitive psychology today (Roediger, 1980), structures are devised by the researcher to account for observed behavior, usually by having the structure that the animal perceives in the world copied into an analogous structure in the mind. In the case of nesting, the nesting of events in the world is copied into, and then later explained by, nesting in the mind.

In contrast, in the skill or complex-process metaphor, learning, memory, and perception are accounted for by the animal's developing or tuning or differentiating its abilities, methods, strategies, or expertise. Both metaphors use both structure and process, but they each minimize one and use complexities in the other to explain behavior. In fact, in the skill metaphor, structure is minimized as an explanatory principle to the extent that its existence often seems to be denied completely.

Consider nests and other structures that we might want to put into the mind. Table 15.1 lists some structures that come to my mind. They are all internal copies of external things or relations. Nesting is just one of these structures. I am going to attack nesting only because it is the structure that Professor Neisser chose, but I could take any other structure and make similar arguments. If we want to describe the environment, not what is in the mind, any one of the structures listed in Table 15.1 would be a good description for some levels of some things in the environment.

Each kind of structure has its own properties, and each has its own

uses (Rumelhart & Norman, in press). I still have a soft spot for old-fashioned associations. In fact, in a recent and extremely nonecological paper, Michael Friendly and I made a minor perturbation on association theory's *m*, came up with a new variable, produced norms for it, and showed its effects on recall (Rubin & Friendly, 1986). Associations have certain properties. The one we exploited in our paper is that they are directional. That is, the strength of association between node *A* and node *B* need not equal the strength between node *B* and node *A*. Other structures, such as similarity spaces, are not directional, and the distance from node *A* to node *B* in a space must be the same as from node *B* to node *A*. Moreover, if there are three nodes in a similarity space, *A*, *B*, and *C*, the distance from *A* to *B* is always shorter than the distance from *A* to *C* plus the distance from *C* to *B*. This triangle inequality, however, need not hold for associations.

I used to be bothered by all of these structures. I was getting a headache fitting all of them into my finite skull. The prospect of fitting them into an even smaller bird brain was probably part of what kept studies of animal behavior closer to a process metaphor for so long; *learning* is a process, whereas *memory* is a structure, even though both terms have identical operational definitions. Professor Neisser minimized my discomfort, though probably not the bird's, by saying that the reason we have all these structures, and the reason psychologists invent new ones every time they study a new domain, is not because of a lack of elegance; it is merely that the world has many ways in which to be described and many aspects to be described. The trouble is that Gibson's ecological approach does not let us copy any of them into the mind.

Let us return to nests. I think nests are much too rigid, and I choose the word *rigid* because nests, like the modules Professor Neisser also uses, are objects. Consider why nests are too rigid. The evidence comes mostly from Neisser's writings, but is supplemented from other chapters in this book.

First, events can be multiply nested; so this conference is embedded in my sabbatical year, it is embedded in other conferences, it is embedded in trips to Atlanta (Neisser, 1986). All of this is true in the real world and in memory. Moreover, for memory, the same event will be easier to remember in some nestings than in others. Second, mental nests do not map into a physical time line as simply as perceptual nests map onto physical space. We have events such as conferences that are separated, but the trees that are seen at one time nested in a forest are all next to each other (Neisser, 1986). Third, sets of events may be fused together and become one event, as in repisodic memory (Neisser, 1981). Fourth, all nesting cannot be determined at the time of an event; some nesting has to wait until much later (Neisser, 1982). Fifth, nestings may have to

be very flexible and change as categories do (Barsalou, 1983). Sixth, we may need separate nestings along many different and not always obvious dimensions, such as reported versus nonreported events (see chapter 13), and thoughts that are beeped versus actions that are beeped (see chapter 3).

The point of all this is that once we commit ourselves to a complex-memory structure, it is not easy to get from the world to that memory structure. Why is it harder to do in memory than in perception? It is because memory lets us escape the tyranny of the present and combine almost any aspects of experiences, including those that are not temporally or physically adjacent (Bartlett, 1932).

