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# Knowledge Structures in the Organization and Retrieval of Autobiographical Memories

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In this paper, the role of knowledge structures in organizing and retrieving autobiographical experiences is investigated. It is proposed that autobiographical events are organized in memory by the knowledge structures that guided comprehension and planning during the experience. Individual experiences are retrieved from memory by first accessing the knowledge structures used to encode the event, then using information in those structures to predict features of the target event, thus directing search to paths likely to lead to that event. Two types of structures are investigated as candidates for these organizing contexts. *Activities* are sequences of actions performed to achieve a goal, while *general actions* are situation-free components occurring as part of several activities and represent what is common to that action across those activities. It is predicted that activities are more important in retrieving experiences, because (1) these structures constitute the principal contexts used to store experiences and (2) information contained within these structures is more useful for predicting features of target events. The greater utility of activities in retrieving experiences was demonstrated in two autobiographical memory retrieval time experiments. First, retrieval of a personal experience matching an activity and action combination was faster when subjects were given an activity cue before a general action cue, because processing could get a "head start" when the activity context was presented first. Second, specifying an activity and action led to faster memory retrievals than specifying only the action, while no such facilitation occurred when an activity was augmented by a general action. In both experiments, retrieval was slowed when more processing was required to infer probable features of the target experience, as predicted by the directed nature of the search process. These experiments and this model provide a general framework for studying the organization of events in autobiographical memory. © 1985 Academic Press, Inc.

## INTRODUCTION

A widespread use of memory in everyday cognition is the retrieval of personal or autobiographical experiences. Cognition relies not only on

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generalizations that have been abstracted from experience, but also on countless individual events that are encoded in memory. Retrieving such individual events is an important component of many cognitive processes such as learning (Schank, 1982), planning (Carbonell, 1982; Hammond, 1983), and problem solving (Ross, 1984). How is memory organized to facilitate retrieval of past experiences? Retrieving the memory trace for an event requires finding the item in a memory store containing an enormous number of recorded experiences. This search is complicated further because it is typically initiated by a query containing an incomplete specification of the target event. A complete theory of human memory must therefore include an account of how personal memories are represented and organized and an account of the processes that search this store of information to find the representation of a specific experience.

Previous research has revealed a number of facts about the recall of autobiographical memories. For example, the accurate retrieval of natural experiences decreases with elapsed time, as does memory for artificial materials learned in the laboratory. Subjects are able to recall fewer events as the amount of time elapsed since the occurrence of the events increases (Crovitz & Schiffman, 1974; Rubin, 1982), and subjects are less accurate in remembering personal events as time increases (Bahrick, Bahrick, & Wittlinger, 1975; Linton, 1975, 1978; Messe, Buldain, & Watts, 1981; Thompson, 1982; Whitten & Leonard, 1981). The emotion associated with an experience also affects its accessibility. In particular, experiences associated with intense emotion are easier to recall than less emotion-laden experiences, regardless of whether the emotion is positive or negative (Holmes, 1970; Menzies, 1935; Robinson, 1980; Turner & Barlow, 1951; Waters & Leeper, 1936). Although this research has provided some interesting and valuable descriptions of a few of the general factors affecting memory for experiences, the findings have not been related to models of the mental representations and retrieval processes involved in autobiographical memory.

Another approach to the study of autobiographical memory has been the attempt to sketch out some of the processing strategies used in memory retrieval (Whitten & Leonard, 1981; Williams & Hollan, 1981; Williams & Santos-Williams, 1980). While such a focus on the *process* of retrieval has been valuable, these results have not explained why subjects utilized the particular strategies they described. Such an explanation requires relating the strategies to the organization of the memory system. Characterizing the ways in which autobiographical memories are organized and the type of information required to access these memories will provide explanations of why these strategies are effective, and a description of how they function to retrieve the target information from memory.

*Knowledge Structures*

Memory organization has been the focus of much research in cognition. Several models of perception, comprehension, and memory have incorporated the notion that knowledge is chunked into mental structures that organize a rich network of connected propositions so that relevant information can be easily accessed and applied to direct further processing (e.g., Bartlett, 1932; Bobrow & Norman, 1975; Charniak, 1977, 1978; Grasser, 1981; Minsky, 1975; Rumelhart, 1980; Rumelhart & Ortony, 1977; Schank, 1982; Schank & Abelson, 1977; van Dijk, 1980). Such knowledge structures typically contain generalizations that have been abstracted from individual experiences. To date, much of the research on knowledge structures has centered on their utilization in comprehending and remembering stories. For example, Schank and Abelson (1977) proposed *scripts* as knowledge structures containing information about stereotyped sequences of events. Scripts have been shown to affect comprehension and recall of narrative texts (Abbott, Black, & Smith, in press; Bower, Black, & Turner, 1979; Graesser, Gordon, & Sawyer, 1979; Graesser, Woll, Kowalski, & Smith, 1980; Haberlandt & Bingham, 1982; McCartney & Nelson, 1981; Sharkey, 1983), but their utility in other types of processing has rarely been examined (but see Abelson, 1976, 1981, for some proposals about the effects of scripts on social behavior).

Knowledge structures are used not only for perception and comprehension, but also in planning and directing behavior, because planning and comprehension processes draw upon the same data base of stored world knowledge (Schank, 1982; Schank & Abelson, 1977; Wilensky, 1983). Since these structures contain knowledge about classes of events, it is reasonable to investigate whether they also organize the individual events that may have been used to construct the generalizations embodied in the structures. In this paper, we present experiments that investigate how knowledge structures function in the organization and retrieval of experiences. Before describing these experiments, we first briefly review some proposals concerning the organization of autobiographical memory that we use as a framework in which to interpret our results. In the remainder of the introduction, we discuss the role played by knowledge structures as organizers of autobiographical memories and in guiding the retrieval of these experiences.

*Knowledge Structures Serve as Organizing Contexts*

Retrieving information from memory requires accessing the context used to encode the event (Tulving, 1983; Tulving & Thomson, 1973). Because most experiences involve deliberate actions, the mental context at the time an experience is encoded will typically consist of those concepts and structures accessed to plan one's behavior and understand the actions of others in the event. For example, the memory structure *Eating in Restaurants* contains generalizations necessary for determining what actions to perform in restaurants and for understanding the behavior of others in restaurants. Accessing this knowledge structure while actually visiting restaurants results in the memory representations of particular restaurant experiences becoming associated with that structure in memory (Kolodner, 1983a, 1984; Schank, 1980, 1981, 1982). Thus, individual experiences become linked to knowledge structures containing generalizations used in planning and comprehension.

The association of individual occurrences with a general schema was originally proposed by Bartlett (1932). In his "schema plus correction" model, understanding consists of finding one or more appropriate schemas that partially fit the presented stimuli, then storing in memory the schema plus the specific deviations from its general information. Similarly, Schank and Abelson (1977) argued that the memory for a story episode consists of the instantiations of the scripts and other knowledge structures used to link together the explicit and inferred story propositions, "tagged" with causally related events not predicted by the script. For example, a *Going to the Opera* episode may consist of the instantiated script, containing values for the variables "name of opera," "principal singers," "concert hall," "other people accompanying the person," etc., and may be tagged with an interesting conversation or a spilled drink during intermission. Graesser (1981) has applied this schema-plus-tag model to other types of knowledge structures, in addition to scripts. A schema-plus-tag model has also been proposed to describe the manner in which visual information about actions and scenes are stored in memory (e.g., Friedman, 1979; Goodman, 1980; Minsky, 1975).

In recent extensions of the schema-plus-tag notion, Kolodner (1983a, 1984) and Schank (1980, 1981, 1982) have argued that experiences are connected to knowledge structures by *indices* specifying the deviations of each particular experience from the prototype or generalized version represented in the knowledge structure. These indices are labeled associations that serve as effective retrieval cues for the experiences when an appropriate knowledge structure context has been accessed. Indices typically entail discriminations concerning those features that are "predictive" or causally related to other features in the event, such as motivations for engaging in events, standard varieties of activities (e.g., Italian restaurants, science fiction movies), and choice of participants and social roles (Kolodner, 1983b; Reiser, 1983). Since many experiences share features that discriminate them from other experiences in that context, knowledge structures form at several levels of generality in order to capture important generalizations about these experiences. For example, one may have generalizations about the goals, appearances, props, and social roles involved in the knowledge structures *Eating in Restaurants, Eating in Italian Restaurants, Taking Dates to Restaurants,* etc. The particular details of the Schank and Kolodner models need not concern us here. The principal representational claim motivating the present investigations is that experiences are encoded in memory as indexed associations of planning/comprehension knowledge structures.

*Knowledge Structures Guide Retrieval*

The encoding context for an autobiographical event is the particular knowledge structure representing generalizations for that class of events. Thus, the first step in retrieving an autobiographical event is to access a contextualizing knowledge structure. In some cases, the initial search context may be determined by information explicit in the query. Memory queries are typically incomplete, however, and thus selection of appropriate memory structures to use as search contexts is often guided by inference mechanisms that process the information specified in the query to predict the most plausible location in memory where the target information might reside (Kolodner, 1983a; Norman, 1973). Autobiographical retrieval therefore contains an important strategic or predictive component that directs the search to particular portions of the memory system likely to contain the targeted event by elaborating the original query into a more complete description of the target information (Kolodner, 1983a, 1984; Norman & Bobrow, 1979; Reiser, 1983; Williams & Hollan, 1981). When a context has been accessed, the predictive mechanisms use information in the *content frame* or set of general knowledge encoded in each knowledge structure to make additional elaborations sufficient to discriminate an experience with the target features among the many experiences associated with that context (Kolodner, 1983a). For example, a subject asked to recall a particular library experience may think about reasons one goes to a library, such as class assignments, pleasure reading, etc., and then use that motivating reason to refine the search (Reiser, 1983; Reiser, Black & Kalamarides, in press).

In Kolodner's model, selecting a context and traversing indices is a recursive process, where the context is continually refined on the basis of other contexts that have been accessed. At each step, information in the content frames of knowledge structures that have been accessed can be used to add to the predicted features of the target event and to direct the search to appropriate paths within more specific knowledge structures, until finally an index is found leading to an individual event. Of course, not all the information is equally useful. The elaboration process is guided by reasoning mechanisms that utilize social knowledge about the causes and motivations of behavior in order to predict circumstances likely to result in the target event. In this way, autobiographical memory search is essentially a problem solving process depending on causal reasoning to guide the search. In some respects, this search model is similar to earlier models in which memory is repeatedly probed with a set of cue features that is changed or augmented using the results of previous searches (Morton, Hammersley, & Bekerian, 1983; Norman & Bobrow, 1979; Raaijmakers & Shiffrin, 1981; Shiffrin, 1970; Williams & Hollan, 1981), but extends these models by articulating precisely how the features are chosen to use as search cues and by describing how the organization of the data base constrains these search mechanisms.

The following verbal report of a memory search (from Reiser, 1983) illustrates how a memory query may be reformulated during search for an experience:

> Experimenter: Think of a time when you went to a restaurant and didn't get what you wanted.
>
> Subject: Never happened. [pause]
>
> Experimenter: What's going through your mind now?
>
> Subject: Um, I'm thinking about a restaurant in New Jersey I used to go to all the time, and get pizza, and it was, you know, really crazy but I always got what I wanted. It was in Morristown, Jersey, and it was called Cutter's, and it was probably around '77, '78, and it's a really hectic place but I always got what I wanted.

In this example, the initial search context is probably the knowledge structure *Eating in Restaurants,* which is explicitly provided in the query. However, the constraining feature of the question (*didn't get what you wanted*) may not be expressed in a form coinciding with the features that index this subject's restaurant experiences. The subject appears to have elaborated this query into a search for "hectic" restaurant experiences, presumably because this type of situation might result in not getting what was wanted. This reformulation relies on causal knowledge represented in *Eating in Restaurants* (or perhaps more generally represented in *Contractual Situations,* a structure superordinate to *Eating in Restaurants*). Here, the inference processes may have tried to predict the circumstances likely to result in not getting what one ordered. For examples, waiters tend to make more errors when they have many orders to fill, as when a restaurant is very busy or understaffed. In this way, the search was directed to hectic restaurants and then to a set of hectic restaurant experiences associated with a particular restaurant, although the search of this subset failed to recover an experience possessing the target features.

