The Content of Event Knowledge Structures

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Abstract

Autobiographical retrieval has been modeled as a predictive retrieval process, in which strategies elaborate the original retrieval cue relying on information accessed in knowledge structures to direct the search. Previous studies have demonstrated that event concepts differ in their utility in this process. The present study examines the type of information made available by accessing two such event concepts, activities and general actions. Activity structures are shown to enable more concrete predictions about included objects, people, and setting information, while general actions tend to be associated with internal mental states. These differences in available features are consistent with previously observed retrieval time differences between these types of concepts and support a general underlying mechanism of predictive inferencing in retrieval. The results suggest the types of information that computer models of memory organization should utilize in their representations of event structures and the reasoning mechanisms that depend on those structures.

Recent proposals concerning the organization of individual events in memory have suggested that experiences are stored in memory associated with knowledge structures, indexed by their differentiating features (Kolodner 1983, 1984; Reiser, 1986a; Reiser, Black, & Abelson, 1985; Reiser, Black, & Kalamarides, 1986; Schank, 1982). In the context-plus-index model, experiences are retrieved from memory by first selecting a context in which the target experience was likely to have occurred, then elaborating the original description until enough features are assembled to discriminate an event with the target properties (Reiser, 1986a, 1986b; Reiser & Black, 1983; Reiser et al., 1985; Reiser et al., 1986). This elaboration relies on information contained in knowledge structures that have been accessed to direct the search. Computer models of retrieval have demonstrated that knowledge structures used to make inferences during comprehension provide the type of information needed for such a strategic elaborative retrieval process.

In order to model the inferencing process, it is necessary to determine both the types of knowledge structures and the features they make available that would be useful in retrieval. Experiments examining the effectiveness of event descriptions have demonstrated that event knowledge structures differ in their utility in autobiographical memory retrieval (Reiser, 1986a; Reiser, Black, & Abelson, 1985). For example, phrases describing common activities (e.g., *saw a movie*) are more effective retrieval cues than phrases describing actions generalized across contexts (e.g., *paying*). We have argued that these retrieval time differences arise because knowledge structures differ in their ability to provide features useful for predictive inferencing during retrieval. Consider the example from Reiser et al. (1985) of trying to predict and interpret an event involving "paying in a restaurant". While knowledge about paying can be used to infer that a financial transaction occurs, most of the details in the event, such as the appearances of the people involved, the physical characteristics of the surroundings (tables, chairs, food smells, wine, music), the social roles involved (waiter, maitre d'), and motivations for the event (hunger, socializing) are drawn from knowledge about restaurants.

The argument based on these retrieval results suggests that event structures that are predictive of more features, particularly those features useful in elaboration of events, will be more effective retrieval structures. The present experiment examines this hypothesis by investigating the types of features encoded in representations of common events. Our hypothesis is that the number and variety of features encoded in an event structure could be used to predict its utility in autobiographical retrieval.

We investigated two types of event descriptions used in previous experiments of autobiographical memory search. Common activities are represented as a stereotypical sequence of deliberate actions undertaken to achieve one or more goals, e.g., *Grocery Shopping* and *Going to the Movies* (Schank, 1982; Schank & Abelson, 1977). General actions represent the common aspects of a component of several different activities. For example, *Make Reservations* is a component of several activities such as *Eating in Restaurants*, *Going on vacation*, and *Playing racquetball*. Reiser et al. (1985) found activities to be more effective retrieval cues than general actions, suggesting that these structures provide more of the information needed for inferencing during retrieval. Within the general actions, those that described the failure of a goal and were therefore more unusual also led to slower retrievals. We argued that this difference arises because more careful inferencing is required to assemble a set of features in which such a non-normative event would have occurred.

The goals of this experiment were to determine whether the amount of features these structures made available could account for their effectiveness in retrieval. In addition, examing the types of features these structures elicit will suggest the types of concepts that must be encorporated in models of general and specific event knowledge.

