8

The content and organization of autobiographical memories

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As evidenced by many of the chapters in this volume, as well as in Rubin (1987), cognitive psychologists have become increasingly interested in the study of autobiographical memories. But because this development is relatively recent, it understandably exhibits certain gaps and weaknesses. Although numerous experiments have addressed the retention of autobiographical memories, relatively few have addressed the content of autobiographical memories, how they are organized, or how they are related to world knowledge. Although a fair amount of empirical work has addressed autobiographical memories, no major theories have been proposed to account for them or to integrate them with other phenomena such as comprehension, learning, and problem solving.

A benefit of the cognitive science atmosphere that has grown with the development of cognitive psychology is that diverse methodological and theoretical frameworks contribute to one another’s development. Insights from one approach fill gaps, stimulate new research, and occasionally restructure another approach. This chapter reflects such cross-fertilization. My initial interest in autobiographical memories was stimulated by Janet Kolodner’s computational theory of autobiographical memories (Kolodner, 1978, 1980, 1983a,b, 1984; Schank & Kolodner, 1979), and our discussions of this work led to some very preliminary attempts to integrate psychological and computational perspectives (Kolodner & Barsalou, 1982, 1983).

In contrast to cognitive psychology, computational work on autobiographical memories has primarily been theoretical and has focused on the content and organization of autobiographical memories, along with their relation to world knowledge. It has also attempted to integrate autobiographical memories with the processes of comprehension, learning, and problem solving. My students and I found Kolodner’s proposals sufficiently provocative that we initiated a research program to explore them. More complete reports of our work can be found in Barsalou, Lancaster, Spindler, George, and Farrar (1988) and Lancaster (1985).
Overview

The first of the remaining sections briefly summarizes Kolodner's (1983a,b, 1984) computational theory of autobiographical memories, as well as assumptions from a similar theory proposed by Schank (1982). Because these theories motivated the primary hypotheses in our work, and because they dictated the structure of our experiments, they provide essential background for what follows. The next two sections review the findings from our empirical explorations. The first addresses the kinds of information that comprise people's autobiographical memories and tests a hypothesis suggested by computational theories that people have extensive idiosyncratic, generic knowledge about events. The second section addresses how people organize this information and tests a hypothesis suggested by computational theories that activities and generalized actions form the primary organization of autobiographical memories. The final section presents a theory of autobiographical memories that has evolved from our work and that is serving as a framework for our current research. This theory assumes that (1) extended-event time lines form the primary organization of autobiographical memories, (2) idiosyncratic summarizations of events become nested within these time lines, (3) a specific event is represented as a collection of exemplars from different ontological domains, and (4) an event summarization is constructed from the experience of a single specific event. Each section also reviews recent findings from other laboratories that bear on particular issues of interest.

Computational work on the organization of autobiographical memories

Computational theories of autobiographical memories had their origin in computational theories of language comprehension. Early comprehension systems attempted to understand language with word-based semantics (e.g., Schank, 1975). Such systems retrieved meanings for the words in a sentence and combined them by various rules to determine its meaning. Because this approach could understand only the simplest forms of language, it was far from satisfactory.

A central problem with word-based semantics is its inability to generate the inferences necessary for understanding the bulk of human language. As a result, a second generation of language-understanding systems incorporated world knowledge to support extensive inferencing. Such knowledge has generally taken the form of scripts (Schank & Abelson, 1977) and frames (Minsky, 1975). Including such knowledge in language-understanding systems has led to substantial progress in machine comprehension.

The most recent generation of systems has gone a step further. The recent theories of Kolodner and Schank have proposed that successful language-understanding systems must also have knowledge of specific events (Kolodner, 1978, 1980, 1983a,b, 1984; Schank, 1982; Schank & Kolodner, 1979). These theories propose that specific events are important to language understanding for two reasons: First, memories of earlier events often provide a means of understanding later events by analogy. Second, memories of previous events are necessary for the continual abstraction of new generic knowledge that expedites the subsequent processing of similar events. Kolodner and Simpson (1984) and Kolodner, Simpson, and Sycara-Cyranoski (1985) have extended this theoretical framework to learning and problem solving.

The comprehension hypothesis of event organization

In the process of implementing event-based comprehension systems, Kolodner and Schank encountered an interesting problem: How should information about specific events be organized in the memory of a language-comprehension system? I refer to Kolodner and Schank's solution to the organization problem as the "comprehension hypothesis of event organization." This hypothesis first assumes that when one attempts to understand an event, or to understand text about an event, one retrieves generic knowledge relevant to comprehending it. This knowledge generates explanations about what has occurred so far, expectations about what may occur in the future, appropriate behaviors, and so forth.

Second, this hypothesis proposes that memories of events similar to the current event may become available and thereby generate more precise inferences. If one is reading about a visit to a Morrocan restaurant, for example, one may first retrieve generic knowledge about restaurants in general to help understand the event. However memories of specific trips to Morrocan restaurants may also be retrieved to provide more precise explanations and expectations.

Third, and most important, this hypothesis assumes that the memory for an event becomes integrated with the generic knowledge and specific episodes used to comprehend it. For example, the memory for the trip to a Morrocan restaurant would become integrated with knowledge about restaurants in general and with memories of Morrocan restaurants in particular. The comprehension process determines how memories for events become organized in memory.
“diplomatic meetings” - $\text{MEET}$

- included in "negotiations"
- participants are foreign diplomats
- topic is an international contract
- topic involves the United States
- is political and occupational for Vance

Figure 8.1. Event organization in CYRUS after it has processed 60 descriptions of diplomatic meetings (Kolodner, 1983a, p. 270). The E-MOPs in this figure are referred to as "MOPs," and events are indicated by "EV." Not all events instantiating subordinate E-MOPs are shown.

**CYRUS**

Kolodner (1983a,b, 1984) implemented an explicit account of an event-based comprehension system called CYRUS, which simulates Cyrus Vance’s memory of his experiences as secretary of state. The basic unit used in CYRUS to represent classes of events is the event-memory organization packet or E-MOP. An example is shown in Figure 8.1 for the event type diplomatic meetings. As can be seen, an E-MOP contains two kinds of information: (1) prototypical information about its class of events (i.e., "norms") and (2) secondary organizational structures that organize instances of that kind of event by their differences.

Although Kolodner generally assumes that the memory for an event becomes organized with all the relevant knowledge structures used to comprehend it, she has primarily addressed the role of event types in organization (e.g., meetings, trips, restaurant visits). What constitutes an event type is not entirely clear. However the activity in an event, as specified by its goals and actions, seems most important in determining its event type.

This emphasis on event types manifests itself in a number of important ways in CYRUS and suggests that event types provide the primary organization of event memories. For example, CYRUS’s highest level of memory organization is comprised of basic event types. As Kolodner (1983a, p. 249) states, “In general, we can expect an event memory to have E-MOPs for each major type of event it knows about,” such as for “getting up in the morning, eating in a restaurant, going to the movies, and driving to the office.” Other attributes organize more specific E-MOPs and event memories within these highest-level E-MOPs. In Figure 8.1, for example, subordinate E-MOPs and event memories are organized by topic, participant’s nationality, and so forth within the E-MOP for diplomatic meetings. In general, attributes such as these establish secondary organizations within the event types that comprise the highest level of memory organization.

CYRUS’s emphasis on event types also manifests itself at retrieval. When searching for a particular event, CYRUS’s first step is to determine the kind of event sought (see Figure 8 in Kolodner, 1983b). In fact, identifying an event type is a necessary step in retrieving an event. If a retrieval cue does not specify an event type (e.g., remember an event that occurred in San Francisco), then an event type must be inferred before search can begin (e.g., eating in a restaurant). It is impossible to retrieve an event directly from cues that do not specify an event type (e.g., from San Francisco). Furthermore, if CYRUS cannot find a sought-after memory in the context of the event type initially established, it employs various strategies to identify alternative event types whose memories are then searched (Kolodner, 1983b, pp. 299–305). Finally, as each event type is identified, secondary attributes provided by the retrieval cue direct search through attribute organizations within the selected E-MOP. For example, a retrieval cue might specify that a sought-after diplomatic meeting involved the SALT treaty and a defense minister. As subordinate E-MOPs are accessed via these secondary attributes, their norms provide further expectations in the form of inferred attribute values that also guide retrieval. As can be seen from Figure 8.1, a given event can generally be accessed by numerous unique paths of attribute values within its E-MOP (e.g., EV2). Barsalou and Bower (1984) discuss various issues associated with this form of organization.

In general, CYRUS’s organizational scheme clearly supports event
comprehension. When an event is experienced, CYRUS's organization directs search toward E-MOPs and event memories that facilitate comprehension. The information retrieved about an event type establishes a rich context in which to explain an event and generate useful expectations about what has not yet been perceived. Conversely the process of comprehension alters memory organization. As an event is comprehended, it becomes part of memory, thereby changing it. In addition, integrating an event into memory usually causes new generic knowledge to be created along the path of comprehension (Kolodner, 1983a, pp. 264–266). All of these changes to memory organization make it better prepared to support comprehension of future events.

The activity dominance hypothesis

Reiser and his colleagues have performed a wide range of interesting studies closely related to Kolodner's theory in particular and to the comprehension hypothesis of event organization in general (Reiser, 1983, 1986; Reiser, Black, & Abelson, 1985; Reiser, Black, & Kalamarides, 1987). Similar to Kolodner and Schank, they have assumed that event memories are organized by the knowledge used to comprehend them. Similar to Kolodner, they have focused on the role of event types in comprehension and retrieval (Reiser et al., 1985, pp. 91–93). Similar to Kolodner, this focus has led them to assume that event types provide the primary organization of event memories, stating that "activities . . . constitute the principal contexts used to store experiences," where "activity" is equivalent to "event type" as I have been using it (Reiser et al., 1985, p. 89). Following Kolodner, these theorists generally assume that organizational attributes such as participant and location are subordinate to event types (never vice versa) and that identifying an event type is necessary to retrieving an event memory.