Reiser (1983) argued that the automatic retrieval models typically postulated to explain behavior in verbal learning and semantic memory tasks do not account for the central aspect of autobiographical memory retrieval—namely, for the strategic inference mechanisms directing the search. In some cases, enough information may be provided in the memory cue so that access of an experience may occur without strategies, e.g., cases of spontaneous reminding. More typically, the memory query becomes elaborated as strategies are employed in an attempt to predict the attributes of the target. One interpretation is that in these cases there are too many possible paths for search to traverse them efficiently. For example, in terms of spreading activation theories (e.g., Anderson, 1976, 1983; Collins & Loftus, 1975), the spread of activation is too diffuse, so additional information is required to *direct* the search to the relevant paths in memory. The inference or predictive mechanisms provide this guidance by using generalizations encoded about events to direct the search (perhaps by channeling activation down appropriate paths). The search is thus reconstructive or inference driven, since information not contained in the original retrieval specification (knowledge about events) is required to select among the numerous paths available for search. In general, the predictive nature of the search suggests that the difficulty of a memory retrieval will be partially determined by the type and amount of processing necessary to select an appropriate search context and the difficulty of finding the appropriate indices to the experience within that context.

For our purposes, the principal processing claims for autobiographical memory search can be summarized as follows:

1. Experiences are retrieved by first accessing the knowledge structures used to encode the event, then specifying features that discriminate an event with the target features from others indexed within that context.
2. The retrieval query is elaborated using general information contained in the knowledge structures to predict additional features of the target event, thus directing search to paths likely to lead to that event.

### *The Nature of the Organizing Knowledge Structures*

It is important to describe the types of knowledge structures that serve as the contexts in autobiographical memory. The organizing knowledge structures will be those planning and comprehension structures active during encoding and effective in directing search during retrieval. Hence, the organizing contexts must be structures rich in predictive power. Some type of event knowledge structure appears to be the most reasonable candidate for the principal organizer of experiences, because the information encoded in autobiographical memory is a set of experiences, and experiences are certainly events rather than static facts or propositions. It is possible, however, that other types of concepts might organize these events in memory. One candidate organizer, for example, is the type of emotion associated with experiences. However, consider the predictive power of emotion knowledge structures. Although these structures enable predictions about the actions causing and resulting from a given emotion (Lehnert, 1981; Roseman, 1982), emotions are experienced in such a wide diversity of situations that information from other sources is likely to be necessary to discriminate experiences with a given emotion. In fact, Robinson (1976) found that subjects were faster to recall experiences involving a given activity (e.g., *throw, visit*) or an object (e.g., *dollar, car*) than affect-related or state cues (e.g., *brave, happy*), supporting the notion that experiences are more typically associated with some type of event concept than with more abstract concepts such as affects. Similarly, subjects asked to recall experiences involving a given emotion often reformulate the query into a question about a particular type of event (Reiser, 1983; Reiser et al., in press). For example, a subject asked for an experience involving *ambition* first reported that she sometimes felt ambitious when studying for an exam, and then proceeded to try to pin down one experience in a *studying for exams* situation.

Another possible organizing structure is the "person schema" or prototype, which contains information about the attributes and behaviors of a person possessing a particular trait or personality (Cantor & Mischel, 1977; Hastie & Kumar, 1979). However, person schemas are subject to the same problems as emotion schemas; one may encounter exemplars of a particular stereotype in many different situations. In fact, Cantor, Mischel, and Schwartz (1982) have shown that knowledge about situations (i.e., settings for common activities) is at least as accessible as knowledge contained in person schemas. Situational knowledge appears to contextualize the retrieval of person information, so that person information is more accessible if a situational context is also provided, suggesting that situational knowledge is more central than person schemas in memory. Peoples' prototypes for social situations are very rich structures, including substantial amounts of information about typical people, behaviors, and feelings associated with the situation.

These results support the role of event structures as organizers of experiences in memory. Events can be represented at many different levels of description, however. Most events are components of larger, more comprehensive events and can also be decomposed into smaller component events. For example, the descriptions *lifting a fork, eating a lobster, eating a meal, eating at Leons, eating in a restaurant,* and *going out for the evening* can all refer to and include the same action. Which level of abstraction represents the optimal type of knowledge structure for encoding autobiographical events? Our experiments address this question and investigate the mechanisms involved in retrieving an individual experience. Our strategy is as follows: We begin with the representational and processing assumptions outlined earlier, namely, that experiences are retrieved by accessing a knowledge structure context, then using information in that context to discriminate among the associated experiences. Using the framework provided by these assumptions, we examine how the type of information contained in a knowledge structure determines its function in memory and derive a set of empirical predictions. If knowledge structures have a role in organizing and retrieving experiences, then we should be able to predict the effectiveness of a memory cue by the type of knowledge structure accessed in processing that cue. We present two experiments that test these retrieval predictions. We consider these results within this framework of knowledge structure contexts and indices, then discuss the way in which our results constrain models of autobiographical memory, and point out several models built in alternative frameworks which we feel are inconsistent with our results.

Although our studies examine only memory retrieval, the results have implications for both encoding and retrieval. Examining the utility of various types of information in searching for an individual experience reveals the essential types of knowledge used by retrieval mechanisms. In addition, these results allow us to infer the way the experiences were encoded and stored in memory. We argue that the results suggest at which level of abstraction experiences tend to be encoded in memory and, thus, the types of knowledge structures that are primarily used to encode and index autobiographical memories.

### *Activities and General Actions*

Our experiments examine two candidates for the event knowledge structures used to organize personal experiences: *Activities* and *General Actions*. These types of knowledge structures are heavily used to both understand and plan behavior in many common experiences (Abbott et al., in press; Abelson, 1981; Bower et al., 1979; Galambos & Black, 1982; Galambos & Rips, 1982; Graesser, 1981; Haberlandt & Bingham, 1982; Nelson, 1978; Nelson & Gruendel, 1981; Schank, 1982; Schank & Abelson, 1977) and are therefore reasonable candidates for organizers of autobiographical memory. We use the term *activity* to refer to a stereotyped sequence of deliberate actions undertaken to achieve one or more goals. For example, one performs the activity *Eating in Restaurants* to satisfy hunger, to be entertained, and to socialize. Other activities are *Shopping in Department Stores, Going to Libraries,* and *Going to the Movies*. These structures refer to those types of events meant to be captured by scripts (Schank & Abelson, 1977) and *Memory Organization Packets* (Schank, 1982). We use the more neutral term *activities,* since some of the features of these particular proposals are not relevant to the purposes of the current experiments. For example, whether the individual component actions of the activity are represented as conceptual dependencies (Schank, 1975; Schank & Abelson, 1977), subject–predicate nodes in a memory network (e.g., Anderson, 1976), or mental images (Kosslyn, 1980) does not affect the predictions or interpretations of the current experiments. Thus, activities simply refer to knowledge structures encoding information about stereotyped sequences of actions.

Each component of an activity is an action accomplishing one of the subgoals of the activity. These actions are typically components of several activities, but differ somewhat in the manner in which they are performed in each activity. We use the term *general action* to refer to the memory structure encoding the generalizations about the action common to all the activities that contain that action. For example, the activity *Eating in Restaurants* includes the actions *Make Reservations* (sometimes optional), *Enter, Be Seated, Order, Eat, Pay,* and *Exit.* The general action *Make Reservations* is also a component of the activities *Going on Vacation, Playing Indoor Tennis,* and *Going to Nightclubs.*

Our general actions correspond roughly to what Schank (1982) termed *Generalized Scenes.* Schank argued that components of activities exist in memory at two levels of abstraction—an activity-specific version and a general version. Consider the action *Paying* in the activity *Eating in Restaurants.* The activity structure must contain a representation of how one pays for a meal in a restaurant. We also have knowledge about *Paying* that has been abstracted from the contexts of particular activities. Certain features of the *Paying* action are constant across all of the activities that contain it. For example, paying always involves the transfer of some money (or its equivalent in credit) for some service or items. If cash is not used, some document must be signed, and so on. The type of information contained in the content frame for the action is shown in Fig. 1. Schank suggested that this general information about the action is encoded in a memory structure called the *Paying Scene.* Each activity that includes a *Paying Scene* must contain the information about how paying in that activity is different from the general (non-activity-specific) version of the action. For example, paying in grocery stores takes place at "check-out counters," paying in department stores occurs at designated desks (where there is often a line of customers), while paying in restaurants may occur at the table or at a counter. Thus, general actions are modified by the *context-specific* information contained in the content frame for each activity (see Fig. 1).

Thus, an activity is a self-contained sequence of situation-specific actions performed in service of a goal, while a general action is a single situation-free action that occurs in various situations as part of an activity. The crucial distinction between activities and general actions is that activities are essentially "self-contained." Although there may be many circumstances in which one would choose to dine at a restaurant, it is

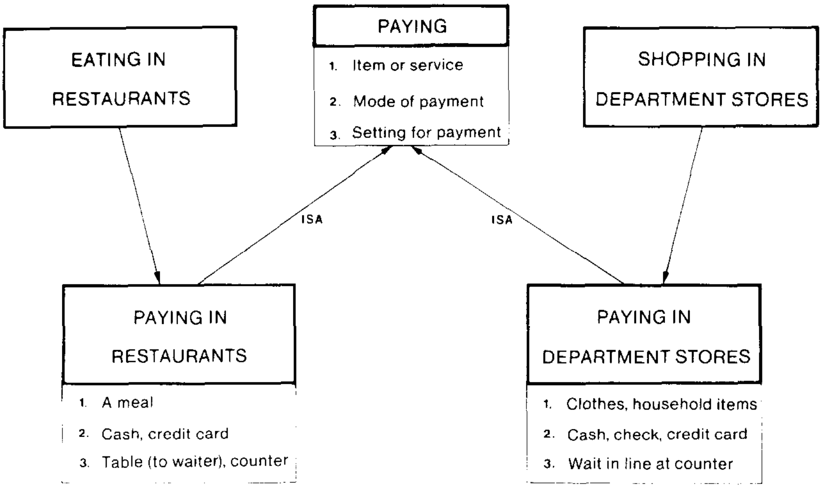


FIG. 1. A representation of the modifications of the information in a general action by two activities. More specific values for the three slots in the *Paying* action are provided in the content frames of the activities *Eating in Restaurants* and *Shopping in Department Stores*.

not elliptical if someone reports that he or she "ate at a restaurant last night." On the other hand, if one reports that he or she "paid for something last night," the response is likely to be "What was it? Where?" The goals of the general action are too abstract to form a sufficient explanation for the event (cf. Grice, 1975). Another consequence of the self-containment property is that, unlike activities, general actions are not performed in isolation. One does not pay for something, except in the context of an activity. However, any of the activities named above might be performed without being incorporated into a larger activity. Furthermore, even if it is part of a larger context (e.g., a business trip, a vacation) a description of the activity without this larger context remains comprehensible and does not sound awkward.

In addition, activities are often associated with a particular type of location possessing a characteristic appearance. For example, one knows that the activities *Eating in Restaurants, Visiting Museums,* and *Going to the Movies* occur in restaurants, museums, and movie theaters, respectively. In fact, many of the features of objects, people, and behavior in our society are correlated. Studies of situation prototypes (Cantor et al., 1982) and representations of environmental scenes (Tversky & Hemenway, 1983) suggest that representations of activities contain information about behaviors of people, perceptual features of the environment, and characteristic person types associated with the activity. Thus, many of these other attributes vary along with our manipulations of activities but do not completely account for our manipulation.

*The Role of Activities and Actions in Memory*

We now address the role of these knowledge structures in organizing individual experiences in memory. We have argued that experiences are indexed in memory within the knowledge structures that directed behavior during the experience. One possibility is that when an experience is stored in memory, it is indexed within both the activity and the component general actions that were performed (see Fig. 2a). This alternative would allow experiences to be retrieved from memory by searching from either the relevant activity or general action memory structures. For example, a restaurant-paying experience would be accessible given either *Restaurant* or *Paying* as contexts. However, not all information in a memory trace is equally effective as a retrieval cue (Morton et al., 1983). Our hypothesis is that the nature of information represented in these two types of memory structures will lead them to function differently in the encoding and later retrieval of experiences. Specifically, we shall argue that activities function as the principal contexts in autobiographical memory. In this type of representation, displayed in Fig. 2b, activities serve as the organizing contexts for experiences, and thus the experiences are indexed within the structure *Eating in Restaurants*. In order to retrieve one of these experiences when given a general action such as *Paying* as a cue, it would be necessary to first access one of the activities containing this action.