What can we do instead of using nesting or other rigid structures? We can use concepts like skill or tuning. That is what an ecological approach, according to Gibson, might do. It wants to change the structures, such as associations, hierarchies, nests, and spaces, into processes such as tuning or skill. Jacoby ended his talk with the thought that memory is not something we search, but something we use. Kolers, Skinner, Bartlett, Neisser (1967), and, most important for our purposes, Gibson tried to avoid copying the animal's environment into one of the structures in Table 15.1. Professor Neisser, to try to do ecological memory in the form that Gibson talks about, should try to avoid it too. It is theoretically possible.

To show the possibility, I need to demonstrate that the explanatory power of a structure can be traded for the explanatory power of a process. Figure 15.1 is a similarity space of animals that can be in the mind. It was formed from the lists of animals that 100 Duke University undergraduates gave in 60 sec. Animals listed near to each other by the undergraduates appear near to each other in Figure 15.1. The method used to form Figure 15.1 is identical with that describe in Rubin and Olson's (1980) study. If we have a complicated structure like Figure 15.1, we can simply put a drop of water on it and let it spread, and we have what is called *spreading activation*. If we put the drop on the node *tiger*, it will spread quickly to *lion* and *elephant* and more slowly to *rabbit*. Similarly, if *tiger* was listed, then the subject would tend to list *lion* and *elephant* near it, often with all three animals occurring together in a rapid burst or cluster of activity. Although spreading activation is one of the simplest (and, in the form portrayed here, one of the stupidest) of all possible processes that we could have, if we have the correct structure, it will describe lots of data. That is, we can have a very stupid process, if we have a very good structure.

Figure 15.2 shows an alternative. We need some paper, a pencil or pen, a real-world Atlanta rat (not a laboratory albino mouse), and a bucket. We write the nodes on pieces of paper, crumple them up into

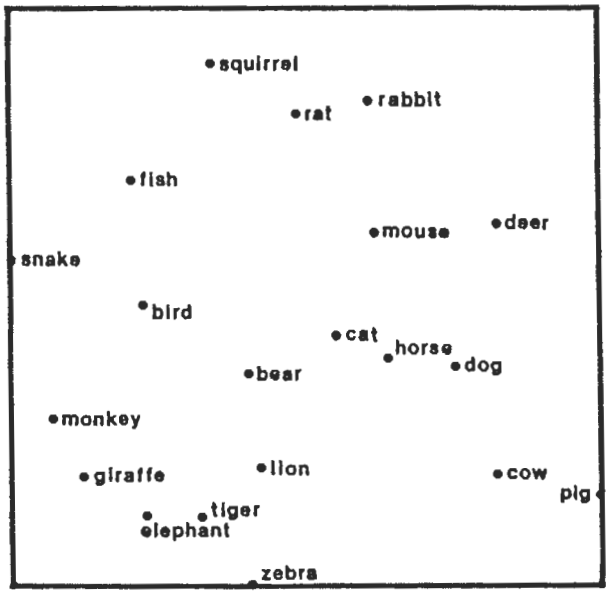


Figure 15.1. A similarity space for the domain of animals.

balls, and throw them into the bucket in a random order. Next we teach the rat, or tune the rat, or develop the rat's skill, to find the right nodes. Teaching and tuning and developing a skill are admittedly currently less specific hypotheses than the structure in Figure 15.1, but unfortunately such process metaphors usually are. In any case, we have a very complicated process and a very stupid structure. The structure is so stupid that we need not talk about it at all. Instead, we can describe the system totally in terms of the rat's tuning and thereby mystify our colleagues who hold to the complex-structure metaphor. Anything that can be done with the similarity space can be done with the bucket. (We can even describe a considerable body of data with a stupid process and a stupid structure [Landauer, 1975], but then we have to be very clever.) We cannot separate the model in Figure 15.1 from the model in Figure 15.2 empirically. They are just different metaphors or approaches.

Which metaphor do we want to use? If we want to remove the object nature of nests and of modules, we choose complicated processes like tuning and say as little as possible about the internal structure.