This stress on event types reflects a focal interest on the roles of goals and causal reasoning in the comprehension and retrieval of events. Kolodner (personal communication, March 1985) and Reiser (personal communication, March 1986) both emphasize this, but also state that they accept the comprehension hypothesis of event organization in its full form, namely, that an event memory is stored with all the knowledge used to comprehend it, not just event types. However the assumption that event types provide the primary organization of event memories is strongly implied by their theories, in their conceptions of both event storage and event retrieval. This assumption seemed sufficiently important to us that we deemed it a hypothesis worth explicitly formulating and testing. Moreover, because goals and causal reasoning are so central to events, it seemed plausible that event types could provide the dominant organization of event memories. In fact, the research tradition that has evolved from Schank and Abelson (1977) can be viewed as resting heavily on this assumption.

So far I have been referring to the primary organization assumed by Kolodner and Reiser as organization by "event types." Actually Kolodner generally refers to event types as "contexts," and Reiser often refers to them as both "contexts" and "activities." For the remainder of this chapter, I follow Reiser in referring to this kind of organization as organization by "activities," primarily to contrast it with organization by participants, locations, and times, which will be addressed later. In addition, I refer to the hypothesis that event types form the dominant organization of event memories as the "activity dominance hypothesis."

Findings that address the content of autobiographical memories

The initial goal of our work was to test the activity dominance hypothesis. In the process of exploring organization, however, it became apparent that we needed to consider another issue first, namely, what kinds of information comprise the content of autobiographical memories. This next section presents findings from our experiments that bear on this issue. Of particular interest was the extent to which autobiographical memories contained event summarizations, as might be expected from the extensive formation of E-MOPs in the theories of Schank, Kolodner, and Reiser.

Free recall

At the beginning of a fall semester, an experimenter stopped people on the Emory campus and asked if they would participate in a survey. If they agreed, the experimenter continued:

What I would like you to do for the next five minutes is tell me about events you were involved in this past summer. In telling me what you did this summer, simply describe events you were involved in. Most importantly, describe the events exactly in the order in which they come to mind. When an event comes to mind, describe it immediately, and when the next event comes to mind, describe it. Simply describe events that occurred during your summer in the order in which they come to mind. Continue to remember events in this manner for the full five minutes.

The remainder of the instructions continued to stress that subjects remember "events" from their summer vacation and that they report them "in whatever order they come to mind." The experimenter tape-recorded the subject's protocol, which was later transcribed. In analyzing
Table 8.1. Percentages of statement types and examples of statement types from the free-recall study

<table>
<thead>
<tr>
<th>Statement type and examples</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summarized events</td>
<td>32</td>
</tr>
<tr>
<td>we also went to movies while we were there</td>
<td></td>
</tr>
<tr>
<td>I watched a lot of TV every day we would leave our house</td>
<td></td>
</tr>
<tr>
<td>Comments about aspects of events</td>
<td>31</td>
</tr>
<tr>
<td>I did that for about four weeks the family is friends of ours . . . we had a lovely apartment</td>
<td></td>
</tr>
<tr>
<td>Specific events</td>
<td>21</td>
</tr>
<tr>
<td>we saw a play</td>
<td></td>
</tr>
<tr>
<td>we had a little picnic</td>
<td></td>
</tr>
<tr>
<td>filled out an application at home</td>
<td></td>
</tr>
<tr>
<td>Extended events</td>
<td>9</td>
</tr>
<tr>
<td>I worked there for two weeks</td>
<td></td>
</tr>
<tr>
<td>I took a trip to Italy</td>
<td></td>
</tr>
<tr>
<td>I went on a diet</td>
<td></td>
</tr>
<tr>
<td>Alternative events</td>
<td>3</td>
</tr>
<tr>
<td>I had not taken a shower</td>
<td></td>
</tr>
<tr>
<td>I'll probably go back to work at Christmas . . . they could have given me a job for a week . . .</td>
<td></td>
</tr>
<tr>
<td>Miscellaneous statements</td>
<td>4</td>
</tr>
</tbody>
</table>

*Statement types are defined in the text.*

aspect of an event. Subjects often commented about themselves, how long an event lasted, the people involved, the location, the outcome, why the event occurred, and so forth.

The next most common kind of statement was a description of a specific event. These were single events that lasted less than a day, such as seeing a play, going on a picnic, and so forth. Although the instructions explicitly asked subjects to recall "events" from their summer vacation, only 21% of the statements in their protocols described specific events.

The next most common kind of statement was what we refer to as an extended event, which is a single event lasting longer than a day. Typically these events are not continuous, being frequently and systematically interspersed with other kinds of activities. Having a job, for example, is an extended event that is frequently interrupted because most people do not work 24 hours a day. Extended events and specific events differ in that extended events typically (but not necessarily) are long, interrupted, and significant, whereas specific events typically are short, uninterrupted, and insignificant.

An infrequent but nevertheless interesting kind of statement was what we refer to as an alternative event. These were events that (a) had not occurred during the summer, (b) were alternatives to what actually occurred, or (c) might occur in the future. Not only did subjects describe what occurred during their summer, they also described what had not occurred.

We were rather surprised by these results. We originally believed that the primary content of autobiographical memory was supposed to be memories of specific events. Yet subjects, when asked to describe "events" from their summer vacation, spent only 21% of their time recalling specific events.

We were sufficiently troubled by this outcome that we ran another version of the study in which we pointedly tried to elicit only specific events from subjects. In the instructions, subjects were told about the difference between specific and summarized events and were repeatedly asked only to recall specific events. In addition, if a subject did anything but retrieve specific events during this recall, the experimenter stopped the interview and reminded the subject to describe only specific events. We found that even under these conditions subjects had difficulty recalling only specific events. Subjects often retrieved other kinds of information and frequently had to be stopped. This new procedure appeared to disturb subjects' normal mode of recalling the past. The retrieval of summarized and extended events, along with other kinds of information, appears to play an important role in accessing information about periods of one's life.
Cued recall

In our next study, which also occurred at the beginning of a fall semester, each subject participated in three sessions. During the first session, subjects were told they would shortly perform a categorization experiment. But before starting this experiment, the experimenter asked the subjects to answer a short question that was part of an unrelated experiment. Subjects received one of four questions and verbally provided answers for 60 sec. Twenty-four of the subjects were asked to produce “the names of as many people as you can think of whom you did things with this summer.” Another 24 subjects were asked to produce “the names of as many places as you can think of where you did things this summer.” Another 24 subjects were asked to produce “as many different kinds of activities as you can think of that you did this summer.” A final 24 subjects were asked to produce “as many times as you can think of when things occurred during the summer.” The answers that subjects generated to these questions will be referred to as “cues,” for reasons that will become apparent shortly.

Between 1 and 2 weeks later, subjects returned, believing they would continue with the categorization experiment. Instead they received the cues they had generated during the first session in a random order. As they received each cue, they were asked to “tell me as many events as you can remember” that involved the particular cue. Subjects then attempted to remember events for 60 sec before receiving the next cue.

Between 1 and 2 weeks later, subjects returned for a third session and provided various judgments about the cues and events they had generated during the first two sessions. One of the questions we asked subjects was whether the events they had generated during the second session were specific or summarized events. After receiving definitions and examples of specific and summarized events, subjects were asked to “indicate whether each event that you generated was a specific event, that is, something that occurred on one specific occasion, or a general kind of event, that is, something that occurred on more than one occasion” (these instructions used “general events” in referring to what I have been calling “summarized events”). Subjects were also allowed to indicate when they were not sure whether an event was specific or summarized. Examples of events judged as specific were “I went to the beach the day after graduation,” “I visited her in the hospital,” and “showed me everything he made with wood.” Examples of events judged as summarized were “went to movies,” “late night parties,” and “long discussions.”

As can be seen from Table 8.2, only around 40% of the events that subjects generated were specific events, by their own judgment. In contrast, approximately 60% were summarized events. None of the differences between cuing conditions was significant.

The importance of summarized events

On the basis of these two studies, it is obvious that autobiographical memories are not exclusively memories of specific events. In fact, the most common kind of information retrieved by subjects in both studies concerned summarized events. Whereas summarized events comprised around 60% of the cued-recall protocols, specific events comprised only around 40%. Whereas summarized events comprised 32% of the free-recall protocols, specific events comprised only 21%. In addition, the free-recall protocols contained several other kinds of information, including extended events, alternative events, and comments about aspects of events.

Summarized events in CYRUS

The prevalence of summarized events in our data is what would be expected from Kolodner’s (1983a,b, 1984) theory of autobiographical memory. Subordinate E-MOPs in CYRUS correspond to what we refer to as summarized events. Whenever CYRUS detects that two events of a given type share values on one or more attributes, it constructs a subordinate E-MOP for that new “kind” of event. For example, if two events are encoded about going to a movie with one’s grandmother in the afternoon, then an E-MOP is constructed for movies with one’s grandmother in the afternoon that is subordinate to the E-MOP for movies. The norm for this new E-MOP contains prototypical information about this kind of event, and subordinate attribute structures organize instances of it. Because events of a particular type often share attributes, CYRUS predicts continual evolution of new generic knowledge about specific events.