We believe that activities are the principal organizers not only of common experiences, but also of relatively unusual experiences. For example, hearing important news might occur during a day at one's job, meeting one's spouse might occur at a party, receiving an injury might occur during a neighborhood softball game, etc. However, some unique or highly novel events may not be processed using these everyday goals and knowledge structures; instead they may be represented in event structures of their own.

There are two lines of argument supporting activities as the organizers of personal experiences over the multiple indexing scheme displayed in Fig. 2b. The first is an encoding argument. Retrieval begins by selecting the memory structures likely to have encoded the target event. However, events are never experienced in terms as abstract as the descriptions encoded in general actions: Real-life events are always composed of actions *colored* by the activity being executed. One never experiences *Paying* in the abstract, but only in the context of activities like *Eating in Restaurants* and *Shopping in Department Stores*. Yet due to the essentially self-contained nature of activities, the *Eating in Restaurants* activity contains much of the knowledge necessary for functioning in that experience, without having to rely heavily on more specific knowledge struc-

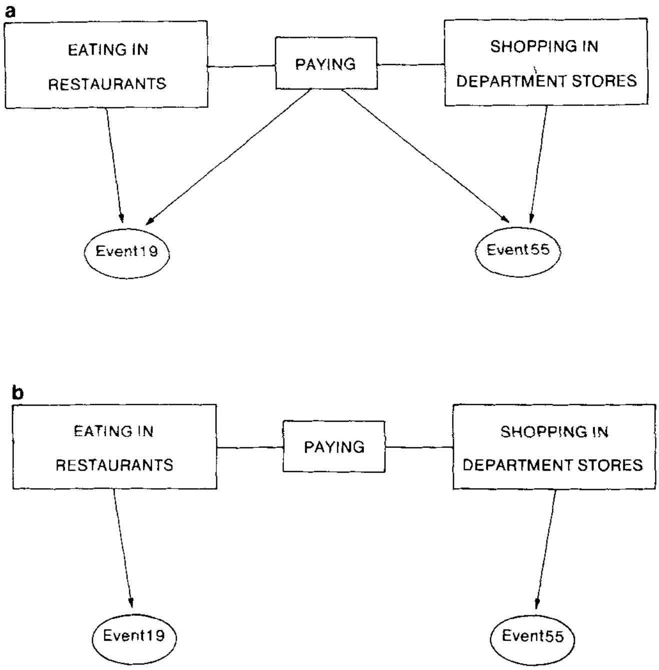


FIG. 2. Alternative models of the way individual experiences are connected to structures in memory. In Model a, experiences are indexed within both activities and general actions. In Model b, experiences are primarily indexed within activities, and retrieving an experience given an action as a cue requires first accessing an associated activity.

tures (e.g., *Eating in Italian Restaurants*). Thus, activities and the activity-specific versions of general actions represent the *level of abstraction* at which experiences are originally conceptualized. This suggests that encoding an experience involves constructing indices from activity structures to the experience. General actions will be effective retrieval cues only when they direct search to an appropriate activity.

A retrieval argument supports this encoding argument. Activities are better structures for directing the search for an experience, because information contained in activity structures is likely to be more useful for inferring features of an individual event during retrieval. Each activity contains context-specific knowledge of several types. This information includes the overarching goal for the events (the reason these particular general actions are being placed together in this sequence) and the actors and props in the event. For example, one expects salespeople, merchandise, a cash register, a counter, and shoppers in the *Shopping in Department Stores* activity. Much of this information is used to specify how the performance of each action in the activity is modified from the general action version. An activity is thus an inference-rich structure, so its access allows many features of an event to be predicted. In contrast, general actions contain only abstract generalizations about the action's performance and thus enable fewer predictions about event features. To see this more clearly, compare the utility of the *Restaurant* activity and the *Paying* general action in predicting features of a *Restaurant–Paying* experience. The general action provides the information that a monetary transaction occurs, but the probable appearances of the recipient of the money and the physical surroundings, the nature of the purchased items (food), the reasons for the event (hunger, entertainment, socializing), and many other features can only be predicted using knowledge specific to the *Restaurant* activity. Since retrieval of an event requires inferring features of that event to use as retrieval cues, this leads to the prediction that accessing an activity will be of greater utility in retrieval than accessing a general action.

We conducted two experiments to compare the functions of activity and general action structures in the retrieval of personal experiences. These experiments compared the utility of cues based on these structures in an autobiographical memory retrieval task. Demonstration of superiority for one of these cue types supports the use of that type of structure as the organizing contexts in autobiographical memory. We reasoned that if activities are more useful in retrieval than general actions, retrieval of a target event should be more efficient if processing begins with an activity cue rather than a general action cue. We tested this prediction in Experiment 1 by giving subjects an activity and general action pair, while varying the presentation order of the two cues. We further reasoned that if general actions are only effective cues when they lead to activities, augmenting an action with a relevant activity cue should create a better retrieval context than specification only of the action, while augmenting an activity with an action should not aid retrieval. Experiment 2 tested this prediction.

## EXPERIMENT 1: PRESENTATION ORDER

The first experiment tested the prediction that the memory of an experience would be easier to retrieve if subjects were given an activity as a retrieval cue before a general action. The design of our study is a modification of a methodology used by Freedman and Loftus (1971) for studying the organization of semantic memory. They asked subjects to name an item matching a noun and an attribute, e.g., a *vegetable* that is *green*. The presentation order of the two cues affected the time to produce a matching instance. Subjects were faster to produce an instance when the noun cue was presented first. Freedman and Loftus argued that the results demonstrate that noun concepts rather than adjectives correspond to the types of categories organizing information about objects. When the noun is presented first, the retrieval process can begin to access the proper category ("vegetable"), so the retrieval of an instance on presentation of the second cue is facilitated. If the attribute cue is presented first, because there is no category of "green things," category access must wait until the second cue is presented, so retrieval is slower. Applying this paradigm to autobiographical memory, if activities are the principal categories for individual experiences, presentation of an activity before a general action should lead to faster retrieval of an experience matching both cues. When the action is presented first, the information available for memory search is less useful until a contextualizing activity can be found to augment it, so retrieval should be slower for these cases. In order to test this hypothesis, we asked subjects to recall specific experiences fitting a presented activity and general action, varying which cue was presented first.

We included two types of general actions in order to examine the effects of the amount of constraint provided by the type of memory cue. "Regular actions" described actions that are normative components of an activity (e.g., *picked out what you wanted, paid at the cash register*), while "Failure actions" described the failure of some goal of the action (e.g., *didn't get what you asked for, couldn't find a seat*). There are arguments for both failure and regular actions being more effective cues. Schank (1981, 1982) argued that the aspects of events conflicting with expectations are the differentiating features used to index events in memory. Thus, describing a goal failure (which is typically a case of a failed expectation) might help retrieve an individual experience by specifying the way it is linked to the general knowledge structure for that type of event. Providing the differentiating features for an event may lead to easier retrieval than forcing the subject to generate such features. In fact, goal failure events in script-based stories are better remembered than typical actions (Bower et al., 1979). On the other hand, these failure actions greatly restrict the number of experiences within the activity context that could be used as a response, and this might slow retrieval: More processing would be necessary to predict the type of circumstances that would result in that particular type of goal failure, while normative actions would require less of this predictive processing, because virtually any circumstance in the activity would suffice.

In addition to retrieval times, we collected two types of ratings for the experiences recalled by subjects. First, we asked subjects to record the dates of occurrence of each event. Past experiments have shown that the number of experiences recalled by subjects decreased with the age of the experience, suggesting that older events are less accessible in memory (Crovitz & Schiffman, 1974; Rubin, 1982). We also asked subjects to rate the pleasantness or unpleasantness of each event at the time it occurred. Events associated with more intense affect are more likely to be recalled (Holmes, 1970; Menzies, 1935; Turner & Barlow, 1951; Waters & Leeper, 1936) and are recalled more quickly (Robinson, 1980). We collected these ratings to ensure that neither of these two factors would underlie any of the effects under investigation.

## Method

*Materials*. Twenty activity phrases were constructed. Each phrase described a common stereotypical activity that we thought undergraduates were likely to have experienced. These phrases were in the past tense and were from three to six words long.

Twenty general action phrases were constructed, so that each general action was a component of two activities. These phrases, also in the past tense, were from two to six words long. Each general action phrase was worded so as not to reveal a particular activity context. Half of the actions were regular actions that described a standard component of an activity. The other half were failure actions that described the failure to attain a goal of the action within the activity. Six failure actions involved an explicit negation (e.g., *couldn't find a seat*), and four failure actions did not involve a negation (e.g., *wanted to leave early*). Some of the general actions were necessarily less concrete descriptions than the activities (e.g., *decided where to go*), while others were as concrete as the activity phrases (e.g., *paid at the ticket booth*). Examples of two activities and two general actions are presented in Table 1; a complete list of all stimuli is presented in the Appendix.

The activities and general actions were constructed in quartets, so that two activities could each be paired with the same regular and failure action. Thus, four activity–action pairs were formed from each of the 10 quartets, by pairing each activity with a regular action and a failure action (see Table 1). This resulted in 20 activity + regular action pairs and 20 activity + failure action pairs. To avoid possible priming effects, a subject saw each activity and each action only once. For example, in the quartet from Table 1, if a subject saw *went out drinking* paired with *paid at the cash register*, he or she would also see the pair *had your hair cut—didn't get what you asked for*. The 40 activity and action pairs were therefore divided into two lists, and each list was divided in half, so that the activity phrase was presented first for half of the trials for each type of combination. The mean length of the activity and action phrases in each of the four conditions for each list was balanced to within 0.6 syllables. Subjects were assigned to one of four groups according to the order in which they were tested. Two groups of subjects saw each list, with each item occurring at one presentation order for one group, and at the other order for the other group. Thus, each subject received 10 combinations involving each type of action cue, five trials with activity first and five trials with action first. The order of these 20 trials was randomized anew for each subject. In addition to these stimuli, four more combinations were constructed to serve as practice trials using different activities and actions. Each subject received the same four practice trials.

*Procedure*. Subjects were instructed that they would receive descriptions of events on the screen of a computer terminal, and should recall a specific experience from their own past that matched the presented description, indicating whether they were successful by pressing a *Yes* or a *No* key. Each subject was run alone and was seated in front of a computer terminal connected to a PDP-11/40 computer which controlled the presentation of the stimuli. Each trial began with a fixation signal on the screen (the word *Ready*). When ready (with the right and left hands resting on the *Yes* and *No* keys, respectively), the subject pressed the *Yes* key, initiating the trial, whereupon the fixation signal was replaced by the first phrase of the trial. After a delay of 5 s, the second phrase was displayed one

TABLE 1
A Sample Quartet of Items from Experiment 1

| | | |
|---|---|---|
| 1a | Activity<br>+ Regular Action: | Went out drinking<br>Paid at the cash register |
| 1b | Activity<br>+ Failure Action: | Went out drinking<br>Didn't get what you asked for |
| 2a | Activity<br>+ Regular Action: | Had your hair cut<br>Paid at the cash register |
| 2b | Activity<br>+ Failure Action: | Had you hair cut<br>Didn't get what you asked for |

line below the first phrase. Both phrases remained on the screen until the subject responded by pressing the *Yes* or *No* key.

Subjects were instructed to recall an experience from their own past that matched the *combination* of the two phrases. Subjects were told that they were not just answering whether they had experienced the event described on the screen, but that they should be sure to have one *specific* experience in mind before responding *Yes*, although it was not necessary to recall all of the details of that experience before responding. If the subject could not recall a specific experience or had never experienced the event described he or she responded by pressing the *No* key. We emphasized that once initiating the trial, subjects should try to recall the experience as quickly as possible, and should respond *Yes* as soon as they were sure they had a specific experience in mind, or respond *No* as soon as they decided they could not recall an experience. Retrieval times were measured from the presentation of the second phrase until the keypress.