Consider an actual example of trading structure for process. We had a discussion at the conferences as to whether the autobiographical memory structures presented in Barsalou's chapter 8 were really in the mind

Figure 15.2. A complex-process memory model.

or whether general processes of making a narrative produced the structure Barsalou observed in his summarized-event data. Neisser (1982) raised the same point with respect to the canonical structure of flashbulb memories. We could say that autobiographical memories are stored in a structured way, and we simply start at the beginning and spread until we produce a whole sequence about the occurrences of a summer. Alternatively, we could say that the process of constructing a narrative orders memories that were stored randomly, very much like the semantic nodes were tossed randomly into the bucket in Figure 15.2. Either way will explain the data: the latencies between times, the order of output, and clustering. It may just take a little longer to learn narrative structure or to train a rat than it takes to create a memory structure.

We can say that when people learn, they either have added to their internal structure or have developed a skill. For riding a bicycle, most of us, I think, would prefer to talk about skill, because we would not want to draw a structure such as that in Figure 15.1 for how a 7-year-old maintains balance while going around a curve on a bicycle. But, equivalently, bicycle riding could be described with a complex structure. For catching

a ball and for other activities, Bartlett (1932) also preferred skill. After all, his book was named after the complex process of remembering, whereas the book by Ebbinghaus that he criticized was named after the complex structure of memory. Gibsonians would not want to describe complex structures; rather, they would want to say that the behaviors involved become more skilled. We can explain behavior with either a complex structure or a complex process, but if we use a complex process, we get rid of the thing in the mind.

But Professor Neisser uses complex structure. Can he do it otherwise? I do not think so, because I think that he is right about our spatial abilities. Our spatial abilities are so pervasive and so strong that they do not allow for the development of complex-process models. As Neisser (1976) has noted, even the flow diagrams of processing in information-processing models become little boxes. Process ends up being drawn on a blackboard spatially as structures. Even my clever rat had to run around in a spatial bucket because I could not think of, or describe, a process without a rigid, definite structure. Neisser, I, and everyone else I know about work with a spatial metaphor. We just cannot fully utilize a complex-process metaphor. Instead, we tend to change process into structure. That is one reason that Gibson, Kolers, Skinner, and even Bartlett are difficult to understand and seem opaque or even crazy to many people when they stress the complex-process metaphor to the exclusion of mental structures. That is one reason why concepts like tuning or resonance are hard to develop, whereas a concept like semantic network is sufficiently easy to develop that everyone can devise his or her own.

Perhaps approaches that use the mechanisms of mathematics, and thereby remove themselves from normal thought processes, will allow us to develop complex-process models, as opposed to complex-structure models (Grossberg, 1982; McClelland & Rumelhart, 1985). Perhaps we shall stop being so involved with the models we build and with our attempts to distinguish between functionally equivalent metaphors and turn more of our energies to understanding the behaviors that the models and metaphors were initially intended to explain. Time will tell.

For now, however, it appears that Neisser, and the rest of us, simply cannot devise the process model that would advance Gibsonian ecological theory and that current complex-process metaphor solutions, such as tuning and resonance, are too vague. Who could offer an attractive alternative to the complex-structure metaphor? Following Gibson's general approach, I think we should look for an animal that evolved in a constantly changing dense liquid or heavy-gas environment without stable landmarks or directions.

NOTES

The title of this chapter, "Go for the Skill," is a slight change from what Professor Neisser asked me to do in my discussion of his work. I added the *S*. Support for the preparation of this chapter was provided by NSF grant BNS-8410124. I wish to thank Susan Havrilesky for drawing Figure 15.2, Lynn Hasher, Peter Holland, and Wanda Wallace for their comments, and Ulric Neisser for making this chapter possible.

REFERENCES

Barsalou, L. W. (1983). Ad hoc categories. *Memory & Cognition, 11*, 211–227.

Bartlett, F. C. (1932). *Remembering: A study in the experimental and social psychology*. Cambridge University Press.

Bransford, J. D., McCarrell, N. S., Franks, J. J., & Nitsch, K. E. (1977). Toward unexplaining memory. In R. Shaw & J. Bransford (Eds.), *Perceiving, acting, and knowing: Toward an ecological psychology* (pp. 431–466). Hillsdale, NJ: Erlbaum.

Gibson, J. J. (1966). *The senses considered as perceptual systems*. Boston: Houghton Mifflin.

(1979). *The ecological approach to visual perception*. Boston: Houghton Mifflin.

Grossberg, S. (1982). *Studies of mind and brain: Neural principles of learning, perception, development, cognition, and motor control*. Boston: D. Reidel.