Our finding that summarized events dominate autobiographical proto-
cols is consistent with CYRUS's proclivity for summarization. However it remains to be seen if the conditions under which CYRUS generalizes are the same as those under which people generalize. For example, if CYRUS encountered two instances of going to a movie with one's grandmother in the afternoon, it would construct summarizations for movies with one's grandmother, movies in the afternoon, and movies with one's grandmother in the afternoon (but only if grandmother and afternoon were found to be predictive indices; Kolodner, 1983a, pp. 251–261). In contrast, people might form only the last of these summarizations.

Nelson and her colleagues have similarly argued for some time that children form event summarizations as soon as they experience two events of the same kind (Nelson, Fivush, Hudson, & Lucariello, 1983; Nelson & Gruendel, 1981). Hudson and Nelson (1986) and Watkins and Kerkar (1985) have addressed this issue directly and have found a robust tendency for people to summarize events. Brewer (1987) discusses additional findings that demonstrate the prevalence of summarization in autobiographical protocols.

Implications for the distinction between episodic and generic knowledge

Rather than viewing episodic and generic memories as sharply differentiated (e.g., Tulving, 1972, 1983), these findings suggest that it may make more sense to view episodic and generic memories as a continuum. At one end are specific episodes (e.g., going to an Indian restaurant on one's 30th birthday). Next are those summarized events that were abstracted from a few highly specific and similar events (e.g., going to Indian restaurants on one's birthdays). Next are summarized events that were abstracted from events that have occurred often (e.g., going to Indian restaurants). Finally at the far end is relatively stable and abstract knowledge that may be culturally shared to a large extent (e.g., going to restaurants). Whereas intermediate generic knowledge often may be idiosyncratic to individuals because of its episodic basis, the generic knowledge that is least episodic may be so because of its origin in cultural and linguistic tradition.

Findings that address the organization of autobiographical memories

This next section addresses the organization of autobiographical memories. In particular, it summarizes results from studies that bear on what I have termed the activity dominance hypothesis. As discussed earlier, this hypothesis stems from a basic assumption in the work of Kolodner and Reiser that activities provide the primary organization of autobiographical memories.

Evidence for the activity dominance hypothesis

Reiser et al. (1985) suggested that if activities form the primary organization of autobiographical memories, then receiving an activity as a cue should result in faster retrieval of a specific event than receiving other kinds of information. To test this, they assessed whether activities (e.g., went out drinking) or generalized actions (e.g., paid at the cash register) provided faster access to event memories. On each trial of their Experiment 1, subjects received two descriptions, one of an activity and one of a generalized action, separated by 5 sec. Subjects' task was to remember a specific event that involved both pieces of information, the dependent measure being how long it took to remember the event. The critical manipulation was the order in which the two cues were presented. If activities provide better access to event memories, then receiving them before generalized actions should result in faster access than receiving them in the reverse order.

As predicted, Reiser et al. (1985) found that subjects were much faster in retrieving a specific event when activities came first than when they came second. In Experiment 2, they further found that activities, when presented as single cues, provided much faster access to event memories than did generalized actions. On the basis of these findings, they concluded that activities constitute the primary organization of autobiographical memories. Reiser (1983, 1986) and Reiser et al. (1987) reported further evidence for this position. It should be noted that Reiser's results frequently are inconsistent with Schank's (1982) proposal that generalized actions are more important organizers of event memories than are activities.

Alternative organizations of autobiographical memories

Reiser and his colleagues have clearly shown that activities are central to the organization of autobiographical memories. As Reiser et al. (1985, p. 132) point out, however, they have primarily focused on activities and have not examined other potentially important forms of organization. In addition, the competing organizations they have considered, such as generalized actions and emotions, are arguably not the strongest contenders available. Consequently one of the central goals of our research program has been to explore what we perceive as stronger contenders.

The alternative organizations we have addressed are organization by participants, organization by locations, and organization by times. For example, it often seems that people remember two or more events involving the same person, even though these events do not share a common activity (e.g., going to a baseball game, building a fence, and going camp-
Table 8.3. Average time in seconds to retrieve an event as a function of cue order in an extension of Reiser et al. (1985)

<table>
<thead>
<tr>
<th>Cue 1/Cue 2</th>
<th>Cue order</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity/Person</td>
<td>3.17</td>
</tr>
<tr>
<td>Activity/Location</td>
<td>2.58</td>
</tr>
<tr>
<td>Activity/Time</td>
<td>2.92</td>
</tr>
<tr>
<td>Person/Location</td>
<td>3.32</td>
</tr>
<tr>
<td>Person/Time</td>
<td>3.26</td>
</tr>
<tr>
<td>Location/Time</td>
<td>2.58</td>
</tr>
</tbody>
</table>

As in the work of Reiser et al., the central manipulation was the order in which subjects received the two pieces of information from a given pair. For each pair, half of the subjects received the two pieces of information in one order, and the other half received them in the reverse order. For example, half the subjects received watched TV/with your mother, and half received with your mother/watched TV, this being an instance of an activity/participant pair. Each subject received instances of each kind of pair in each order; however a subject received a given piece of information as a cue only once in the study (i.e., specific pairs were counterbalanced between subjects). An effort was made to construct each pair such that its two pieces of information were not highly predictive of one another.

On each trial, the first cue was presented for 2 sec before the second cue and remained on the screen during presentation of the second cue. Subjects pressed a response key as soon as they had remembered a specific event or decided they could not remember an event. When subjects remembered an event, they wrote a brief description of it. In the results that follow, only reaction times for trials on which subjects remembered an event are reported.

If activities are the primary organizers of autobiographical memories, with the other cues being subordinate indices, then receiving activity information first should result in faster access than receiving activity information second. As can be seen from Table 8.3, however, none of the differences between the two orderings for a given pair was significant. Order did not have an overall effect and did not affect any particular pair. Most important, order did not affect any of the pairs containing activity information (in the upper half of Table 8.3). In fact, receiving activity information first resulted in slightly slower retrieval than receiving it second for two of these pairs.

These results probably did not result from task insensitivity to differences in cue order. Reiser et al. found an effect of over 2 sec for the cues they studied, indicating that this task can clearly detect order effects. Instead these data suggest that none of these four types of information—activities, participants, locations, or times—is more important than another in organizing events. Consequently, other kinds of knowledge appear just as important in organizing event memories as activities. It does not appear that activities are the primary organizers of events, with participants, locations, and times providing subordinate indexing schemes within specific activities.

Wagenaar’s (1986) study of his own memory similarly compared the effectiveness of who, what, where, and when cues in retrieving events. Analogous to our result just described, he found that the order in which he received pairs of these cues did not affect the probability he would remember an event. Because his classification of cues appears fairly different from ours, however, care should be taken in comparing results. Wagenaar...
found that participant cues generated more total events than activity cues, that location cues generated the same number of total events as participant and activity cues, and that time cues generated fewer total events than each other kind of cue. One could argue that these results are trivial because, after all, the total number of retrieved events reflects the total number of available cues. However, it is perhaps interesting to note that if one wants to maximize the number of events retrieved with a single kind of cue, then the availability of a certain kind may make it more productive overall than other kinds.

The third row shows the average number of events generated per cue. Statistical analyses found that location cues generated more events on the average than participant and time cues. Although the difference between location and activity cues was not significant, location cues generated .70 more events per cue on the average than did activity cues.

The fourth row shows the average number of events generated in the first 5 sec of the 60-sec protocol period by a subject. This measure indexes how quickly subjects accessed events using a particular type of cue. Statistical analyses found that participant cues resulted in faster access than any other kind of cue, that locations resulted in the next fastest access, that times resulted in the next fastest access, and that activities resulted in the slowest access (each of these differences was significant). If in fact it were necessary to access an activity organization before accessing an event, then activity cues should have provided the fastest access, not the slowest access. To retrieve an event with a participant cue, according to the activity dominance hypothesis, it would first be necessary to infer a possible activity associated with that participant before an event could be found. Because other kinds of cues provide faster access than activities, retrieving an event does not appear to require the use of activity organization.

None of the measures in Table 8.4 shows an advantage for activity cues over nonactivity cues. Activity cues were not the most frequent kind of cue. They did not retrieve the largest number of total events, they did not retrieve the most events per cue, and they resulted in the slowest access of events. Similar to our reaction-time study, we failed to find an advantage of activity organization over organization by participant, location, and time. It should be noted that subjects were just as likely to access memories of specific events from nonactivity cues as from activity cues (Table 8.2). Nonactivity cues were at least as fast and productive as activity cues in accessing autobiographical information and provided equal access to memories of specific events.