Upon a *Yes* or *No* response, the screen cleared, and a new fixation appeared. After each *Yes* response, subjects wrote a brief description (one or two sentences) of the experience on an answer sheet. The written responses were not timed, and subjects were told that there was no time pressure for this stage of the experiment. When the subject finished writing the response, a new trial was initiated by pressing the *Yes* key.

Subjects first received the four practice trials, after which any remaining questions or problems were discussed. They then received the 20 experimental trials. At the conclusion of the retrieval time portion, subjects were instructed to fill out a rating form. Subjects first recorded the approximate date of occurrence for each experience. If unable to recall the month and year, they were urged to record the season and year, or simply the year. In addition, the subject rated the "pleasantness" of each experience (when it occurred) on a $-3$ to $+3$ scale, where 0 indicated a neutral experience, a negative rating indicated an unpleasurable experience, and a positive rating indicated a pleasurable experience.

*Subjects.* Thirty-two Yale undergraduates participated in this experiment to fulfill a course requirement. The subjects ranged in age from 17 to 21, with a mean age of 18.6 years. Data from two potential subjects were discarded. One of these subjects reported difficulty in following the instructions. The other subject's retrieval times were over 10 times longer than the mean for all subjects, rendering this subject's compliance with the instructions suspect.

## Results

All keypress responses that did not match the subject's written responses (1.4% of the potential data) were excluded from all analyses. In eight of these nine cases, the subject hit the wrong key; in the ninth case the subject responded prematurely and thought of an experience after pressing *No*. The written descriptions of their retrieved experiences were intended to ensure that subjects complied with our instructions and recalled individual experiences. The descriptions did indicate compliance, so we do not discuss these responses further. Separate analyses of variance were performed on the means for each condition for each subject ($F_1$ statistic) and the means for each condition for each stimulus item ($F_2$ statistic). The results of these analyses were then combined using Clark's (1973) *min* $F'$ statistic.

*Retrieval Times and Proportion of Successful Retrievals*

Subjects were able to retrieve experiences in 76.3% of the trials, and responded *No* in 22.3% of the trials. Before analyzing the latencies for the successful retrievals, we Winsorized the data by replacing all retrieval times longer than the subject's mean for successful retrievals + 2.5 standard deviations with that criterion point (thus replacing 3.3% of the retrieval times). The missing data due to *No* responses and incorrect keypresses were problematic, because there were substantial differences between individual items, and different subjects were missing different items. Missing data were therefore replaced using estimates based on subject and item means for each missing datum. To minimize contributions of outliners, trimmed means (excluding the upper and lower 10% of retrieval times) were used. First, a trimmed mean was computed for each subject and for each condition. A trimmed grand mean was also computed. Each missing data point was estimated by the trimmed mean for the subject + the trimmed mean for the condition − the trimmed grand mean. The means were then recomputed including these estimates and the same data points reestimated using the new trimmed means. This procedure was iterated until the average difference between estimates was less than 1 ms. All subsequent analyses of *Yes* responses are based on the data set including these estimated times.

The mean retrieval times and proportion of successful retrievals for each condition are presented in Table 2. As predicted, subjects retrieved an experience more quickly when the activity cue was presented before the general action cue. Subjects were over 2 s faster to recall experiences matching an activity and an action when the activity was presented first (*min* $F'(1,45) = 12.12$, $p < .01$). This supports the prediction than the information contained in the activity is more crucial for the retrieval mechanisms. Subjects were also somewhat more successful in retrieving an experience when the activity was presented first ($F_1(1,31) = 3.60$, $.05 < p < .10$; $F_2(1,19) = 3.45$, $.05 < p < .10$). Therefore, the difference in retrieval times between the two presentation orders cannot be attributed

TABLE 2
Mean Retrieval Times (in Seconds) and Proportions (in Parentheses) for Successful Retrievals in Experiment 1

| Action type | Presentation order: Activity first | Presentation order: Action first | Mean |
|---|---|---|---|
| Activity + regular action | 4.164 | 6.384 | 5.274 |
| | (.88) | (.79) | (.83) |
| Activity + failure action | 5.610 | 7.853 | 6.732 |
| | (.71) | (.67) | (.69) |
| Mean | 4.887 | 7.119 | 6.003 |
| | (.79) | (.73) | (.76) |

to a difference in criteria for responding in the two conditions, or to some other form of speed–accuracy tradeoff. There were no systematic differences between the general actions containing more concrete words and those composed of more abstract words, suggesting that the difference between the activity and general action phrases is not merely due to the generality of their component words.

The second major result involved a retrieval time differences between cue pairs involving failure and regular actions. Subjects were slower to recall experiences matching failure actions than regular actions (*min* $F'(1,46) = 7.75$, $p < .01$). Subjects were also less successful in retrieving an experience for the failure action trials (*min* $F'(1,32) = 6.43$, $p < .01$). The effects of action type were not affected by the presentation order ($p > .20$ for the interaction of the two variables for both retrieval times and proportion *Yes* responses). Apparently, the less constrained regular action cues required less processing than search for an experience involving a particular type of goal failure. The effects of action type were not dependent on the presence of an explicit negation and thus were not due to linguistic differences between the regular and failure actions.

Finally, retrieval times for *Yes* responses were compared with the latencies to respond *No*. There were too few *No* responses to perform Winsorizing and missing data replacement, so only raw data were used for both response types. Retrieval of an experience was significantly faster than a failure to do so: 6.357 vs 13.186 (*min* $F'(1,36) = 5.59$, $p < .05$). This large difference suggests that many of the cases where subjects responded *No* were due to a failure to recall a specific instance even though the subject felt he or she had experienced that type of event, because responses in cases where the subjects know they have never experienced the event are likely to be fast responses (cf. Glucksberg &

McCloskey, 1981; Kolers & Palef, 1976; Norman, 1973). The distribution of retrieval times for *No* responses supported this interpretation by revealing two peaks, one at 3 s and the other at approximately 10 s. The mean latencies to respond *No* showed no significant effects of presentation order or action type (all $F$'s $< 1$), nor did the interaction of the two factors reach significance ($p > .10$).

*Age and Pleasantness of Experiences*

Artifactual explanations for the difference between regular and failure actions must be considered. Goal failures are less frequent events than normative actions in an activity, and thus failure actions may have elicited memories of experiences that occurred on average longer ago than those elicited by regular actions. Older memories are less accessible than more recent memories; subjects are less accurate in remembering the details of experiences as time since the event increases (Bahrick et al., 1975; Linton, 1975, 1978; Messe et al., 1981; Thompson, 1982; Whitten & Leonard, 1981), and older experiences generally take longer to retrieve (Reiser, 1983). Thus, perhaps the age of experiences elicited can account for the observed differences in action types. Furthermore, since failure action cues refer to the failure of a goal in the activity, it is reasonable to expect them to elicit more unpleasant memories than positive cues, which may have affected the difficulty of retrieving those experiences. We collected judgments on the pleasantness and date of each experience to examine whether the elapsed time or the type and intensity of affect associated with the event could account for the observed retrieval time effects.

The subjects' estimates of the dates of occurrence were used to compute the age (in months) of each recalled experience. Previous studies have indicated that these subjective estimates are accurate and reliable enough for the present analyses. Robinson (1976) found that subjects' dating of remembered events was quite reliable (the correlation between dating at the time of initial recall and after a 1-week delay was .94), and Rubin (1982) found that 74% of the subjects' dates given for remembered experiences were accurate to within a month (assessed by comparing the estimated dates to the recordings of the events in the subjects' diaries). The age of the experiences recalled by subjects in this experiment ranged from 0 to 189 months, with a mean age of 11.82 months. However, there was a strong skew toward recall of more recent events, as found in previous studies (e.g., Crovitz & Schiffman, 1974; Reiser, 1983; Rubin, 1982). The modal event age was in fact 0 months (19% of responses), and the number of experiences recalled was lower for each successive month of elapsed time. More than three-quarters of the experiences had occurred within the year prior to the test date.

The mean age of the recalled experiences was computed in each condition for each subject and for each activity. The means for each condition are presented in Table 3. Failure actions indeed elicited somewhat older experiences than regular actions, although this difference failed to reach significance ($F_1(1,31) = 2.23$, $p > .10$; $F_2(1,17) = 3.65$, $.05 < p < .10$). The presentation order of the activity and action cues had no significant effect on the age of the experience recalled ($p > .20$). There was some tendency for older experiences to be recalled more slowly, but this difference was only reliable in the subjects analysis (5.496 s mean retrieval time for experiences below median age vs 7.144 s for experiences above the median: $F_1(1,31) = 8.93$, $p < .01$; $F_2(1,19) < 1$). To ensure that differences in the age of the recalled experiences did not cause the differences in retrieval time described earlier, we performed analyses of covariance. Using the age of experiences as a covariate, the effects of action type and presentation order each remain highly significant (*min* $F'(1,42) = 11.22$, $p < .01$, for presentation order; *min* $F'(1,47) = 10.65$, $p < .01$, for action type).

The rated pleasantness of the recalled experiences for each condition is also displayed in Table 3. Not surprisingly, failure actions elicited more unpleasant experiences than regular actions (*min* $F'(1,36) = 36.49$, $p < .01$). The presentation order of the cues did not affect the pleasantness of the recalled experiences ($p > .20$), nor was the difference between failure and regular actions affected by presentation order ($p > .20$). When the pleasantness of experience is used as a covariate, the effect of action type is somewhat reduced (*min* $F'(1.46) = 3.41$, $.05 < p < .10$), but the effect of presentation order remains highly significant (*min* $F'(1,43) = 11.76$, $p < .01$). Moreover, there was no difference in retrieval times for pleasant and unpleasant experiences. Finally, the intensity of each recalled experience was assessed by taking the absolute value for each pleasantness rating. There were no significant effects of presentation order or action type on the intensity of experiences. Experiences of

TABLE 3
Mean Age (in months) and Rated Pleasantness of the Recalled Experiences in Experiment 1

| Action type | Presentation order | Age | Pleasantness |
|---|---|---|---|
| Activity + regular action | Activity first | 10.98 | .97 |
| | Action first | 8.98 | .84 |
| | Mean | 9.98 | .91 |
| Activity + failure action | Activity first | 14.77 | −1.22 |
| | Action first | 12.56 | −1.21 |
| | Mean | 13.67 | −1.21 |

greater emotional intensity were recalled somewhat more quickly than less intense ones as reported by Robinson (1980), but this difference did not reach significance (5.093 s mean retrieval time for experiences above median intensity vs 6.894 s for experiences below the median: $F_1(1,28) = 3.39$, $.05 < p < .10$; $F_2(1,16) < 1$).

## Discussion

Retrieval of an experience was easier when the activity involved in the experience was presented before the general action. Subjects were both faster and somewhat more likely to successfully retrieve an experience matching the cues. Differences in the age or pleasantness of the recalled experiences were unable to provide alternative explanations for this presentation order result. The superiority of activity cues enables us to contrast the role of activity and general action knowledge structures in organization and retrieval.

### *Function of Activity Structures*

Earlier we argued that activities constitute the principal organizing and retrieval contexts in autobiographical memory. The superiority of the activity-first condition supports this claim. First, activities represent the level of description at which experiences are likely to have been processed. When the activity cue is presented first, an activity knowledge structure can be assessed, and the search process can begin to access and examine the associated experiences, even before the action cue is presented. If the general action cue is presented first, then a candidate activity must be generated to be used as a context. This major inference requires extra processing, leading to slower retrievals in the action-first condition.

Second, the information available in activity memory structures is more effective in the next stage of retrieval, finding indices by predicting features of the target event. When the activity is presented before the action, retrieval mechanisms can begin to generate features of potential target events. These predicted features can be used to specify indices to discriminate among the types of experiences associated with the context. One type of prediction occurs when retrieving the basic activity provides features that can be used to specify discriminations leading to more specific categories of events. For example, considering the types of goals that might occur in the *Eating in Restaurants* activity provides features that discriminate several more specific versions of that activity (e.g., *Celebrations at Restaurants, Business Lunches*). Each of these contexts contains more specific predictions about the features of events indexed within that context. In this way, the information in the activity memory structure can be used to refine the search context into a more precise specification that is "closer" to an individual experience (Reiser, 1983; Reiser et al., in press).