Method

In order to determine the amount and type of information encoded in these structures, we asked subjects to list the common features for each of twenty activities and twenty general actions. We followed Rifkin's (1985) modification for event categories of Rosch, Mervis, Gray, Johnson, Boyes-Braem's (1976) original procedure for eliciting features of object categories. Subjects were told to think about what the given type of situation is "usually like", then to list the characteristics common to that situation. They were told their characteristics should be described in five words or less, and were warned not to be redundant. They were also instructed that they should list general characteristics that come to mind when they imagine the situation, and not to respond in terms of associations, such as reporting that the item *you are food shopping* "reminds you of 'my friend who works in the vegetable section of the A & P.'"

The stimulus phrases were taken from the activities and general actions used in the Reiser et al. (1985) experiments, and converted to the present tense for use in this experiment. Of the general action phrases, ten were regular general actions, describing normative components of events, such as *you are paying at a ticket booth*, *you are waiting for your turn*. Ten phrases described the failure of a goal, e.g., *you don't get what you asked for* or *you want to leave early*. The forty phrases were divided into two stimulus sets, each containing ten activities, five regular actions, and five failure actions. An equal number of subjects were assigned each of the two stimulus sets. Subjects were given a booklet containing the twenty stimuli in randomized order, and were given two minutes for each event to list the characteristics that came to mind. Twenty Princeton University undergraduates were paid for their participation in the experiment.

Results

We first considered the number of responses listed for each event. The mean number of responses per event for each event type are listed in the first column of Table 1. The number of responses listed for each item was significantly different for the three types of stimuli ($F(2, 37) = 36.2$, $p < .001$). Subjects listed more features for activity cues than for general action cues. Among the general action cues, more features were listed for the regular actions than for the failure action cues. This pattern of results mirrors the retrieval time effects found by Reiser et al. (1985), also shown in Table 1. As expected, those items previously found to elicit faster retrieval of autobiographical experiences also elicited retrieval of more event features in the present experiment.

Table 1: Mean Number of Features Generated and Retrieval Time for Activities and Actions

Event Type	*Mean Number Responses Listed*	*Mean Number Features Listed*	*Retrieval Time (sec)*
Activities	14.3	15.8	2.100
Regular General Actions	11.5	12.6	5.139
Failure General Actions	10.1	11.0	5.306

In order to determine whether the three event types elicited different types of information, we categorized all the responses generated by subjects into *feature types*. Each response was coded according to the type of information it contained. We developed 16 categories that captured the various types of information mentioned by subjects. The categories included internal states (Mental States, Physical States, Evaluation), actions and action elaborations (Action, Action Condition, Action Modification), taxonomic relations (Event Subcategory), relations to other events or states (Goal, Event Outcome, Reason, Other Event), physical and abstract referents in the event (Physical Object, Abstract Object, Setting), people (Role), and references to time (Time). Some typical examples are shown in Table 2.

Table 2
Examples of Categorized Features

Feature Type	*Response*	*Stimulus Item*
Emotion/Mental State	nervous	you sit down and wait
Physical State	cramp in hand	you are taking an exam
Action	fill out form	you go to a bank
Action Condition	admission price	you go to a movie
Action Modification	leisurely	you visit a museum
Event Subcategory	cast parties	you go to a party
Physical Object	counter	you pay at the cash register
Abstract Object	excuse	you want to leave early
Event Outcome	wrong turn	you get directions to find something
Reason	celebration	you go out drinking
Goal	want to sit down	you are waiting for your turn
Time	weekend	you go to a nightclub
Setting	big auditorium	you attend a concert
Role	go up to cashier	you pick out what you want
Evaluation	unfriendly	you take a ride on a train
Other Event	restaurants	you go on vacation

Categorizing the responses revealed that a number of responses (approximately 10%) included more than one feature. For example, the phrase "look at menu" was mentioned by a subject in response to the activity *you go to a restaurant*. This cue was categorized as both an Action and a Physical Object. Similarly, the phrase "go up to cashier" in Table 2 includes both Action and Role features. The three stimulus types do not differ in the mean number of features listed per response; thus the number of features listed for activities and actions show the same pattern as the number of responses. The second column in Table 1 displays the mean number of features listed for each event type.