Wagenaar (1986) compared the effectiveness of various kinds of cues and found, contrary to us, that effectiveness dropped sharply from what to where to who to when cues. As discussed earlier, however, his classifica-

<table>
<thead>
<tr>
<th>Measure</th>
<th>Participant</th>
<th>Activity</th>
<th>Location</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cues</td>
<td>19.54</td>
<td>11.79</td>
<td>11.50</td>
<td>5.13</td>
</tr>
<tr>
<td>Number of events</td>
<td>87.75</td>
<td>65.58</td>
<td>71.50</td>
<td>27.13</td>
</tr>
<tr>
<td>Number of events per cue</td>
<td>4.61</td>
<td>5.48</td>
<td>6.18</td>
<td>5.08</td>
</tr>
<tr>
<td>Number of events in</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>first 5 sec</td>
<td>1.30</td>
<td>.62</td>
<td>1.05</td>
<td>.78</td>
</tr>
</tbody>
</table>
Table 8.5. Percentages of cluster types and examples from the free-recall study

<table>
<thead>
<tr>
<th>Cluster type and examples</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parts of an extended event</strong></td>
<td>29</td>
</tr>
<tr>
<td>and after this time I took a trip to Europe</td>
<td></td>
</tr>
<tr>
<td>started out in Holland, Amsterdam, with my parents</td>
<td></td>
</tr>
<tr>
<td>from which we went to Heidelberg, Germany, . . .</td>
<td></td>
</tr>
<tr>
<td>then to Italy, Venice, Florence, up to . . . and over to England</td>
<td></td>
</tr>
<tr>
<td>this trip lasted approximately 4 weeks</td>
<td></td>
</tr>
<tr>
<td>at which time, I traveled around England for a week by myself by train and then I flew home around August 11th</td>
<td></td>
</tr>
<tr>
<td><strong>Instances of a kind of activity</strong></td>
<td>17</td>
</tr>
<tr>
<td>went swimming at Red Oaks with a friend of mine</td>
<td></td>
</tr>
<tr>
<td>went swimming at the University of Hartford because my brother went to summer school there</td>
<td></td>
</tr>
<tr>
<td>went to the reservoir</td>
<td></td>
</tr>
<tr>
<td><strong>Parts of a summarized event</strong></td>
<td>13</td>
</tr>
<tr>
<td>everyday we used to go and sit in this little restaurant before dinner and have coffee or something and watch the people walk by and got to know the waiters that was real interesting everyday we'd see different people walk by on my days off I slept 'til about 10:00 I layed around in the backyard by the pool I usually ate lunch with my dad on days I did work I woke about 6:00 in the morning I went running after I went running about 2 or 3 miles I got dressed for work</td>
<td></td>
</tr>
<tr>
<td><strong>Events organized chronologically or by a particular time</strong></td>
<td>11</td>
</tr>
<tr>
<td>after school got out I stayed home from graduation and flew home to Connecticut and rested a couple of days and I went to work in a retail store . . .</td>
<td></td>
</tr>
<tr>
<td><strong>Parts of a specific event</strong></td>
<td>9</td>
</tr>
<tr>
<td>and we went to Circus World one day my brother . . . brought his girlfriend . . . I brought my boyfriend . . . my mom and dad went it was really good we rode all sorts of rides we saw a circus we spent most of the day there</td>
<td></td>
</tr>
<tr>
<td><strong>Events involving the same person or group of people</strong></td>
<td>6</td>
</tr>
<tr>
<td>I also saw many of my friends from school before I left Italy and we went around Rome and we walked and we went shopping and we saw a lot of Rome</td>
<td></td>
</tr>
<tr>
<td><strong>Adding on to a previous grouping</strong></td>
<td>5</td>
</tr>
<tr>
<td>we would take a lot of Metro rides subway rides one time I had my sunglasses stolen in the Metro . . . another time we saw these bands of robber kids being caught . . . and they had musicians who stand in the middle and play then they'd ask for money</td>
<td></td>
</tr>
<tr>
<td><strong>Events in the same location</strong></td>
<td>4</td>
</tr>
<tr>
<td>miscellaneous groupings</td>
<td>6</td>
</tr>
</tbody>
</table>

*Cluster types are defined in the text.

*These were cases in which a cluster of statements was a continuation of a cluster that had been generated earlier but that had been interrupted by at least one other different kind of cluster.

The organization of cues was different from ours, and his what cues appeared to be a combination of several factors, including activities and objects. Most important, cues were sampled very differently in the two studies. Whereas he selected cues for each event as he experienced it, subjects in our experiment produced cues of one particular kind long after experiencing the events and produced cues in response to a very general type of retrieval request (e.g., produce "the names of as many people as you can think of [with] whom you did things . . . this summer"). Wagenaar's study shows that the cues he generated at encoding varied in potency, whereas our study shows that cues generated while thinking about the past do not.

**Free recall**

These next data are from the free-recall study described earlier. Subjects in this experiment were asked to describe events from their summer vacation in whatever order they came to mind for 5 min. In one analysis, we attempted to identify clusters of statements in a subject's protocol that reflected particular organizing principles. Table 8.5 shows the kinds of clusters we identified and how often they occurred.
The most frequent kind of cluster was a series of statements that comprised an extended event, where an extended event, as discussed earlier, is a specific event that lasts longer than a day and is typically significant and interrupted (e.g., a job, a course in school, a diet). The example in Table 8.5 contains three extended events, two of which are nested in a higher-order extended event (i.e., a trip to the Continent and a trip to England are nested in taking a trip to Europe).

The second most common kind of cluster was a series of statements that were all instances of the same kind of activity (e.g., instances of going swimming). Similar to the previous two studies, however, these data again indicate that activity organization does not dominate all other organizations. Although activity organization accounted for 17% of the clusters, organization by extended events accounted for a much larger proportion (29%).

The third most common kind of clustering was a series of statements that described a summarized event, where a summarized event, as discussed earlier, is a kind of event that occurs repeatedly. In a sense, the summarized events in these protocols are similar to scripts, which have received much attention recently (Abbott, Black, & Smith, 1985; Barsalou & Sewell, 1985; Bower, Black & Turner, 1979; Fivush, 1984; Galambos & Rips, 1982; Mandler & Murphy, 1983; Nelson et al., 1983; Nelson & Gruendel, 1981; Nottenburg & Shoben, 1980; Schank & Abelson, 1977).

However the summarized events in this study differ in two important ways from scripts as they are often discussed. First, whereas scripts often are assumed to represent culturally shared knowledge (e.g., going to a restaurant), these summarized events were highly idiosyncratic. Instead of being knowledge shared by a culture, they were generally unique to a person or to a very small group of people. Subjects often mentioned their daily routines and sometimes mentioned repeated events shared with family or friends.

These summarized events differ from traditional scripts in a second way as well. Whereas much work on scripts generally has focused on their action sequences, our subjects often failed to include an action sequence when recalling a summarized event. Instead subjects often described participants, locations, temporal properties, and other aspects of a summarized event at least as much as they described its actions. Consequently it appears that other kinds of ontological knowledge besides actions play an important role in summarized-event representations.

The remaining entries in Table 8.5 show examples of other kinds of groupings we observed and how often they occurred. Subjects clearly used a number of different organizational schemes when describing this period of their lives.

Higher-order organization of protocols

Although the frequency with which various clusters occurred provides an important source of information about organization, there is another important dimension of these data to consider. Clusters in all of these protocols were to some extent hierarchically organized, even though many protocols contained violations of strict hierarchical organization. Consequently it is also important to consider the kinds of organization that characterized the highest levels of organization. This is especially true because being a high-level organization could preclude being a frequent organization.

Generally speaking, the highest level of organization in subjects' protocols was chronological order. This kind of organization occurred infrequently—9% of all the organizational clusters we identified—because it primarily operated at the high levels of protocols, organizing more numerous kinds of smaller organizational clusters. Subjects generally began by describing what occurred at the beginning of their summer and then progressed chronologically through the rest of their summer.

It is important to note again that the instructions for this experiment repeatedly asked subjects to remember events in whatever order they came to mind. If, in fact autobiographical memories are primarily organized by activities, then these instructions should have resulted in the highest level of organization being different activities. Once subjects began recalling events of a certain type, they should have continued recalling events of that type, if they are in fact stored together. When a subject could no longer retrieve events of a particular type, the subject should then have switched to another type of event and begun recalling events of that type. Because activities rarely comprised the highest level of organization, they again do not appear to be the dominant organizers of autobiographical memories. In contrast, chronological order appeared important because it was often found at the highest level of organization.

What subjects chronologically organized were not specific events. Instead the highest level of organization in many protocols was a chronological sequence of extended events. Subjects often spent the first part of their recall describing an extended event that filled the first part of the summer and then progressed chronologically through subsequent extended events that filled the middle and later parts of the summer. For example, one subject first described the job that began his summer, then described summer school that followed in Europe, and then described staying at home until school started. Another subject first described a trip to Italy that began and extended through much of her summer and then described staying at home for the month before school started.
Although the highest level of organization in subjects’ protocols was not always a chronological series of extended events, such organization occurred at least to some extent for 12 of the 13 subjects.

Another aspect of the highest level of organization was that subjects sometimes pursued parallel tracks of events. After subjects completed describing information about a particular extended event, they occasionally returned to the beginning of that time period and described another extended event, or activities of a different kind, that had occurred during the same time period. As a result, the highest level of organization in some subjects’ protocols contained parallel tracks of chronologically ordered information. For example, one subject, in the middle of her protocol, described a project at school. When finished describing this project, she went back and described things she did with her family during the same period (organization by participant). Another subject began her protocol with a description of the job that began her summer. When finished describing the job, she went back and described social activities that had occurred during the same time period (organization by activity).

A final point about levels of protocols is that all of the other kinds of organization in Table 8.5 were generally subordinate to these global sequences of chronologically ordered extended events. Subjects often organized their protocols at lower levels by activities, summarized events, participants, locations, and so forth. Organization by extended events occurred at lower levels of organization as well.

In summary, the data from this study again indicate that activities do not form either the most frequent or the highest level of organization. Although people often organized events by activity, they typically did so at a relatively low level of organization. Instead chronological sequences of extended events appeared to dominate the organization of subjects’ protocols. Linton (1987) reports similar kinds of organization in free-recall protocols, although she notes that there may be important organizational changes as the period being recalled becomes more distant in time.7

**Clustering in the recall of artificial events**

As is well known in the laboratory literature on memory organization, if subjects are presented with exemplars from taxonomic categories in a random order, they nevertheless cluster these exemplars by categories at recall (see Crowder, 1976, chap. 10, for a review; see Puff, 1979, for a relevant collection of papers). These results have generally been interpreted as showing that people use well-established knowledge about categories in long-term memory to organize incoming information. As each exemplar is encoded, it becomes integrated with information about its category. Because exemplars from the same category become integrated with the same category information, they become organized together in memory such that they are later clustered at recall.