Another way that information in the activity can be used to direct processing concerns instances of the activity (i.e., particular museums or movies) or people involved. For example, the appearance of a particular restaurant or the type of object sought in a shopping trip may discriminate an experience from others in that context. Moreover, considering a particular feature may enable recall of an experience involving an interesting unexpected occurrence involving that feature. For example, retrieving the feature "restaurants have waiters" may enable the access of a particular waiter who behaved in some way different from the standard expectations about waiters, and this discrimination may then be an index to an individual experience (or a small set of experiences) involving that waiter. In general, cues based on activity information are likely to be more effective than those based on the kind of information found in general actions—e.g., the ways in which one might make arrangements for the purchase of an item or the manner in which one can purchase an item. Such information is too abstract to enable very precise predictions about the target event and must be concretized using an activity in order to be effective. Thus, general action cues are "memory cues" in that they enable memory search that can lead to the target information. However, it is not the action structure itself that is being used by the search mechanisms; retrieval initiated from a general action can be effective if the original query can be reformulated into one involving an activity that can then be used to guide further search. For example, retrieval using the *Paying* action might consider the types of items that can be bought (e.g., food, clothing, shelter) and thus access the activities *Grocery Shopping, Eating in Restaurants*, or *Looking for Apartments*. Of course, these inference mechanisms entail extra processing when retrieval begins with a general action.

In summary, processing gets a "head start" when the activity is presented before the general action. Activities typically provide the contexts in which the events were originally encoded, and thus accessing the activity will be necessary to find a path in memory to the experience. Furthermore, activities contain features that can be useful for selecting among the indices associated with the context to find a path to an experience. Thus, extra processing is required when the general action is presented first, and retrieval is both slower and somewhat less successful in finding a particular experience.

We should note that these data are more strongly supportive of the second point in our explanation than the first. It is naturally more of an inference from retrieval data to underlying representations than to the retrieval mechanisms themselves. For example, one might propose as an alternative explanation that experiences are connected to both activities and actions (Fig. 2a), but that the links to activities are stronger or in some way more accessible. Thus, retrieval is facilitated if search can proceed from activities rather than actions. In fact, however, this position is not all that different from what we have been espousing. One explanation for this increased strength is that the activity structures were more heavily used in the original encoding of the experience, which is consistent with our arguments of the greater utility of activities in planning and comprehension. Thus, even though experiences may be linked to both structures, they are not playing the same role—activities are functionally the organizing contexts because it is the connections to activities that appear to matter. Furthermore, no matter whether experiences are connected only to activities or to both activities and general actions, we have argued that the search is not purely automatic but requires strategic direction. The data support the view that activities contain information more useful for these retrieval mechanisms and thus serve as the principal retrieval contexts. Finally, it is important to note that the encoding and retrieval explanations of the functions of activities are essentially two aspects of the same functionality. The predictiveness and inference richness of activities that makes them useful in retrieval also makes them useful in comprehension and planning. For this reason, activities are the structures directing most of the cognition in the original experience and are therefore likely to be the principal contexts to which experiences become associated.

*Regular vs Failure Actions*

Our second major finding concerned the difference between regular actions and failure actions. Subjects were less successful in retrieving experiences in response to activity and failure action combinations than to activity and regular action combinations. Furthermore, recall was substantially slower for failure action cues. Although failure actions elicited somewhat older experiences and experiences associated with more negative emotional ratings, neither of these factors accounted for the full retrieval time difference between regular and failure actions. This finding is consistent with another experiment in which we compared low- and high-frequency actions that differed only in how frequently they occurred in performances of an activity but did not differ in the success or failure of a goal (Reiser & Black, 1983). Experiences involving low-frequency actions took longer to retrieve than high-frequency ones, suggesting that the difficulty of failure actions in the present experiment arises from their low frequency rather than from some factor particular to the failure nature of the action.

Why should these infrequent occurrences be more difficult to retrieve?

Since activities provide the principal contexts for memory retrieval, the action descriptions determine the type of search necessary within that context. The actions themselves do not specify indices directly leading to experiences but provide constraint on features of the target experience. Regular and failure actions provide different amounts of constraint on the choice of the experiences associated with the activity, and thus differ in the difficulty of finding a path within the context leading to an experience possessing the target features. When a regular action cue is given, virtually any retrieval path within the activity context leads to an appropriate experience. Since the regular actions describe typical events within the activity, experiences retrieved by any combination of indices is very likely to contain that action. However, failure actions specify experiences that are more unusual, requiring a greater use of the causal knowledge contained in the activity to predict the types of circumstances that would result in the specified goal failure. Hence, more inference is required to select among the paths associated with the activity. Furthermore, with the regular actions the subject is relatively free to use any of the indices within the context, while for the failure actions only some subset of these indices will specify an experience containing the targeted type of goal failure. Thus, the subject is free to use the most salient or highly associated experiences in response to the regular actions, but he or she may have to search among the less accessible experiences to find appropriate responses for the failure actions.

The results for failure actions demonstrate that adding constraint to the search cue does not always increase its effectiveness in eliciting matching experiences. Even if goal failures describe useful discriminating features for an event, there appears to be a trade off between providing these discriminating features and forcing the subject to search for a very specific type of experience. Subjects may do better if given just enough context to restrict search to a reasonable category and then be allowed to select their own preferred failures or other features to use as retrieval cues. In fact, these optimum circumstances seem to hold for the regular action cues presented in conjunction with activity concepts.

*An Alternative Model: Probability of Match*

In this section, we consider an alternative explanation of why retrieval is faster when an activity is presented first that does not entail postulating differences in retrieval utility between activities and actions. Suppose that experiences are equally accessible in memory using activities and general actions. When the action is presented first, even though an experience is easily retrieved, it may not match the activity that is then presented after the delay. On the other hand, when the activity is presented first and a memory is retrieved, the experience is much more likely to contain the action. For example, when given the action *waited for your turn*, the subject might think of an experience at a post office, only to find that the activity then presented is *went to a bank*. In the other condition, when *went to a bank* is presented first, any experience retrieved would be very likely to contain the action *waited for your turn*. In this view, the action-first trials would be slower on average because sometimes the retrieved experience must be discarded and the memory search resumed.

If this "probability of match" model is correct, then we do not need to posit a greater ability to predict experience features from activities than action cues; instead the result can be explained purely in terms of the probability that the experience retrieved given the first cue will match the second cue. However, this probability of match model is less credible when one considers the failure action conditions. This model rests on a comparison of likelihoods, arguing that the retrieved memory associated with the activity is quite likely to fit the action cue, while a memory associated with the action is much less likely to match the particular activity cue presented. This is certainly true for the regular actions. Almost every restaurant experience has a paying action, but paying is experienced in contexts other than restaurants. Consider how this explanation would be applied to the failure action items, however. It would have to be the case that an episode retrieved in response to the activity cue would be very likely to fit the failure action description. However, these failure actions are more unusual than the regular actions, and experiences matching these actions are more difficult to find in memory. It seems unlikely that the memory retrieved for the given activity would contain the particular type of goal failure specified in the failure cue. Yet the advantage of presenting the activity first is equally large for the failure actions. The probability of match model is unable to account for this result.

Comments from subjects did indicate that they sometimes retrieved an experience during the delay and then found that it did not match the second cue. Should there still be an advantage in presenting the activity first for cases where a memory is rendered unusable when the second cue is presented? The answer lies again in the utility of the information encoded in activities. Once the subject has retrieved an experience involving a particular activity, it should be easier to retrieve another experience with the same activity containing the specified type of action than to begin searching with a different activity, because all the context-specific information utilized in the retrieval of the first experience may be used in the search for the next experience. It would thus be easier for memory search to "stay within" the same activity than to access a different activity. Support for this hypothesis was provided by Reiser (1983). A priming experiment found faster retrieval times and more repetition of experience features when a trial repeated an activity cue from a preceding trial than when a general action cue was repeated from a preceding trial.

In summary, we have argued that although there may be cases where it is necessary to reinstate the memory search, a greater probability that a retrieved experience will match the second cue for the activity-first condition can not completely explain the difference between the two presentation orders, so the action-first condition is slower for reasons other than retrieving an unusable experience. The next experiment was designed to provide further support for the claim that activities are a more crucial component of the encoding and retrieval of autobiographical events than are general actions.

## EXPERIMENT 2: SINGLE VS COMBINED CUES

The results of Experiment 1 support the claim that accessing an activity structure is an important part of retrieving an individual experience. We test further predictions in this next experiment. If accessing an activity concept is a crucial step in retrieving an experience from memory, then a general action should become a better cue when it is pared with an activity, because this will save the processing required to generate an activity to aid search. However, the efficacy of an activity cue will not be improved by supplementing it with an action cue, since it is the activity that provides the central component of the search context. In fact, the addition of action may add constraints on the search and increase the time necessary to retrieve an experience. Moreover, an action presented by itself should be an inferior cue to an activity presented alone.

The probability of match model makes a different set of predictions. If the presentation order results of Experiment 1 were simply due to cases in which an experience was retrieved that turned out not to match the second cue, we should be able to find evidence that activities and actions are equally good retrieval cues. The simplest test of this prediction is a comparison of activities and actions when presented as single cues. If experiences are as accessible from general actions as they are from activities, there should be little difference between retrieval difficulty for these two types of cues. Furthermore, any difference between activity and action combination cues and those cues presented singly should be the same for actions and activities. For example, one might argue that two cues would be better than one cue (since the search might be able to converge on a target item faster with two sources than with only one), in which case any advantage in augmenting an action with an activity should also be found when an activity is augmented with an action. Or, if one argues that two cues constrain the search more than one cue and therefore should slow retrieval time, then retrieval time for single activities and single actions should both be faster than for an activity–action combination.

We tested the different predictions of these two models in a second experiment by comparing retrieval times for three types of cues: (1) action-alone, (2) activity-alone, and (3) activity + action combination. To summarize the predictions, if activities have greater utility than actions in retrieval, then (a) action cues should lead to slower retrieval than activity cues and (b) action cues should become better retrieval cues when paired with an activity, while the activity cues should not improve (and may be hurt) by pairing them with an action. Alternatively, if experiences are equally accessible from activity and action concepts, then (a) action and activity cues should evoke similar retrieval times and (b) any advantage or disadvantage in adding an activity to an action cue should be found for adding an action cue to an activity. Although comparison (a) involves different stimuli (activities and actions), comparison (b) constitutes a somewhat more controlled comparison, because it can be tested by comparing the same action phrase when it is presented alone to the case where it is augmented by an activity phrase.

## Method

*Materials.* The 20 activities, 10 failure actions and 10 regular actions from Experiment 1 were used to generate materials for this experiment. The same 40 activity and action pairs were included in this experiment. In addition, each activity and each action were presented as single cues, yielding three major types of trials: activity alone, action alone, and activity + action. The action-alone and activity + action trials divide into two groups each, those trials involving regular actions and those involving failure actions. The result is a total of 80 different items distributed over five conditions as follows: 20 activities, 10 regular actions, 10 failure actions, 20 activity + regular action combinations, and 20 activity + failure action combinations.

As in Experiment 1, each subject saw each activity and action exactly once. Recall that the stimuli from Experiment 1 were constructed by pairing two activities with a failure action and a regular action to create four combinations. In the present experiment, a subject saw only one of these four combinations, supplemented by single-cue presentations of the activity and action that were *not* used in the combination. For example, consider the trials formed from the activities *went out drinking* and *had your hair cut,* and the actions *didn't get what you asked for* and *paid at the cash register.* If a given subject saw the combination item *went out drinking–didn't get what you asked for,* then he or she would see the items *had your hair cut* and *paid at the cash register* each presented in isolation. Four lists were constructed in this fashion, so that each activity and action combination appeared on one of the four lists, and the remaining activity and action appeared alone for that particular list. In this way, each list contained all 40 cues, 20 of these cues presented as single trials and 20 combined to form 10 activity + action pairs. Thus, each list contained 10 activity-alone trials, 10 activity-alone trials, and 10 activity + action trials. Half the actions of the action-alone and activity + action trials in each list were failure actions, and half were regular actions.