We next considered whether the patterns of the types of features generated were different for the three types of events. Table 3 summarizes the mean number of features of each type per item listed by subjects. We used a discriminant analysis to determine whether the types of features generated would significantly discriminate the three feature types. The analysis revealed that membership in the three groups could be significantly predicted by the features. Those feature types that significantly discriminated the three types of stimuli are indicated in the table.

Table 3: Mean Number of Features Generated for Each Feature Type

Feature Type	*Activities*	*Regular Actions*	*Failure Actions*
Emotion/Mental State*	.46	1.13	2.15
Physical State	.35	.20	.44
Action	3.34	3.24	3.97
Action Condition	.03	.17	.01
Action Modification	.22	.15	.10
Event Subcategory	.23	.11	.01
Physical Object*	5.82	3.69	1.14
Abstract Object	.23	.49	.25
Event Outcome*	.10	.34	.39
Reason*	.10	.07	.35
Goal	.17	.21	.24
Time	.29	.28	.30
Setting*	2.14	.80	.33
Role*	1.34	.82	.64
Evaluation	.67	.30	.28
Other Event	.30	.55	.31
Unclassified	.02	.05	.05

*Significantly discriminates activities, regular actions, and failure actions.

The two strongest predictors are the Emotions and Physical Objects feature types. Activities elicit more Physical Objects than do the general actions, while the general actions elicit more Emotion features than activities. In addition, activities elicit more Setting and Role information, while general actions elicit more Reason and Event Outcome features. These findings are very consistent with the notion of activity structures as they are used in models of comprehension (e.g., Graesser & Clark, 1985; Schank & Abelson, 1977). Retrieval of an activity structure not only provides a stereotypical sequence of actions that achieve a goal, but includes a description of the various social roles involved in the interaction, and physical objects and other setting information characteristic of the event. The concrete predictions provided by activity structures are used in planning and comprehension of events, and protocol studies of autobiographical retrieval suggest that predictions based on these features can be used to elaborate a retrieval description during autobiographical retrieval (Reiser et al., 1986). The general actions provide less of this information, and appear to provide more information based on internal mental states and emotions. Thus, the differences in features elicited by these structures appear to be quite consistent with the observed differences in their efficacy during retrieval.

To summarize our findings to this point, we have demonstrated that event structures that are more effective in retrieval also elicit a greater number of features. Analyses of the specific types of features elicited indicated that activities are associated with more concrete predictions about included objects, people, and setting information, while general actions are more associated with internal mental and states. The next question to address concerns whether the differences in features can account reliably for the retrieval time differences found by Reiser et al. (1985). To investigate this, we performed a multiple regression using the number of features for each type as independent variables to predict retrieval time. The two largest predictors of retrieval time were Mental States and Physical Objects. A larger number of Physical Object features were associated with faster retrieval times ($r = -.55$), while a larger number of Mental State features were associated with slower retrieval times ($r = .62$). Not surprisingly, then, the feature types that best discriminate between the three stimulus types also predict retrieval time.

Discussion

We have found that presenting activity cues to subjects enables them to generate more features of a typical event than do general action cues. Analyses of the types of features listed indicate that in addition to the total number of features retrieved, these event structures also differ in the type of features they access. Activities retrieve more information about physical objects, characteristics of the physical setting, and types of people present in the event. General actions retrieve more information about mental states and emotions, and connections to other events (reasons and outcomes). Finally, two of these factors also predicted retrieval time -- an increased number of physical objects is associated with faster retrievals, and an increased number of mental states is associated with slower retrievals.

These findings are consistent with a model of autobiographical retrieval as a predictive process. Retrieval requires elaborating the cue in order to assemble features sufficient to discriminate a target experience from others of its general type. First, accessing activity structures appears to provide more information than does accessing general actions. This additional information appears to be useful in retrieval, as indicated by the retrieval time effects of previous studies. Furthermore, studies of retrieval protocols reveal that subject given information more abstracted from context, such as general actions or emotions, tend to focus their reasoning on finding a plausible activity context in which the event could have taken place.

The findings concerning the nature of retrieved features also suggest the types of information required in the retrieval process. Activities structures appear to provide more concrete information that is generally useful for search strategies. General actions on the other hand retrieve less of this type of information, and instead seem to elicit more features referencing internal states. It is important to consider how the types of features retrieved by activities and actions differ in their utility in retrieval.