Lancaster (1985) extended this theoretical framework to the organization of events. She argued that if activities are the dominant organizers of autobiographical memories, then when subjects receive randomly ordered descriptions of artificial events, they should cluster them by activity. Lancaster performed a series of experiments in which subjects received descriptions of artificial events that could be organized in multiple ways and observed how subjects organized them. Across experiments she generally found that subjects used a number of different organizational strategies. Although subjects often organized events by activity, they often organized them in other ways as well. In addition, there were large individual differences between subjects. Whereas some subjects primarily organized events by activities, other subjects primarily organized events in another manner (e.g., by participants). There was no overwhelming dominance of activities over other forms of organization. This fourth set of data from our laboratory again indicates that activities do not dominate other organizers of autobiographical memories.

**Pivoting**

Subjects in Lancaster’s experiments sometimes switched between organizations in an interesting way, what she referred to as “pivoting.” This occurred when the last event in one cluster of events initiated the retrieval of a different cluster of events. For example, a subject might first recall a cluster of events that all involve Leonard Bernstein, but that share nothing else in common. Having exhausted the cluster of events involving Leonard Bernstein, the subject switches attention from the participant dimension to another dimension, such as activity. If the value from this dimension for the last event retrieved was went sailing, the subject would then retrieve a new cluster of events that all involve sailing. Because the event involving Leonard Bernstein going sailing ends the Leonard Bernstein cluster and begins the going sailing cluster, it serves as an organizational pivot.

The observation of pivoting in these laboratory studies caused us to return to the free-recall study discussed earlier, where we found many interesting cases. One subject, for example, recalled a cluster of events involving local travel (organization by activity), the last of which took place in the subway. She then pivoted from events involving local travel to nontravel events involving the subway (organization by location). Another subject recalled a cluster of events that involved friends (organization by participant) and then pivoted to events that involved swimming (organization by activity).
As discussed by Lancaster, pivoting has been observed before in young children, who pivot between taxonomic and thematic clusters of words in free recall (Ayres, 1982; Ceci & Howe, 1978; Melkman & Deutsch, 1977; Salatas & Flavell, 1976). On the basis of casual observation, pivoting appears to be a ubiquitous and important characteristic of human thought. Consider conversations. As conversants progress through a topic, incidental features of a statement often trigger a new topic. For example, a statement in a conversation about movies might mention a comical plane flight, which thereby initiates a new conversational focus on comical plane flights, both in movies and in other contexts. Pivoting may also occur in other cognitive processes, such as in planning and decision making.

Pivoting may be a ubiquitous cognitive phenomenon whose purpose is to provide continuity of thought. Just as pivoting may serve as an important means of perpetuating conversations, it may also serve as an important means of perpetuating other processes, such as retrieval from long-term memory. Because this meandering and nonfocused quality seems so ubiquitous in human thought, it should be captured by the basic architecture of cognitive theories.

*Distinguishing organization in memory from organization at retrieval*

Before ending this discussion of organization, it is necessary to consider explanations of organization in recall. When subjects cluster information at recall, it could be for either of two reasons: First, subjects could be clustering information because it happens to be stored together. Once a piece of information is retrieved, information stored with it is also retrieved because of relations between them. Second, subjects could be clustering information because they are using a retrieval strategy that happens to select a certain type of information from memory. By focusing on a particular property, a strategy can direct search through many different suborganizations of memory and retrieve all information possessing that property.

It is often difficult to determine which of these two sources of organization underlies clustering. As discussed by Barsalou and Sewell (1985, pp. 650–652), however, certain data can increase one’s confidence that clustering is mediated by underlying memory organization. The next two sections discuss data that can be diagnostic in this way.

*Frequency of clustering.* It is reasonable to assume that subjects frequently use the means of retrieving information that is easiest for them. Because following the underlying organization of memory is an easy way to retrieve information, it can be assumed that subjects fre-

quentely retrieve information in this manner. Imagine that autobiographical memories are actually stored by activity. If so, then it should be much easier to retrieve memories involving a particular activity than it would be to retrieve memories involving a particular participant. Whereas all the memories for the activity are stored in a single activity organization, all the memories for the participant are distributed throughout numerous activity organizations. Consequently much more search effort would be required to retrieve events by participant than by activity. When subjects are free to retrieve information in any manner, why should they use a retrieval strategy that does not maximize the ease with which they can retrieve information? To the extent that subjects can be assumed to be using the easiest strategy available, it follows that the clustering most frequently observed in recall reflects the clustering of information in memory.

As described in previous sections, when we have observed frequency of clustering in our studies, activities generally have not constituted the most frequent type. To the extent that one is willing to grant that subjects generally prefer to use underlying memory organization in our tasks, it follows that activities are not dominant organizers of autobiographical memories.

*Retrieval time.* Measures of the time to retrieve information provide stronger evidence of information being stored together. To the extent that subjects are faster at retrieving a certain kind of information, it is likely that the information is stored together in memory. Information that is not stored together, but is distributed throughout different suborganizations, should generally take longer to retrieve than information stored in a single suborganization. It is hard to imagine how searching many different suborganizations could be as fast as or faster than retrieving all of the information from a single suborganization.

As described in previous sections, when we have observed time to retrieve events in our studies, activity cues have not provided faster access than other cues. In fact, in the cued-recall study, activities provided the slowest access. Activities do not appear to be the primary organizers of autobiographical memories. If they were, they should have provided faster access than other cues.

*Narrative styles.* It is important to bear in mind, however, that people may employ various narrative styles when describing events from their lives. These narrative styles may in some cases be retrieval strategies that do not reflect underlying memory organization but instead reflect various cultural and linguistic conventions. For example, we found in our free-recall study that the highest level of organization
often was a chronological sequence of extended events. This could represent a narrative style in which people begin at the beginning of a temporal interval and work toward the end, moving along in units of extended events—what in some sense might be considered personal story-telling. Most important, this organization may not reflect underlying memory organization. Information may instead be organized in a different way or be relatively unorganized.

Although further research is necessary to resolve whether chronologically organized sequences of extended events simply reflect narrative style or whether they actually reflect underlying memory organization, I assume for the remainder of this chapter that they reflect underlying memory organization. As discussed later, the many functions that chronologically organized sequences of extended events appear to serve suggest that they play a prominent role in the organization of autobiographical memories.

A theory of autobiographical memories

Findings reviewed in the previous sections led us to develop a theory of autobiographical memories. It should be borne in mind not only that this theory is post hoc but also that it is based on relatively few exploratory studies. Although this theory should be viewed as highly tentative at this point, it may nevertheless provide some value as a framework for thinking about autobiographical memories and for generating future research.

This theory was primarily motivated by the following three findings: (1) the centrality of chronologically organized extended events in structuring subjects' free-recall protocols, (2) the roughly equivalent use of other organizations across our studies (e.g., organization by activities, participants, locations), and (3) the prevalence of summarized events in subjects' protocols. It should again be noted that these results were obtained from a few exploratory studies and that further research is necessary to assess their generality.

Extended-event time lines: Structural characteristics

According to this theory, extended-event time lines are the primary organizers of autobiographical memories. Kolodner (1978), Schank and Kolodner (1979), and Reiser et al. (1987) have briefly considered a similar kind of knowledge that they refer to as "eras." Brown, Shevell, and Rips (1987), Linton (1987), and Neisser (1987b) have also considered this kind of knowledge. The following sections describe some of its possible characteristics.

Hierarchically and chronologically organized partonomies. An extended-event time line is a partonomy of extended events that are organized hierarchically and chronologically. As shown in Figure 8.2, for the extended-event time line for school, extended events such as college, junior, and summer are nested within one another hierarchically, and extended events that are parts of the same extended event are ordered chronologically (e.g., job, vacation, and at home). In general, extended-event time lines appear to be a type of highly idiosyncratic generic knowledge that is constructed in the process of reviewing, assessing, and organizing the events in one's life.

Extended-event time lines are fundamentally different from the primary organization in Kolodner's (1983a,b, 1984) CYRUS. Whereas the
primary organizational units in CYRUS are generic event types, the primary organizational units in this theory are specific extended events. In addition, the basic units in CYRUS are organized taxonomically by inclusion relations, where each subordinate unit is an instance of its superordinate. In contrast, the basic units in this theory are organized into partonomies, where each subordinate unit is a part of its superordinate.

At some point, an extended event must decompose into specific events that last less than a day. These specific events (and the more specific events that comprise them) may also be parts of their respective event time lines, as suggested by Brown et al. (1987). However, these specific events may generally become much less accessible in memory than the extended events they comprise. Because an extended event may be activated during the processing of many specific events, and because it may often be retrieved during reminiscence, it may become well established in memory. In contrast, because a specific event may receive much less processing, and because it may experience interference from many events of its type, it may become relatively inaccessible after a short time.

Parallel extended-event time lines. This theory further proposes that people have parallel extended-event time lines for each of the basic kinds of activities that comprise their lives. There may be extended-event time lines for family, school, work, romantic relationships, friendships, and so forth, each representing different aspects of a given temporal interval. Assuming that the horizontal dimension of Figure 8.2 represents time, extended-event time lines for school, work, and relationships parallel one another to a large extent. In support of this, subjects in our free-recall study, after describing one extended event that spanned a particular interval, occasionally went back through the same interval and described another kind of activity. Linton (1987) reported a similar finding.