In order to minimize the possibility of the activity of one trial facilitating retrieval in an action-alone trial that followed, the 10 trials for each trial type were blocked. A Latin square was used to construct three versions of each list, so that each trial type occurred at each of the three serial positions. An equal number of subjects were assigned each of these 12 lists, and a different random order of the trials within each block was used for each subject. Finally, 6 practice trials (used for all subjects) were constructed from the activities and actions of the practice trials of Experiment 1; these consisted of 2 action-alone trials, 2 activity-alone trials, and 2 activity + action trials.

*Procedure.* Since the activity + action trials were necessarily composed of more words than the single-cue trials (and would therefore require more time simply to read and understand the cue), some method of partitioning the total processing time into comprehension and memory search components was necessary. Therefore, we modified the procedure to include collection of separate reading and retrieval times for each trial. Trials were initiated by pressing the *Yes* key, whereupon the *Ready* signal was replaced by the cue phrase(s). Single phrases were displayed on the line immediately beneath the location of the fixation signal. In the two-phrase activity + action trials, the activity was displayed on the line beneath the fixation signal, and the action was displayed simultaneously on the line beneath the activity. Subjects were instructed to press the *Yes* key *as soon as* they had read the last word of the cue, to indicate that they had read and understood it and were now ready to begin thinking of an experience. Immediately upon this keypress, an asterisk (*) was displayed near the bottom of the screen to signal the subject to start searching for a personal experience. The recall portion of the instructions was then the same as in the previous experiment: Subjects were to recall as quickly as possible an individual experience that matched the event description on the computer screen. It was pointed out that for some trials, this description would be a single phrase, while for other trials, the description would consist of two phrases. Subjects were told to be sure that their recalled experience matched the *combination* of the phrases for the two-phrase descriptions. When the subject responded *Yes* or *No*, the screen cleared, and a new fixation signal appeared. Subjects wrote a description of the recalled experience on an answer sheet, and initiated the next trial by pressing the *Yes* key.

Reading times and retrieval times were collected for each trial. Reading times were measured from the onset of the stimulus until the first keypress, and retrieval times were measured from this reading time keypress until the subject's *Yes* or *No* memory response.

Subjects first received the 6 practice trials, after which any questions or problems with the procedure were discussed. They then received the 30 experimental trials. At the conclusion of these trials, dates of occurrence were collected for the experiences as in Experiment 1.

*Subjects.* Thirty-six students and New Haven residents who had not been in Experiment 1 participated in this experiment to fulfill a course requirement or were paid $4. (The paid subjects were recruited from an advertisement in the campus newspaper). The subjects ranged in age from 16 to 40, with a mean age of 21.0 years.

Data from eight potential subjects were discarded. Adding separate reading and memory keypresses to the procedure made the instructions more difficult to follow. Four subjects had difficulty in following the instructions properly and were not included in the analysis. (One subject failed to write descriptions of the experiences, while other subjects wrote their descriptions before pressing the button.) Four other subjects were discarded for consistently excessive retrieval times. These subjects' mean retrieval times were over four times longer than the mean for all other subjects, rendering these subjects' compliance with the instructions suspect. It is possible that these subjects also wrote their experiences before pressing the key, or that they were generally slower in responding due to a different criterion for deciding when they had sufficiently recalled an experience.

## Results

### *Reading Times*

The mean reading time was computed for each stimulus item. The number of syllables for each stimulus item was highly correlated with the reading time for that item ($r = .84$). The estimate of reading time from this correlation was 144 ms per syllable, which is similar to standard estimates from text comprehension research (e.g., Gibson & Levin, 1975). In order to ensure that these reading times did not reflect any additional processing that should have been included in the retrieval times, a residual reading time was computed for each item using number of syllables as the predictor variable. An analysis of variance was performed on the residual reading time for the 80 items nested within the five conditions. No differences in residual reading time were found among the conditions ($F(4,75) = 1.23$, $p > .20$), indicating that the stimuli were read at the same rate in each condition, and therefore that the collection of reading times was successful in partitioning that portion of the processing necessary to comprehend the stimulus items. Furthermore, the sum of reading times and retrieval times yields comparable results to those found in Experiment 1. Thus our separation of reading and retrieval times in this experiment did not seem to distort the retrieval processes. The mean reading times for each condition are presented in Table 4.

### *Retrieval Times and Proportion of Successful Retrievals*

As in Experiment 1, subjects' written responses that did not match their keypress responses (2.9% of the potential data) were not included in the analyses. Again, the written descriptions indicated the subjects had recalled individual experiences. Subjects recalled an experience in 82.6% of the trials, and answered *No* on 14.5% of the trials. The data for *Yes*

TABLE 4
Mean Reading and Retrieval Times (in Seconds), Proportion Recalled, and Age of Experiences (in Months) in Experiment 2

| Stimulus type | Reading time[a] | Retrieval time | Proportion *Yes* | Age |
|---|---|---|---|---|
| Activity | 1.226 | 2.100 | .91 | 14.03 |
| Regular Action | 1.415 | 5.139 | .87 | 7.86 |
| Failure Action | 1.536 | 5.306 | .87 | 17.21 |
| Activity + Regular Action | 2.190 | 3.185 | .78 | 11.06 |
| Activity + Failure Action | 2.281 | 3.974 | .62 | 14.57 |

[a] Mean reading times are computed for all responses; mean retrieval times and ages are computed for successful retrievals only.

responses were Winsorized and missing data were replaced as in Experiment 1.

Mean retrieval times for each condition are presented in Table 4. Separate analyses of variance were performed using the subject means (5 conditions × 36 subjects) and the means for each item within each condition. Retrieval times for the five stimulus types were significantly different (*min* $F'(4,207) = 7.34$, $p < .01$). Two orthogonal planned comparisons were used to test for specific predictions. Predictions (a) and (b) described earlier were tested in a planned comparison that contrasted the retrieval times for each of the three trial types. Specifically, to test the prediction that retrieval times for the trial types would be ordered activity-alone < activity + action < action-alone, the following weights were used for the five conditions: (−2) activity, (0) activity + regular action, (0) activity + failure action, (+1) regular action, and (+1) failure action. As predicted, retrieval times for general actions were slower when the actions were presented alone than when the actions were paired with activities, and the activity-alone condition was the fastest of the three trial types. This contrast was highly significant (*min* $F'(1.65) = 17.39$, $p < .01$). A second comparison tested for a difference between the failure and regular versions of the actions, using the following weights for the five conditions: (0) activity, (−1) activity + regular action, (+1) activity + failure action, (−1) regular action, and (+1) failure action. As in Experiment 1, trials involving failure actions were slower than those involving regular actions. However, this contrast was significant only in the analysis by subjects ($F_1(1,35) = 4.28$, $p < .05$; $F_2(1,75) = 2.09$, $p > .10$). The residual between conditions variations was not reliable ($F_1(2,70) = 2.28$, $p > .10$; $F_2(2,75) = 2.43$, $.05 < p < .10$).

The proportion of successful retrievals for each condition is also displayed in Table 4. The five conditions differed significantly in the proportion of *Yes* responses (*min* $F'(4,138) = 4.79$, $p < .01$). Activities and actions alone were equally effective in eliciting experiences, and therefore the comparisons between the retrieval times for these conditions cannot be attributed to criterion differences. Unfortunately, subjects were less successful in retrieving experiences for the activity + action trials. Thus, it is possible that some of the reduction in retrieval times for these conditions relative to the action-alone conditions may be attributed to an earlier termination of search.

Finally, retrieval times for *Yes* responses were compared to latencies to respond *No*, as in Experiment 1. Retrieval of an experience was again faster than the latency to respond *No*, 3.862 vs 7.049 s (*min* $F'(1,83) = 12.73$, $p < .01$). The mean latencies to respond *No* were 5.480 s activity-alone, 9.299 s regular action, 13.950 s failure action, 6.319 s activity + regular action, and 5.140 s activity + failure action. The pattern in the

*No* latencies for each trial type was similar to that for the successful retrievals and was significant by the same contrast (*min* $F'(1,52) = 5.03$, $p < .05$). There was no effect of action type on the *No* latencies ($p > .20$). The interaction between condition and the response type was significant in the subjects analysis and marginally so in the items analysis ($F_1(4,108) = 3.66$, $p < .01$; $F_2(4,65) = 2.40$, $.05 < p < .10$). This interaction appears to be due primarily to the differences in patterns between trials involving failure and regular actions.

*Age of Experiences*

The age in number of elapsed months since the occurrence of each experience was computed as in Experiment 1. The age of the experiences ranged from 0 to 369 months, with a mean age of 12.95 months. As in Experiment 1, the model event age was 0 months (34% of responses), and the number of experiences recalled was lower for each successive month of elapsed time. Approximately 82% of the experiences recalled had occurred within the year prior to the test date.

The mean age for each condition is presented in Table 4. The three trial types did not differ in the age of the experiences recalled (both $F$'s $< 1$). Trials involving failure actions elicited somewhat older experiences than trials involving regular actions, but this was significant only in the analysis by subjects ($F_1(1,35) = 4.48$, $p < .05$; $F_2(1,75) = 2.67$, $p > .10$). When the age of the experiences is used as a covariate, the difference in retrieval times between the three trial types remains highly significant (*min* $F'(1,66) = 18.80$, $p < .01$). The comparison of retrieval times for failure and regular versions is only marginally significant in the subjects analysis ($F_1(1,34) = 3.66$, $.05 < p < .10$) and is not significant in the items analysis ($F_2(1,74) = 1.41$, $p > .20$). Thus, the trend for slower retrieval times for the failure trials may be due primarily to the retrieval of older experiences, but the difference between the three trial types cannot be attributed to any differences in the age of the recalled experiences. Finally, as in Experiment 1, there was some tendency for the more recent experiences to be recalled more quickly, but the small numbers of observations in each condition for each subject prevented an analysis of the reliability of these trends in the data.

## Discussion

This experiment provides strong confirmation for the superiority of activities over actions as retrieval cues. If the presentation order effect of Experiment 1 were due simply to predicting the wrong activity in the action-first condition, actions and activities should be equally good retrieval cues when presented alone. As predicted, however, subjects were able to recall experiences much faster (in fact, 3 s faster) when presented with an activity than when given an action. Furthermore, when an action cue was paired with an activity, the time necessary to retrieve an experience was substantially reduced. No such facilitation occurred when an activity was augmented with an action; instead, adding the action slowed retrieval. Therefore, the advantage of the combination items over the action-alone cues cannot be explained simply by arguing that more information always yields a better retrieval cue. More information only aids retrieval if the right type of information is added. The facilitation in retrieval when an activity is added to the action indicates that the activity provides important information for the retrieval process. Search from the general action must access an activity to find an experience. Furthermore, the access of an activity from a general action requires a substantial amount of processing; if it did not, the subjects themselves could simply augment an action cue with an appropriate activity and the activity-alone and action-alone conditions would differ only slightly.

When an activity was augmented with a general action, retrieval time was increased. This increase was greater if the general action was a failure action rather than a regular action. The addition of the general action provides more constraint on the search for an experience, but this constraint may necessitate more inferencing to direct the search to appropriate types of experiences. Consider the item *took a ride on a train–paid at the ticket booth*. Although the regular action *paid at the ticket booth* is a relatively typical action in that activity, it is not necessarily performed in every train ride. One may have bought the ticket in advance or on the train itself. Therefore, extra inferencing may be required to direct the search to train experiences that are likely to include this action. For example, one might consider the types of circumstances that would result in the performance of that action and exclude from examination experiences where the train ride was bought in advance through a travel agent or cases where one arrived at the station just before the train was about to depart (and therefore bought the ticket on the train). As we argued earlier, even more of this type of inferencing is necessary for failure actions, because they occur in fewer types of situations. Thus, this additional elaboration required when an activity cue is augmented with an action results in slower retrievals.

Furthermore, more extensive checking of the retrieved experiences may be necessary for the activity + action trials. The subject must be sure to retrieve an experience involving the given action, and therefore must check the experience to be sure the part described by the action is present for that particular memory. For example, when given *went to a restaurant–decided where to go*, the subject must first retrieve a restaurant experience and then examine it to ensure that the memory contains the action of deciding on a particular restaurant. This check is not necessary for the activity-alone trials, where the subject can respond as soon as any restaurant experience has been retrieved. Examining the experience to ensure it contains the target action requires extra processing time, which slows retrieval.