Memory retrieval is an iterative process, in which each search retrieves partial information that can be used in further probes of memory (Kolodner, 1984; Norman & Bobrow, 1979; Reiser, 1986a, 1986b). Thus, event structures that access features useful for directing further probes of memory will be more effective retrieval structures. Consider the types of features that activities make available that were the most highly associated with retrieval time. These features seem to be themselves better predictors than those that general actions retrieve. For example, the activity *riding a subway* elicits physical object features such as maps, graffiti, tokens, signs, and so on. These features are themselves highly correlated, so that any of them might be used to predict other features. Similarly, physical object features such as a chalkboard, a blue exam book or social roles such as a waiter, conductor, and bartender are all predictive of particular events. Such features would appear to be quite useful by inferential retrieval mechanisms. On the other hand, emotions and mental states are generally not diagnostic of particular activities. One may feel excited, bored, or tired in a great variety of situations. Inferring a mental state for an event would not appear to be as useful for further inferences. Thus, it appears that the information activities access can be iteratively used to direct search, while the information accessed by general actions is of less utility to the reasoning mechanisms in retrieval. These results are consistent with the approach taken by Kolodner (1984) and Lebowitz (1983) in their computer models of knowledge structure organization. In these models, knowledge structures are continually developed by building structures to capture new patterns of features that discriminate a number of events within a category. The features selected to build these structures and index them within their more general category are those that are *predictive* of other characteristics of the event.

These findings are also quite consistent with the memory processes of *reality monitoring* discussed by Johnson and Raye (Johnson, 1985; Johnson & Raye, 1981). Johnson and Raye describe the mechanisms by which subjects distinguish between memories of external origin (records of real experiences) and internally derived memories, such as thoughts, imagined events, and dreams. They found that externally derived memories have more contextual attributes and sensory attributes, while internally derived memories have more traces of mental operations such as decisions and reactions. Our results concerning the type of information provided by activities and general actions appear to map well into Johnson and Raye's reality monitoring mechanism. The physical objects, setting, and person information provided by activities are contextual information of the type useful for reality monitoring. On the other hand, the information provided by general actions references internal states. Such information cannot be used to discriminate real autobiographical events from internally generated events such as thoughts, imagined events, or dreams. Thus, the key difference between activities and general actions may be summarized as the retrieval of external information by activities and internal information by general actions. The same information used as a basis for reasoning about events by activity structures can also be used by reality monitoring mechanisms to discriminate real from imagined events. The precise relation of strategic elaboration of retrieval descriptions and reality monitoring remains to be explored in future research. At this point, it seems clear that the differences in information content between activities and general action event structures can play a role in two ways. Our retrieval time and protocol studies results suggest that activities provide information of greater use to strategic retrieval mechanisms. In addition, activities appear to trigger retrieval of features that are of greater utility in distinguishing externally derived from internally generated events.

In summary, these results support the notion that retrieval is a predictive process. We have shown that structures that enable prediction of more features, particular externally derived features, lead to faster retrieval of individual experiences. Of course, it must be stressed that our analyses of the role of the features in these event structures in influencing retrieval time is purely correlational. That is, we have demonstrated that two types of event structures, activities and general actions, differ in the amount and type of information they make available. This difference in features is highly predictive of the retrieval time difference. However, the possibility remains that there are one or more underlying factors that account for both the differences in feature elicitation and retrieval time.

It is also important to note that these studies have concerned only activities and general actions. We have focused on these structures in our investigations because they are of great interest in studies of comprehension, and have been a focus of computational models of reasoning and comprehension. However, we do not mean to suggest that all events can be encoded as activities or actions, nor do we mean to suggest that these are the only useful retrieval structures in autobiographical memory. Indeed, our work suggests that in part activities are useful in that they provide additional information about physical objects, settings, and people. In fact, Barsalou (in press) has demonstrated that cues of this sort may be as effective in retrieving experiences as event cues.

Our results concerning activities and general actions suggest a general underlying mechanism of predictive inferencing in retrieval. The present experiment suggests the type of information that computer models of memory organization should utilize in their representations of event structures and the reasoning mechanisms that depend on those structures.

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