Interrelation by the logic of goal attainment. The extended events in extended-event time lines may be interrelated by the logic of goal attainment, which may play the following two roles. First, it may specify how a particular extended event becomes divided into parts. For example, the extended events for trip and travel might be partitioned as shown at the top of Figure 8.3, because these parts reflect phases that are essential to goal attainment. Second, the logic of goal attainment may provide conceptual relations between extended events. As shown at the bottom of Figure 8.3, a gardening job may have served to earn money for dating a high school sweetheart.

Neisser's conjecture. As has often been noted, the structure of space often is metaphorically extended into other conceptual domains (e.g., Clark, 1973; Lakoff & Johnson, 1980a,b). Spatial terms enter into people's understanding of time (e.g., times that are close versus far), social relationships (e.g., people who are close versus distant), psychological states (e.g., feeling high versus low), and so forth.

Neisser (see Chapter 14) makes some provocative points about this metaphorical extension of spatial structure. First, he suggests that spatial structure may be an important root metaphor because it has an innate neurological basis in the hippocampus. Because this inheritance enables
all people to perceive the organization of space in relatively the same way, and because it may mature early in development, it provides a source of many socially shared metaphors.

Neisser further suggests that the organization of space may be extended to the organization of autobiographical memories. As he notes, people often use spatial terms to describe events from their lives (e.g., “I’m glad to have all of those events behind me,” “that event occurred between two I would rather not remember”). Because events occur in time, and because time is often viewed spatially, events may be perceived spatially and thereby become organized temporally in memory.

Neisser’s conjecture is highly compatible with the construct of extended-event time lines. Both schemes propose that the primary organization of events is chronological. In Neisser’s scheme, the spatial organization imposed on events reflects their chronological order. In extended-event time lines, extended events are organized chronologically within a given hierarchical level. Both schemes also propose that events are organized hierarchically into partonomies. In Neisser’s scheme, the understanding of how spatial locations are hierarchically nested within one another (e.g., cities within states within countries) is extended to events. Analogously, extended events in an extended-event time line are assumed to be hierarchically nested within one another. These parallels suggest that the metaphorical extension of space to time may provide the cognitive basis of extended-event time lines.

**Extended-event time lines: Functions**

*Efficient summarization of life history.* Extended-event time lines provide an efficient means of summarizing a person’s life. Because the concept for an extended event distills a large number of experiences into a single representation, extended-event time lines provide an efficient means of summarizing the tremendous amount of information that comprises a person’s life history. Extended-event time lines also provide an efficient means of summarizing a particular period within a person’s life. When people are asked to retrieve information from a particular period, they can retrieve the part of an extended-event time line that covers this period and thereby provide a global account of what occurred. For example, when our subjects were asked to describe their recent summer vacation, some began their protocols by briefly describing the sequence of extended events that spanned their summer. After completing this brief summary, they then returned to each extended event and expanded on what had occurred in its context. Initially accessing extended-event time lines in this manner may also have caused other subjects to globally organize their entire protocols around chronologically ordered extended events.

Primary organizers of autobiographical memories. Extended-event time lines may provide the primary organizers of autobiographical memories. As discussed earlier for the free-recall study, extended-event time lines generally provided the highest level of organization in these protocols. Casual observation further suggests their importance in retrieving events. For example, when one person asks another to remember an event from their life, the person requesting the event often provides extended events in which the sought-after event was nested. For example, a high school classmate might ask: “Remember that time in the advanced Latin course during our junior year of high school when the teacher kicked you out of class?” People may provide such cues when posing retrieval questions because it is culturally understood—as part of shared knowledge about metamemory—that autobiographical memories are organized around extended events. In support of this, Reiser et al. (1987) observed people using extended events in this manner, although Reiser et al. view organization by extended events as being subordinate to activity organization.

Elaborating cues with extended events is similar to the cue-elaboration strategies discussed by Kolodner (1983a,b, 1984), who proposes that subjects often elaborate retrieval cues extensively in the process of retrieving an event. However CYRUS assumes that the most important elaborations further specify event types, whereas this theory assumes that the most important elaborations further specify extended events. Cue elaboration has also been discussed by Norman and Bobrow (1979), Reiser (1983, 1987), Williams (1978), and Williams and Hollan (1981).

Certainly much more work will be necessary to determine whether or not extended-event time lines form the dominant organization of autobiographical memories. Studies similar to the ones in which we pitted various organizations against one another could be expanded to include extended-event time lines as a possible organization. To the extent that they are the primary organizers of autobiographical memories, they should emerge as a dominant form of organization where none has emerged so far. Brown et al. (1987) also suggest that this kind of knowledge may be central to the organization of event memories.

Temporal reference structures. Extended-event time lines may provide people with a means of “telling time in autobiographical memory.” The extended events that comprise extended-event time lines provide salient temporal reference points for making temporal judgments. For example, when deciding when a political event occurred (e.g., when President Kennedy was shot), people may first attempt to determine what extended event was occurring at the time. Similarly when deciding
which of two events came first, people may attempt to find an extended event that intervened between the two target events to determine their order.

Recent work by Brown et al. (1987) demonstrates the central role of extended events in making temporal judgments. Subjects in their second experiment went from high school to college at the same time that Reagan succeeded Carter as president. When judging events from their own lives, subjects were faster at knowing whether the event occurred during high school or college than whether it occurred during the Carter or Reagan presidency. In contrast, subjects were faster at knowing whether a national event occurred during the Carter or Reagan presidency than whether it occurred during high school or college. These results suggest that specific events are encoded into relevant extended-event time lines, which are later used to estimate when they occurred. Findings from Loftus and Marburger (1983) and Robinson (1987) can be interpreted in a similar manner.

**Self-concepts.** Extended-event time lines can be viewed as personal histories. Because they organize memories chronologically, they enable people to construct explanations of how their lives have evolved. In a sense, extended-event time lines provide people with a sense of self, assuming that a significant aspect of people's self-concepts are what they have done with their lives (cf. Bem, 1972). To the extent that this conjecture is true, amnesics should have impoverished self-concepts (unless extended-event time lines are in fact a form of generic knowledge that is not affected by episodic amnesias). In general, changes in what a person remembers from the past may be accompanied by changes in self-concept. Barclay and DeCooke (see chapter 4), Brewer (1987), Fivush (see chapter 10), and Neisser (in press) also discuss the role of autobiographical memories in self-concepts.

**Summarized events nested in extended-event time lines**

The second structural component of this theory is the *summarized event*. As discussed earlier, a summarized event represents a kind of event that occurs repeatedly. Summarized events often are highly idiosyncratic in the sense that they summarize events unique to an individual or to a small set of individuals.

Because an extended event typically involves kinds of events that occur repeatedly, summarizations of these event types becomes nested within the extended event. For example, a job might typically involve making deliveries to ritzy neighborhoods, going out with co-workers to lunch at Mexican restaurants, and so forth. Similarly a vacation typically might involve evening hikes to open meadows and setting up camp in the rain. As a result, summarizations of these events become nested within their respective extended events, as shown in Figure 8.4. The summarized events that become nested within an extended event provide a representative account of the specific events that comprised it.

As discussed earlier, parallel extended events occur contemporaneously during the same time period (e.g., a job, a relationship, school). Consequently the problem arises as to how a summarized event becomes related to the relevant extended event. For example, if making deliveries frequently occurs for a job, then how does it become related to the extended event for the job and not to the ones for the relationship and school? The answer may simply be that a summarized event becomes related to an extended event only if the two are related by the logic of goal attainment. If making deliveries is not related to the goals for the relationship and school, it is never processed with these extended events in working memory and thereby does not become related to them in
long-term memory. However some summarized events may be related to multiple extended events, thereby becoming related to each (e.g., if making deliveries were also part of a romantic relationship).

Assuming that summarized events become integrated only with relevant extended events explains why subjects do not recall the most frequently instantiated summarizations from a given time period. Why is it that subjects, when describing their summer vacation, do not describe brushing their teeth, getting dressed, eating breakfast, and so forth? One explanation is that subjects simply edit out these summarizations at retrieval because they are so mundane. Another account is that these summarizations are never retrieved. Because they are unrelated to the more interesting extended events that subjects initially access when describing a given time period, they remain inactive.

Hierarchically organized ontological knowledge

In order to discuss the formation of summarized events and the representation of specific events, it is first necessary to discuss ontological knowledge and its hierarchical organization. This aspect of the theory borrows from Keil's (1979, 1981) work on ontological categories (without advocating the controversial M constraint; see Gerard & Mandler, 1983). Keil has noted that children acquire knowledge about different kinds of ontological entities at different ages (e.g., objects, people, places, times, actions, thoughts, etc.). Significant developmental changes in children appear to underlie their ability to comprehend increasingly complex kinds of ontological entities and to construct knowledge for them. Because knowledge appears to be acquired in ontological stages, there may be a separate organization for each kind of ontological knowledge in memory. For example, people may have knowledge of objects organized together, knowledge of places organized together, knowledge of people organized together, and so forth.

Furthermore the generic knowledge for each of these ontological domains may be organized hierarchically to some extent. For example, objects may be organized into a hierarchical taxonomy, with abstract superordinate categories at the top and with more concrete categories at lower levels. Similarly locations may be organized into a hierarchical patronym, with continents and oceans at the top, and with more specific locations at lower levels.

Recent work on the basic level further supports the existence of hierarchically organized knowledge in different ontological domains. As discussed originally by Berlin, Breedlove, and Raven (1973), the basic level is the level of a hierarchy that people prefer to use when processing the entities it organizes. It has now been shown that there is a basic level in each of four different ontological domains. Rosch, Mervis, Gray, Johnson, and Boyes-Braem (1976), along with many others since, have shown that there is a basic level for objects. Cantor and Mischel (1979) have shown that there is a basic level for concepts of people. Tversky and Hemenway (1983) have shown that there is a basic level for locations. Rifkin (1985) has shown that there is a basic level for activities.