An interestingly analogous pattern of results was presented by Cantor et al. (1982). They asked subjects to imagine a particular type of person (e.g., "comic joker"), a particular type of situation (e.g., "party"), or a person in a situation (e.g., "comic joker at a party"). In their study, subjects were faster to imagine the person in the situation than the person alone, and fastest to imagine the situation. The addition of the situation cue to the person cue appears to provide contextualizing information that facilitated the access of the person information. The addition of the person cue to the situation cue did not produce a facilitation, but instead appears to have required the access of extra information (beyond what might normally be retrieved for the situation) and therefore slowed the access time. This pattern of results suggests that the situation concepts, like the activity cues in the present study, provide a retrieval context that facilitates the retrieval of other types of information. In fact, the situations used by Cantor et al. for the most part consist of settings for the type of activities used in our experiments.

In summary, the results of Experiment 2 support the assertion that activity memory structures are the contexts used to encode experiences and contain more useful information than general actions for finding indices leading to individual experiences.

## GENERAL DISCUSSION

We began with the claim that experiences are accessed using generalizations about events found in knowledge structures. Considering the utility of information contained in activities and general action structures enabled us to generate several empirical predictions concerning the effectiveness of memory cues based on these structures. Our results indicate that, in fact, individual experiences are not equally accessible from all types of structures, supporting our assertion that classes of structures may be distinguished by the type of information they contain and the role this information plays in organizing memories and enabling their retrieval.

### *An Optimal Level of Constraint*

The primary conclusion of these studies concerns the types of memory structures used to store and organize autobiographical experiences in memory. The different types of cues used in these experiments vary in terms of the amount of *constraint* they place on the memory search. More constrained cues place more specific requirements on the nature of the target experience and thus reduce the size of the set of relevant experiences in memory satisfying that cue. An activity constrains search through the store of experiences more than a general action, because an action can occur in a number of different activities. An activity presented as a single cue is somewhat less constraining than an activity–action combination, since the combination specifies a particular segment of the event sequence that the target experience must contain. In addition, failure actions are more constraining than regular actions (alone or in combination with an activity), since failure actions specify a particular nonstandard type of occurrence involving the action, rather than the typical form of the action.

Our results indicate that constraint is not monotonically related to retrieval difficulty. Instead, activities appear to provide an optimal type of constraint for the retrieval specification in autobiographical memory retrieval. General actions are clearly not constrained enough for efficient search, since they become better cues when they are combined with an activity. Adding additional specifications to an activity appears to provide unneeded constraint on the search. Subjects are slower to recall an experience satisfying an activity–action cue than one that satisfies only the activity cue, and the addition of a failure action to an activity slows the search more than the addition of a regular action.

What does this optimal level of constraint reveal about the organization of autobiographical memory? Note that if one *particular* experience is targeted for retrieval, it is likely that the more information specified in the retrieval cue, the easier the search will be. In contrast, when asked to retrieve *any* experience matching an event description, an optimal level of constraint for the cue arises from the type of structures in memory from which search can proceed most efficiently to an individual experience. These structures are the principal organizing contexts in autobiographical memory. If too abstract a cue is given, then further cues must be inferred to direct search to a more specific context. If information is provided in the cue that is more specific than necessary, then an overly careful examination of the paths within that context may be required to find an item matching the cue. Activity cues provide this optimal level of specificity, suggesting that activities are the principal structures in memory used to access these types of experiences. The slower retrieval times for cues more constrained than simple activities demonstrates that these differences are not due simply to providing a more precise specification of an experience. The easiest way to get an experience from memory is to specify the activity, but then allow search within the activity to utilize whichever indices are most accessible.

The idea of an optimal level of specificity has been explored for object concepts by Rosch and her colleagues (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976; Rosch, 1978). Rosch has noted that there is a tradeoff between the generality of concepts and their utility in processing information. More specific concepts are more informative (more attributes can be inferred about exemplars of the concept), but more general concepts are advantageous because they produce fewer categories and distinctions to which one must attend. This gain in informativeness is not constant across all levels of the hierarchy. A *basic level* concept (e.g., *chair*) is at the optimal point in the tradeoff between generality and informativeness. Basic level concepts are defined as the most general level at which more specific versions of the concept produce only a slight increase in information. For example, the concept *chair* is much more informative than the concept *furniture*, in that there are only a few features shared by all types of furniture, while there are many perceptual features and behaviors that can be predicted about objects that are chairs. In contrast, the concept *kitchen chair* is only slightly more informative than *chair*. The utility of basic level categories in processing has been demonstrated in a variety of processing tasks—e.g., categorization of pictures (Murphy & Smith, 1982; Rosch et al., 1976).

Abbott et al. (in press) suggested that there is a useful or basic level of abstraction for event knowledge structures as there is for object categories. The importance of this level is that expectations in planning and comprehension should be neither too general nor too specific. Our results suggest that activities are basic-level concepts in event memory, providing the principal source of predictions in comprehension and retrieval contexts for autobiographical memory search. Less constrained cues (general actions) access concepts that are too general and provide information too abstract to guide memory search until they are augmented by information from more specific contexts. On the other hand, adding more information to an activity produces concepts that are too specific. The extra information aids only slightly in specifying experiences and does so at a cost to its generality in applying to a maximal number of instances. A view of activities as basic-level concepts suggests that an experience is conceptualized as an instance of an activity and indexed in memory with respect to that conceptualization.

This account of activities is consistent with recent research on story understanding that concludes that activity-type episodes are the main cognitive units in memory for stories (Black, 1984). For example, Black and Bower (1979) found that recall of a story action is dependent on the other actions in the same episode but independent of actions in other episodes. Thus, episodes describing activities seem to be the major organizers in memory for stories. Particularly relevant for our account of activities is the Abbott et al. (in press) finding that when a story text contained a short activity description (e.g., "They decided to go to a restaurant"), the readers inferred (i.e., falsely recognized) the component actions of the activity (e.g., "They ordered the meal"). However, when the story text presented those actions, readers did not infer finer details (e.g., "They discussed what they wanted to eat"). Thus, in Abbott et al.'s results, as in ours, the activities are the main source of predictive inferences.

This role of activities in autobiographical memory is also consistent with recent applications of Rosch's framework demonstrating a similar relationship between generality and utility for social situations, events, and environmental scenes. Cantor et al. (1982) examined subjects' prototypes for social situations and found middle level categories (*party, interview*) to be more distinctive (less similar to other categories at the same level) than subordinate categories (*cocktail party, job interview*) or superordinate categories (*social situation, stressful situation*). Furthermore, these middle level categories were significantly richer (in terms of number of features in the prototype) than the superordinate categories, while subordinate categories were only marginally richer than the middle level. Rifkin (1981) performed a similar analysis of common events and found that middle level categories (*the movies*) contained significantly more features than superordinate categories (*entertainment*), while subordinate categories (*horror movie*) contained only a few more features than the middle level. Tversky and Hemenway (1983) examined "environmental scenes," asking subjects to list attributes and appropriate activities for three levels of scenes. Similarly, they found middle level categories (*school, restaurant*) to be much informative than superordinates (*indoors*), while the subordinate categories (*high school, fancy restaurant*) were only marginally more informative than the middle level categories.

The results of these studies support the notion of activities as optimal level structures. The basic level categories found by Cantor et al. and Rifkin are expressed at approximately the same level of abstraction as the activities used in our experiments; in fact, several of their stimuli are identical to our activities. One possible difference is that some situations can include several activities (e.g., a party could be the setting for the activity *giving a party* or *going to a party*). However, retrieval protocols collected by Williams and Hollan (1981) and Reiser et al. (in press) indicate that restricting such a setting to an activity is an important retrieval strategy. The activity includes information about goals and social roles not specified by such a situation which are important components in retrieval strategies. This suggests that a situation will be an effective retrieval cue to the extent that it restricts search to a small number of possible activities. Similarly, although Tversky and Hemenway investigated spatial contexts rather than events or situations, the perceptual features and activities associated with these contexts were found to be highly correlated. Thus, environmental scenes, like social situations, are the settings for characteristic activities. The similarity of results from a variety of tasks including listing features of events and scenes, remembering individual experiences, and understanding and recalling stories, supports the claim that the same memory structures are used for planning, comprehension, and organizing individual experiences. Taken together, these results suggest that we categorize the world in terms of the behaviors (of ourselves and others) that take place in physical or social settings—i.e., in terms of activities. Activities are the optimal level descriptions of these events, applying to as many varieties of experiences as possible, while losing little in richness compared to their subordinates (i.e., compared to more specific versions of the activity).

An example of how such an activity structure and its associated experiences may be represented is displayed in Fig. 3. The content frame for the activity *Eating in Restaurants* includes an ordered list of the component actions and several types of predictive features used in comprehension and in directing autobiographical retrieval. These include the goals satisfied in the activity, some larger contexts in which the activity might be performed, the social roles of the participants, associated props (physical objects found in the activity), and the visual appearance of these people and objects. Not shown are the causal rules that govern the various decisions and outcomes in the activity, e.g., rules about how to behave in restaurants, causal rules about the preconditions for good service and good food, rules for tipping waiters, etc. Most of these features would not be present in general actions and thus would be unavailable for search strategies until an activity was accessed.

The figure also includes several more specific versions of the activity, formed when several experiences are recognized as sharing a set of common features. Each structure is accessed from its parent structure by specifying a discrimination on one of the features. For example, the discrimination "Style = Italian" serves as a link to the structure *Eating in Italian Restaurants*. Each of these structures inherits the properties of its parent structure and supplements or modifies them with more specific information about features of the activity. Hierarchical networks such as these have been proposed to represent how generalizations are encoded relevant to many different levels of specificity for events (Kolodner, 1983a; Lebowitz, 1983; Schank, 1982). An individual experience is then indexed within this network by the features that differentiated it from the prototype stored in its parent structure (e.g., "first date with future wife"). Search through this network of contexts and associated indices involves accessing a context, then using information in the content frame to help select an index for traversal. For example, if a subject is asked

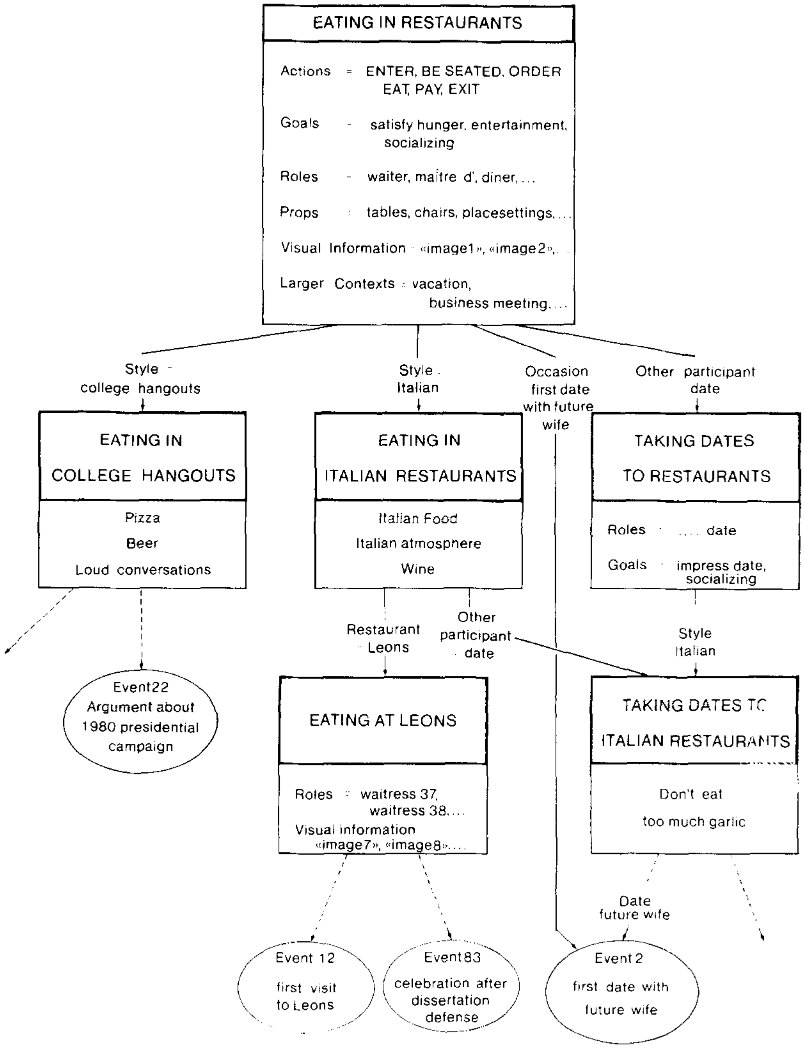


FIG. 3. A portion of the memory representation for the activity *Eating in Restaurants*. Associated content frames are shown in the lower half of the box for each context. Labeled indices connect the contexts to one another and connect individual experiences (shown in ellipses) to the contexts. Dotted lines indicate the presence of additional structures (not shown) intervening between the displayed context and experience.

to retrieve a particular restaurant experience containing a lunchtime conversation with another student, knowledge about students combined with generalizations contained in *Eating in Restaurants* (e.g., the preconditions for eating in different classes of restaurants) can be used to direct the search toward *Eating in College Hangouts* rather than *Eating in Fancy New York Restaurants*, since the latter is unlikely to be the context for the target lunch experience.