Kolers, P. A., & Roediger, H. L., III (1984). Procedures of mind. *Journal of Verbal Learning and Verbal Behavior, 23*, 425–449.

Kolers, P. A., & Smythe, W. E. (1984). Symbol manipulation: Alternatives to the computational view of mind. *Journal of Verbal Learning and Verbal Behavior, 23*, 289–314.

Kvale, S. (1977). Dialectics and research on remembering. In N. Datan & W. H. Reese (Eds.), *Life-span developmental psychology: Dialectical perspectives on experimental research* (pp. 165–189). New York: Academic Press.

Landauer, T. K. (1975). Memory without organization: Properties of a model with random storage and undirected retrieval. *Cognitive Psychology, 7*, 495–531.

McClelland, J. L., & Rumelhart, D. E. (1985). Distributed memory and the representation of general and specific information. *Journal of Experimental Psychology: General, 114*, 159–188.

Neisser, U. (1967). *Cognitive psychology*. New York: Appleton-Century-Crofts.

(1976). *Cognition and reality: Principles and implications of cognitive psychology*. San Francisco: Freeman.

(1981). John Dean's memory: A case study. *Cognition, 9*, 1–22.

(1982). Snapshots or benchmarks? In U. Neisser (Ed.), *Memory observed: Remembering in natural contexts* (pp. 43–48). San Francisco: Freeman.

(1986). Nested structure in autobiographical memory. In D. C. Rubin (Ed.), *Autobiographical memory* (pp. 71–81). Cambridge University Press.

(1987). A sense of where you are: Functions of the spatial module. In P. Ellen & C. Thinus-Blanc (Eds.), *Cognitive processes and spatial orientation in animals and man*. Dordrecht: Martinus Nijhoff.

Roediger, H. L., III (1980). Memory metaphors in cognitive psychology. *Memory & Cognition, 8*, 231–246.

Rubin, D. C., & Friendly, M. (1986). Predicting which words get recalled: Measures of free recall, availability, goodness, emotionality, and pronunciability for 925 nouns. *Memory & Cognition, 14*, 79–94.

Rubin, D. C., & Olson, M. J. (1980). Recall of semantic domains. *Memory & Cognition, 8*, 354–366.

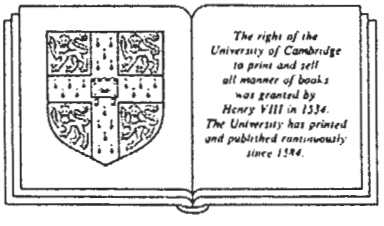
Rumelhart, D. E., & Norman, D. A. (in press). Representation in memory. In R. C. Atkinson, R. J. Herrnstein, G. Lindzey, & R. D. Luce (Eds.), *Handbook of experimental psychology*. New York: Wiley.

Shepard, R. N. (1984). Ecological contraints on internal representation: Resonant kinematics of perceiving, imagining, thinking, and dreaming. *Psychological Review, 91*, 417–447.

Skinner, B. F. (1974). *About behaviorism*. New York: Knopf.

Remembering reconsidered:
Ecological and traditional approaches to the study of memory

Edited by
ULRIC NEISSER
and
EUGENE WINOGRAD



CAMBRIDGE UNIVERSITY PRESS
Cambridge
New York New Rochelle Melbourne Sydney

Published by the Press Syndicate of the University of Cambridge
The Pitt Building, Trumpington Street, Cambridge CB2 1RP
32 East 57th Street, New York, NY 10022, USA
10 Stamford Road, Oakleigh, Melbourne 3166, Australia

First published 1988

Printed in the United States of America

Library of Congress Cataloging-in-Publication Data

Remembering reconsidered.

(Emory symposia in cognition ; 2)

Includes index.

1. Memory–Congresses. I. Neisser, Ulric.
II. Winograd, Eugene. III. Series.
BF371.R38 1988 153.1'2 87-27642

British Library Cataloging-in-Publication Data

Remembering reconsidered : ecological and
traditional approaches to the study of
memory.–symposia in cognition:2)
1. Memory
I. Neisser, Ulric II. Winograd, Eugene
153.1'2 BF371

ISBN 0-521-33031-9