Most important, it is difficult to see how a domain of knowledge could have a basic level and not be hierarchically organized. The presence of a basic level in an ontological domain strongly suggests hierarchical organization. Consequently I assume that people have different kinds of ontological knowledge, each of which is hierarchically organized.

An event as a collection of exemplars from multiple ontological domains

A physical event typically involves entities from many ontological domains. An event often includes objects, people, actions, a location, a time, thoughts, and so forth. Of course not all events involve an entity from every ontological domain, and events vary in the ontological domains that are relevant. However most events probably involve entities from at least several ontological domains.

When an event is experienced, according to this theory, information about each ontological entity in the event becomes integrated as an exemplar into the relevant body of hierarchically organized ontological knowledge. Consider the following event: A man drinks a bottle of wine after work in a Paris cafe and discusses art with his best friend. This event contains entities from many ontological domains, including actions (drinking), an object (bottle of wine), a time (after work), a location (Paris cafe), thoughts (about art), and a participant (best friend). As shown in Figure 8.5, each of these entities becomes represented in memory as an exemplar (e). Furthermore each exemplar becomes related to the most relevant and specific generic concept in the hierarchically organized, generic knowledge that comprises its ontological domain. For example, the exemplar for the bottle of wine becomes related to the generic concept for bottle of wine; the exemplar for the cafe becomes related to the generic concept for Paris cafe; the exemplar for the best friend becomes related to the generic concept for that friend; and so forth.

Perceptual information in exemplars. As noted by Brewer (1987), remembering an event often is accompanied by imagery in several modalities (including the experience of motor movements). Because this perceptual information is a by-product of personally experiencing the original event, it provides memories of the event with a sense of self, that is, of an ego experiencing events in the physical world (Nigro & Neisser,
1983). Such information is not present in memories based on hearsay (although perceptual information may have been encoded through mental imagery).

Because the exemplars comprising events may be represented perceptually to a large extent, they may underlie the imagery that often accompanies remembering events. Such perceptual information may also be responsible for exemplar effects, many of which appear to be controlled by perceptual information (Jacoby & Brooks, 1984; Klerks & Roediger, 1984). In addition, if perceptual information is repeated across exemplars, it may become abstracted into the generic knowledge they instantiate. This would provide a source for the perceptual generic knowledge that people have of events (Brewer, 1987).

Conceptual relations between exemplars. As shown in Figure 8.5, the representation of an event is an intersection of knowledge in different ontological domains. In a sense, events are the means by which different ontological domains become interrelated. However, Figure 8.5 depicts this intersection only as exemplars being related to a common superordinate (E) for the entire event. Although this is a convenient way to represent an event theoretically, it is probably incorrect. Instead of simply being related to a common superordinate, the exemplars that comprise an event probably are interrelated to each other in a much more complex manner by conceptual relations. For example, the location (e.g., cafe) could be related to the activity (e.g., drink wine) by relations of allow and support (i.e., cafes allow and support drinking wine). Similarly the participant (e.g., best friend) could be related to what was thought about (e.g., art) by the relation of likes. Some exemplars may be more interrelated in this manner than others. In addition, knowledge about goals may integrate these relations into hierarchical causal structures. Barsalou, Usher, and Sewell (1985) provide further discussion of conceptual relations. As suggested by DeJong (1983), these relations may be by-products of the comprehension process.

Theoretical consequences of representing events as collections of exemplars

Exemplar-based knowledge evolution. Because Brooks (1978), Medin and Schaffer (1978), and Jacoby (1983) have shown that a wide range of cognitive tasks use exemplar knowledge, theories should provide a natural means of encoding exemplars into memory and relating them to relevant generic knowledge. Viewing events as collections of exemplars provides a natural means of explaining how knowledge in different ontological domains evolves with experience. Every time an event is experienced, it contributes new exemplars to many domains of knowledge. In addition, assuming that generic concepts are continually revised on the basis of new exemplars, this theory also provides a natural means of accounting for the continual evolution of generic concepts.

Sources of comments about events. As discussed earlier for the free-recall study, subjects often commented about the people, locations, and so forth, that comprised events. Generic knowledge related to each exemplar may provide the source of many of these comments. When retrieving an event, its exemplars may activate related generic knowledge, which subjects then include in their protocols.

Multiple access of events. Another consequence of this formulation is that an event can be retrieved directly with a wide variety of cues. Because an event deposits exemplars in many different ontological domains, it becomes possible to retrieve the event by searching any of them. More specifically, the hierarchically organized knowledge within any domain provides a ready supply of retrieval cues, one of which may be capable of eliciting an exemplar from a sought-after event. Once an exemplar is accessed from a generic cue, it may cue other exemplars in its event by the conceptual relations established between exemplars when the event was experienced. To the extent that many or all of the exemplars comprising the original event are retrieved, the event is remembered.
This view is consistent with our findings that no one kind of event information dominates all others as a retrieval cue (e.g., activity, participant, location) and that it is not necessary to first identify an activity to retrieve an event. Instead many different kinds of cues provide direct, parallel access to a given event.

Pivoting. As discussed earlier, the last event of an event cluster may sometimes initiate a new cluster based on a different organizational principle (e.g., when an event involving Leonard Bernstein going sailing pivots between a Leonard Bernstein cluster and a sailing cluster). Pivoting naturally follows from this theory. If search is focused on events involving a particular generic concept (e.g., Leonard Bernstein), then exemplars of that concept may be retrieved, each of which may access an event via conceptual relations to exemplars in other domains. Once no more exemplars of Leonard Bernstein can be retrieved, search may be redirected to a new generic concept in the most recently retrieved event (e.g., sailing). Exemplars of this concept may then be retrieved, each of which may provide access to an event, thereby resulting in an organizational pivot.

Reminding. Many theorists have recently proposed that reminding is central to learning (e.g., Kolodner, 1983a,b, 1984; Ross, 1984; Schank, 1982). An experienced event often will remind a person of a similar event, which then directs processing of the current event. As noted by Schank (1982), there are numerous bases of reminding. In fact, it appears that almost any characteristic of an event can serve to remind a person of another event having that characteristic. The theory proposed here provides a natural means of accounting for this wide variety of remindings: Any exemplar from a current event may retrieve a similar exemplar from a past event and thereby retrieve the past event. Because events can contain many kinds of exemplars, many kinds of reminding are possible.

Event fragmentation. Representing events in this manner also provides a natural way of viewing event fragmentation. It is well known that subjects often cannot remember the people involved in an event or the person who produced a message (i.e., source amnesia). This has recently been extended to showing that subjects often cannot remember where or when an event occurred (Jacoby & Brooks, 1984). One way to think about such loss of event information is that an exemplar in a particular ontological domain becomes inaccessible, perhaps because of interference, whereas all the other exemplars comprising the event remain accessible. Consequently when one tries to remember the event, one retrieves some of the exemplars, thereby partially remembering the event, but not all the exemplars, thereby producing a fragmented event.

Forgetting exemplars may result from interference. When exemplars from many different events become related to the same generic concept in an ontological domain, they may interfere with one another's retrieval, both proactively and retroactively, as well as through output interference. Although such exemplar loss may occur in all ontological domains to some extent, it may occur more often in particular domains. These may be domains in which more exemplars become related to particular generic concepts, thereby resulting in increased interference. Or these may be domains for which little mediating elaboration to other domains—via conceptual relations—is established when events are experienced. Because fewer mediating elaborations link the exemplars of these domains to exemplars of other domains, these exemplars are not as resistant to forgetting.

This interference view appears analogous to Wagemaan's (1986) file-system account of why some cues are more effective than others and why two cues do not function independently: A memory filed under an index with many memories is harder to find than a memory filed under an index with fewer memories, presumably because of more interference; and indexes with many memories function better as cues when a preceding index focuses search, presumably because it reduces interference.

Event confusion. This view of event representation also provides a natural way of accounting for the intrusion of one event into the recall of another. Because exemplars from many different events are related to a given generic concept, the wrong exemplar may be retrieved when accessing an event. For example, if someone is trying to remember an event involving drinking wine with a friend in Paris, the wrong cafe may be retrieved because the correct cafe is less accessible than the cafe in another event memory.

Actually this kind of error requires that memory contain a summarized event for drinking wine with friends in Paris cafes. When trying to remember an event involving drinking wine with a friend in Paris, generic knowledge must be used to generate the inference that the event took place in a cafe. Once this inference is made, search for an exemplar then produces the wrong cafe.

Exemplar accessibility may underlie some of the reconstructive biases observed in eyewitness testimony. For example, an incorrect presupposition embedded in a lawyer's question to an eyewitness may cause the eyewitness to integrate erroneous exemplar information into memory for an event (Loftus, Miller, & Burns, 1978). Because the incorrect exem-
The construction of summarized events from specific events

Summarization after two or more events. Accounts of event summarization typically assume that summarization does not occur until after two or more events of the same kind have been experienced (e.g., Kolodner, 1983a,b, 1984; Nelson et al., 1983; Nelson & Gruendel, 1981; Schank, 1982). Such accounts typically propose that when a second event of the same kind occurs, the first event is retrieved to assist in processing the second. Similar aspects of the two events are then noted and become encoded into memory as a summarization of the two events.