To summarize, we have argued that the type of information contained in a knowledge structure can be used to predict the effectiveness of memory cues that access such a structure. This argument led to retrieval predictions concerning activities and general action cues that were supported by our findings. These results are thus consistent with our original representational and processing claims concerning the role of knowledge structures in autobiographical memory. We believe our results constrain theories of autobiographical memory in several important ways. In the next two sections, we consider models developed using alternative assumptions and discuss why these models are inadequate to explain our results.

### *An Interference Model*

We first consider whether an interference model can explain our findings concerning activities and actions without our representational assumptions concerning knowledge structures in memory. For example, one might claim that there would be more memories and knowledge associated in memory with general actions than with activities. (It is reasonable to expect more experiences in memory to involve a particular general action than an activity, since a general action is typically a component of a number of activities.) According to spreading activation models of memory (e.g., Anderson, 1976, 1983; Collins & Loftus, 1975), search would be less efficient when initiated from a general action, since the activation would be spread out over more paths. Thus, although our results are consistent with the representations of experiences we have described, perhaps a more parsimonious explanation can be found.

In fact, it is reasonable to expect interference considerations to influence the construction of this network of organized concepts. One of the reasons that general actions play a characteristically different role in processing than activities is because general actions are concepts that are more widely associated with other concepts than are activities. General actions are constructed when several experiences occurring in different contexts are recognized as having a general sequence of events in common. For example, as one recognizes commonalities in *Paying for Something* across the different contexts in which one performs that action, a new representation of these commonalities is constructed in memory. The information stored in that concept is then used differently by the system. The reorganization of information in this generalization process forms general actions that contain these abstracted commonalities, while the activity-specific information concerning the action becomes accessible only by first traversing a connection to the activity. Thus, because a general action applies to so many different contexts, it typically must be more completely specified by an activity before it can be useful.

In order to explain the retrieval differences between activities and actions without commitment to the types of representations and retrieval strategies in our model, one might argue that experiences are associated with all types of concepts, but are more accessible from some than from others because of differences in the number of associations that each type of concept typically possesses. If no differences between concepts are to be claimed on the basis of content (type of concept), then the best predictor of retrieval difficulty would be the number of associated experiences, which presumably would be correlated with how frequently one performs an event. By this argument, experiences are associated with both general actions and activities, but the greater number of experiences associated with the general action than with the activity leads to slower search from the general actions. Thus, in this model, retrieval difficulty arises because of the number of associated links, while in our model retrieval difficulty also arises from differences in the utility of the general information contained in two different classes of concepts.

Although activities are less frequent events than general actions and elicit faster retrievals, our results also contain a case where less frequent events are *more difficult* to retrieve. Trials involving failure actions, which are less frequent occurrences than regular actions, evoked slower retrieval times. Reiser and Black (1983) have replicated these results using low-frequency actions that did not contain goal failures. These results argue against a simple interference explanation of the activity–action retrieval differences. If the events possessing a particular attribute form a subcategory of the main category, then an interference model used to explain the activity–action differences would also have to predict that a larger number of such instances should slow the search for a category member possessing that attribute, because the search would be spread over more paths. Any explanation based purely on interference cannot account for both frequency effects. Taken together, these results suggest that it is not only the frequency of the particular type of event specified by a cue that determines the difficulty of the search, but also whether the type of information contained in the cue is useful for the search mechanisms. Although the undirected spread of activation can be characterized by architectural considerations such as frequency and strength of links (Anderson, 1983), autobiographical retrieval is a problem-solving task and requires characterizing the strategic knowledge-based inference mechanisms directing the search (or spread of activation) and the types of information on which these mechanisms rely. As we have argued, activities contain more useful information for these search mechanisms.

*Directed Search Models vs Undirected Random Sampling Models*

We now address the issue of the directed nature of the search mechanisms. To what extent might the difference between failure and regular actions be explainable by a purely undirected (automatic) mechanism which samples randomly within a memory category? Instead of directing search to the right path within a category, one might propose a search process that randomly samples paths to events within a category, testing each retrieved event to see whether it contains the target attributes. In this model, event types that are more frequent are more likely to be retrieved in a given sampling, which would lead to faster retrieval times for the more frequent events, as we have observed for the regular vs failure actions.

Our finding that activities are both less frequent events and better cues than general actions indicates that search mechanisms are at least partially directed. If search were completely random within some very large category (e.g., "social events"), then experiences matching a general action would be easier to retrieve simply because there are more of them. Organizing experiences by activity appears to be one way in which experiences are stored in memory. Thus, the function of the search mechanisms when given a nonactivity cue is to find a candidate activity that might contain the experience. Search is directed at least to the extent of finding an activity category for processing.

What then can we say about search within the category? The results of the present experiments are consistent with a directed search model, but they do not distinguish it from a model of random search within activity categories. However, there are several arguments in favor of directed search within categories. We have argued that retrieval involves predicting features of the target event. It is precisely this predictive aspect of retrieval that allows search to be a directed process. We have shown that structures which are optimally predictive (activities) are good retrieval cues, and that when it is more difficult to predict features of the event within the category (failure vs regular actions), retrieval is slowed. The predictive aspect of memory retrieval has been stressed in many models of question answering and reconstructive memory (e.g., Kolodner, 1983a, 1984; Norman, 1973; Norman & Bobrow, 1979; Williams & Hollan, 1981). Verbal protocols reporting mental processes during memory search that have been collected by Kolodner (1983a, 1984), Williams (Williams & Hollan, 1981; Williams & Santos-Williams, 1980), and

Reiser et al. (in press) provide compelling arguments for the existence of directed search in this type of retrieval task. In these protocols, subjects clearly use strategies of various sorts to reformulate the memory query into an elaborated description. Subjects often described these new retrieval contexts before they had been effective in accessing particular targets. Furthermore, the redefinition of the query is observable in "false starts," cases where the subject articulates a subcategory for search and then discovers that the category does not contain one of the target items. The retrieval protocols presented by these researchers contain many examples of the strategic direction of the search mechanisms to examine a particular set of paths among the total possible paths within the category.

Further evidence for directed search was provided by Reiser (1983). If search were random within a category, then events of equal probability should be equally accessible. However, retrieval cues describing actions constituting more central components of activities led to faster retrieval than actions that were equally probable but of lower causal importance in the activity. Reiser argued that cues describing highly central components provide more of the required information for the inference mechanisms, because they provide access to the causally important features used to discriminate experiences. Cues describing low-salience details do not provide sufficient direction for retrieval. Greater elaboration of the retrieval specification is therefore necessary, and the retrieval mechanisms must search for other information in the content frame to assemble features necessary to discriminate an experience.

A third argument for directed search is based on considerations of parsimony. We have shown that experiences are organized by particular activities and that the search mechanisms are directed to access these activity categories (as shown in Fig. 3). It is unparsimonious to then propose that experiences within these activity categories are randomly organized and randomly searched. Instead, we believe that the same mechanisms that created the organization into activity categories would construct subcategories within the main activity categories. Learning about the world is a continual process; new generalizations are added constantly at various levels of abstraction. Individual experiences must be indexed within these categories to enable efficient utilization of their properties in making new generalizations (Kolodner, 1983a, 1983b, 1984; Lebowitz, 1982, 1983; Schank, 1982; Winston, 1982). It seems reasonable that if a complex indexing scheme exists within the category, then strategies would develop to take advantage of this organization.

We believe that automatic spread of activation will sometimes be effective in accessing an experience from memory. This may occur if the experience is highly associated with a structure that has been accessed by the cues presented. Another way that automatic retrieval may occur is when the initial retrieval context (environmental cues plus the subject's analysis of these cues) provides all the appropriate indices necessary to specify the experience. The reminding processes discussed by Schank (1980, 1982) may be cases of this type of automatic accessing of experiences without directed search within the category. More typically, autobiographical retrieval is an effortful, strategic, directed search process initiated by an underspecified query that applies to too many paths within the category. Activation, if it spreads over these paths, would probably be too weak to access the connected experiences. The inference mechanisms that elaborate the original cue are necessary to direct the processing to pick out some subset of these paths to examine.

*Conclusion*

We have found that considering the functionality of knowledge structures provides an insightful framework for investigating autobiographical memory and that the single and double cuing procedure provides experimental methods that are valuable for these investigations. In the studies reported here, we compared the efficacy of activities and general actions as autobiographical memory cues and found that activities are superior cues. Furthermore, we compared normative actions with ones that indicated a failure of that action and found the standard actions to elicit faster retrievals. Our results suggest that activities are the main organizers of autobiographical memory, but we have only compared them to actions. More experiments are needed comparing not only activities and actions, but also locations, goals, objects, affects, etc. Such research promises to reveal the organizational system of autobiographical memory. In addition, further research is needed to address in detail the memory retrieval processes that are taking place during the relatively long retrieval times (6 s) exhibited by our subjects.

This research has important practical applications to a wide variety of situations, because people frequently attempt to remember experiences from the past as part of other tasks. For example, autobiographical memory retrieval is involved when trying to match faces with people one has met (e.g., "Haven't I met you somewhere before?") trying to remember how to behave in a certain situation (e.g., "What did I do the last time my video recorder did not work?") or even trying to remember key experiences during a therapy session (cf. Singer, 1979). Our results suggest that in all these circumstances, people should be able to remember better if they ask themselves "What might I have been doing when that event occurred?" In other words, reconstructing the activity context should enable access of the details of the experience.

## APPENDIX: ACTIVITY AND GENERAL ACTION CUES

| Activities | General actions |
|---|---|
| Were at work | + Finished everything on time |
| Took an exam | − Didn't think you did well |
| Took a ride on a train | + Paid at the ticket booth |
| Went to a movie | − Couldn't find a seat |
| Cleaned clothes at the laundromat | + Sat down and waited |
| Went to a concert | − Left something behind |
| Went to a restaurant | + Decided where to go |
| Went on a vacation | − Weren't treated well |
| Went to a post office | + Waited for your turn |
| Went to a bank | − Couldn't do what you wanted |
| Visited a museum | + Got directions to find it[a] |
| Went to a party | − Were too tired to enjoy it[a] |
| Went out drinking | + Paid at the cash register |
| Had your hair cut | − Didn't get what you asked for |
| Went to use the library | + Picked out what you wanted |
| Went on a shopping trip | − Couldn't get what you wanted |
| Went for a drive | + Took a map[b] |
| Rode a subway | − Got lost |
| Went to a lecture | + Found a good seat |
| Went to a nightclub | − Wanted to leave early |

*Note*. Each quartet contains two activities and a regular action (indicated by a +) and a failure action (indicated by a −).

[a] The anaphor *it* was replaced by *something* in Experiment 2 in the action-alone condition.

[b] The phrase *took a map* was changed to *used a map* in Experiment 2, because it was often misread in a pilot study (as *took a nap*) when it was presented alone.

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