Summarizations as temporary constructs in working memory. A second account of summarization is that an experienced event causes memories of similar events to be retrieved from long-term memory and be summarized in working memory. This summarization then guides processing of the event (e.g., Kahneman & Miller, 1986). An extreme form of this view—what could be construed as a hard-line exemplar view—holds that summarizations never become established in long-term memory. Instead long-term memory contains only exemplars, and summarizations exist only temporarily in working memory. As argued by Barsalou (1987), however, it would be surprising if summarizations were not transferred into long-term memory as a result of the extensive processing they often receive in working memory. This follows from a long tradition of memory research on the transfer of information from working memory to long-term memory (e.g., Craik & Watkins, 1973; Glenberg, Smith, & Green, 1977; Rundus, 1971). If exemplars become transferred to long-term memory through such processing, why not summarizations?

Summarization after one event. A third account of summarization, and the one proposed here, is that summarizations are constructed after experiencing a single event—summarization does not require that two or more events of the same kind be experienced. Consider the representation of an event memory shown in Figure 8.5. The memory is comprised of exemplars, each of which is an instance of a generic concept. The argument for summarization after one event rests on the following assumption: An exemplar cannot be related to a generic concept without that concept becoming active in working memory. Because a generic concept must become active to comprehend each exemplar, and because the generic concepts for all exemplars are therefore active simultaneously in working memory, they become interrelated and form a summarized event that becomes transferred to long-term memory. An example is shown in Figure 8.6.

Consequently a single event creates two intersections of hierarchically organized ontological knowledge: one for the exemplars comprising the event (E), and one for the generic concepts used to encode it (S). Similar to how conceptual relations may integrate the exemplars comprising an event (as discussed earlier), conceptual relations may also integrate the generic concepts comprising its summarization. These relations, along with their higher-order goals, provide a conceptual model about that kind of event (Gentner & Stevens, 1983; Johnson-Laird, 1983; Lakoff, 1987; Murphy & Medin, 1985; Neisser, 1987a). Conceptual models serve important functions in processing events. During comprehension, they support causal inferencing (DeJong, 1985; Schank & Abelson, 1977). During retrieval, they guide cue elaboration and generate reconstructive distortions (Kolodner, 1983a,b, 1984; Reiser, 1983, in press; Reiser et al., 1987). During planning, they guide instantiation (Barsalou et al., 1985) (see chapter 9).

The construction of a new summarized event should occur only if an event activates a new combination of generic concepts. If an event activates a combination of generic concepts that has been activated by a previous event, then memory should already contain a summarization for that kind of event. Consider the example shown in Figure 8.7. Exemplars for the second and third events should activate the same
generic concepts as the first event and should therefore activate the summarization constructed from the first event. In addition, the second and third events may cause a “reminding” of the first event. This could occur (1) if a generic concept activates an exemplar from the first event or (2) if the summarized event activates the entire event as an instance (via a relation from $S$).

Because generic concepts generally may be better established in memory than exemplars, a summarization constructed after one event may become increasingly more accessible than the event memory as time passes. Consequently, even if a second event does not cue exemplars from the first event, it may cue the more accessible summarization, which then guides processing of the second event. In addition, a summarization should become increasingly established in memory as increasing numbers of its instances are encoded. In contrast, the exemplars comprising these instances should become increasingly difficult to access because of interference. As a result, this account reasonably predicts that increasing the number of instances should increase the gap between the accessibility of a summarization and the accessibility of its instances (Watkins & Kerkar, 1985).

DeJong (1983) has also proposed that summarizations are formed after encoding a single event, although for different reasons. He argues that comprehending a particular event may cause generic knowledge to be constructed, which explains that kind of event in general. For example, in trying to explain how a particular kidnapping occurred, someone might construct a causal account for that kind of kidnapping in general. As a result, this knowledge is available to help explain later events of this type. Kahneman and Miller (1986) also discuss summarization from a single event.\(^{11}\)

### The development of autobiographical memories

**Children.** This theory assumes that well-established, hierarchically organized knowledge for ontological domains exists in adults prior to the construction of a summarized event. However, this relationship is probably reversed for young children. As Nelson et al. (1983) and Nelson and Gruendel (1981) have noted, children construct summarized-event representations long before they construct taxonomic knowledge for ontological domains (Lucariello & Nelson, 1985). As Nelson has argued, taxonomic knowledge may in fact evolve from early event summarizations. The generic concepts that comprise these summarizations may provide the material from which bodies of ontological knowledge later develop.

An analogous reversal appears true of extended-event time lines. The theory proposed here assumes that adults integrate memories of specific events into preexisting extended-event time lines. However very young children may not possess such personal histories (see chapter 10), even though they do remember past events (Fivush, Gray, & Fromhoff, 1987).

One reason for the relatively late development of autobiographical memories in the form of personal histories may be children’s limited opportunity to perceive extended events. The construction of this knowledge may become possible only when children understand that extended events exist and that life can be viewed as a succession of such events. Children’s ability to extend the metaphor of space may ultimately determine when they begin to view events in this manner (see chapter 14).

With this understanding, children may begin to construct extended-event time lines and to nest relevant summarized events within them. In addition, this newly acquired view of life may cooccur with an increased awareness of the cultural importance of developing a personal history (see chapter 10).

Because summarized events enable young children to cope with the repeated events that comprise their daily experience, summarized events are the primary products of children’s initial memory development.
However these summarized events later provide the material from which ontological knowledge and extended-event time lines develop. Once this knowledge has evolved, the encoding of specific events may take place against it, and the organization and evolution of autobiographical memories may begin to look more like the theory proposed in this chapter for adults.

The elderly. Not only may extended-event time lines change substantially during childhood, they also may change substantially as people grow older. Rubin, Wetzler, and Nebes (1987) present evidence for a reminiscence effect. When people older than 30 years receive various cues and are asked to retrieve past experiences, they tend to retrieve more events from the ages of 10 to 30 than from after 30. Moreover, as these people grow older, the number of events from 10 to 30 increases relative to the number of events from years after 30. Rubin et al. suggest that this finding reflects increased reminiscing about the years from 10 to 30 as people become elderly.

Increased reminiscence about one’s life may result in increasingly well-articulated and well-established extended-event time lines for the past. As a result, the elderly may provide much more information about a given period of life (e.g., 10 to 30) than people who are younger. They also may be able to generate this information much more quickly to the extent that they have reviewed the past more often and more recently.

This further suggests the possibility of extended-event time lines for the future. Younger people’s extended-event time lines about the past may not be maximally developed because they are focusing more attention on what they foresee in their lives. The status of people with respect to their education, career, family, and so forth should determine the extent to which they project extended-event time lines into the future. People who have accomplished most of what they planned for their lives should have less-developed projections than people who have “their lives before them.” In general, people’s extended-event time lines for the past and future should reflect their current state of development.

The instability of knowledge

Barsalou (1987, 1988) argues that there are no invariant knowledge structures in memory. Instead, people continually construct unique representations from loosely organized generic and episodic knowledge to meet the constraints of particular contexts. Because no two contexts cause the same information to be incorporated from long-term memory into a representation, no two representations for a particular kind of thing are ever the same (e.g., chair is never represented identically across occasions).

This position may appear contradictory with proposals made here about knowledge for extended-event time lines and summarized events. However there is no reason why this knowledge should not also exhibit instability. For example, there may be substantial differences in how a person represents a particular extended-event time line in working memory across occasions. Although there would probably be similarities, there should also be context-dependent differences. Such instability should also occur for summarized and specific events, with no two representations of the same summarized or specific event ever being the same in working memory. Instability has been neglected in this chapter largely because of an interest in providing an initial and global account of autobiographical memories, and a more developed account would certainly require careful consideration of the mechanisms underlying it.

Conclusion

This theory is highly tentative. It was developed post hoc from a small number of exploratory studies, and all of its theoretical structures have been specified in the vaguest of terms. Clearly much more empirical investigation is needed to develop a sound and a complete empirical base that describes how people encode, organize, and retrieve autobiographical memories. Clearly a much better articulated version of this theory will be necessary for making unambiguous empirical predictions and for knowing how well it accounts for empirical findings. Nevertheless this theory in its current form may at least serve the purposes of suggesting research and stimulating discussion on what appear to be important issues.

NOTES

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knowledge that are somewhat differentiated and that are hierarchically organized to some extent. Whether or not knowledge falls neatly into ontological domains and whether or not these domains are completely isolated from one another are not crucial. I further assume that each body of knowledge is integrated by intuitive theories about its respective domain (Murphy & Medin, 1985; Lakoff, 1987; Neisser, 1987a).

10 The use of "exemplar" in this theory is somewhat different from the senses proposed by Medin and Schaffer (1978), Brooks (1978), and Jacoby (see chapter 6). Whereas these theorists might assume that an entire event is stored as a single exemplar in memory, this theory assumes that an event is stored as a collection of exemplars from different ontological domains. Schank's (1982) theory of dynamic memory also proposes that an event is broken up into different parts, each of which is integrated into a different organizational structure. However, the "parts" in Schank's theory are the various generalized actions that comprise an event, whereas the "parts" in this theory are the different ontological entities comprising an event. In general, an important and difficult problem is to determine how an event is broken up into exemplars, assuming it is broken up at all. A related problem is whether a single exemplar is stored for a given part of an event or whether multiple exemplars are stored. For example, is one exemplar stored for a participant in an event, or are multiple exemplars stored? If so, what determines the number of exemplars? Both of these problems also exist for current exemplar theories.

11 Trying to account for script action sequences substantially complicates the view of summarized events as intersections of generic knowledge from different ontological domains. How should we represent the hierarchically organized action sequences that comprise the "scriptiness" of many summarized events? Furthermore, how should we represent the numerous tracks that such sequences can take (Schank & Abelson, 1977)? Accounting for the action sequences associated with a summarized event is likely to result in a proliferation of structure within the ontological domain for actions, which must then be related to relevant information in other ontological domains.

It may be useful to also view extended-event time lines as intersections of generic concepts from different ontological domains.

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