4 Cross-contextual reminding

There are three different kinds of reminding that are relevant for generalization and learning in processing. These different remindings occur at different points during processing with different purposes. They are:

Structure-exemplification
In the initial part of processing, we must find a relevant processing structure. Thus, we must choose a restaurant script or some other high level structure as a source of predictions. Often the selected structure is very tightly linked to a particular episode in memory. It follows that in some cases the best available structure will be that specific episode. One would thus get reminded at that point in processing. This type of reminding occurs, therefore, before any deviation from normal experience, or any expectation failure.

Failure explanation
In Chapter 3 we described reminding that is caused by the need to explain an expectation failure. This kind of reminding occurs when a processing structure has been selected, and an expectation from that structure has failed, and an explanation has been created.

Intentional planning-aids
Sometimes we seek answers to questions we have posed to ourselves, and, in finding those answers we get reminded. The other two types of reminding noted above are remindings that occur unintentionally. We just get reminded in the normal course of doing something else in processing. However, there are times when we are quite deliberately searching memory for something. When we do not know exactly what we were looking for, sometimes we will find an episode that we did not consciously realize we had, yet which turns out to be what we were looking for after all. When what we were doing was attempting to follow a plan, or create our own, we have Intentional Planning-Aids Reminding.

When we create or follow an elaborate plan to achieve some goal, we have implicitly made a prediction that our plan will achieve that goal. Predictions can be made at all levels of the understanding process, but one of the most important kinds of predictions we make is the eventual outcome of a sequence of events. When we observe the plans and actions of others, it is often important to us to be able to assess how things will turn out. When we are doing our own planning, we want to be reminded of those memories to predict what will happen if we use the plan we are considering.

Predicting outcomes
What we are predicting in those structures are outcomes. Because predicting outcomes is of great utility in our lives, it too helps to organize memory. As before, when our predictions fail, we can expect to find memories of prior failures available so that we can make correct future predictions by making appropriate generalizations about the reasons for our prediction failures. Also as before, key questions are: how are failures of this type to be explained, and what kinds of structures are such predictions likely to reside in?

There are actually two kinds of failures worth noting here. As before, what we expect to happen can fail to happen. This is a standard expectation failure. Another failure worth remembering occurs when a sequence of events result in an outcome that is undesirable, even if anticipated. We may want to note such patterns of events so that we can avert their expected, but undesirable, outcome. Thus, we would expect memories to be organized by such experiences also.

Thus, in processing new inputs, we are not only attempting to understand what happened, but why it happened. An intelligent understannder is seeking to learn from his experiences, to draw new conclusions, to make sense of the world. When an expectation failure occurs we ask ourselves why. Similarly, when a disaster occurs, we want to know why.

Consider, as an example, President Carter’s statements in 1979 about the Russian presence in Afghanistan. He alluded then to the Munich conference of 1938. “No appeasement this time—stop them now” seemed to be the point.

The question for us is: How is an input processed so as to draw out the
appeasement led to disaster episode from memory? It cannot be simply a question of finding relevant plans and goals. Finding plans and goals means understanding what the Russians are doing. Understanding what the Russians are doing in a deep sense, however, implies recognizing what they might want, what the eventual outcome might be. Carter is saying that understanding the Russians requires understanding the Nazis.

How do we grasp that this is his real meaning?

To understand in this sense, we must ask questions about outcomes and steps towards outcomes of events and patterns of events that we hear about or see. By accessing our memories at just the right time and in just the right way, we can view the Russians' actions, and our reactions, in terms of appeasement at Munich. How does this happen?

Throughout this book, we have been developing the thesis that inputs are not processed by totally abstract structures such as goals, scripts, and so on. We have argued that such structures are really organizers of episodic memory. Within each abstraction of a script or goal are sets of episodes organized by that structure. In order to get these memories out, we must find the correct index, or cue, under which these memories have been stored.

It seems obvious what the indices are in this example. We have an aggressive enemy, an invasion, and a setting of peace time. The question is: what kinds of structures in memory are these likely to be useful in searching? In addition, how do we find the relevant structures?

To answer these questions, we can consider some alternative situations and see if they would have been likely to remind us of appeasement in Munich. For example, suppose the Dutch invaded Luxembourg, citing a centuries-old claim to the land. Would there be cries of Stop them now or else we'll have another Munich? The answer seems clearly to be no. There is no match possible between Nazi Germany and Holland unless Holland is characterized in a way that is quite out of keeping with how the Dutch are viewed by Americans.

Now consider an instance where a slumlord is buying up decrepit buildings that he is using as houses of prostitution. In each case, he makes a deal with the authorities that this will be the last one he'll buy if they just leave him alone to conduct his business. Then, later, he says he needs just one more. This circumstance is much closer in spirit to the Munich situation. Further, understanding it would be enhanced if one had access to the moral drawn from appeasement in Munich.

It seems reasonable to suppose that the slumlord example might remind an interested processor of Munich whereas the Dutch example would not. In order for the slumlord reminding to occur, a very abstract structure must be available. This structure is rooted in the very nature of goal-based processing, namely the need to know why something is happening the way it is. Whenever we note that a goal is operating, we ask, as we said in Schank and Abelson (1977), what the reason or motivation for that goal is. In Schank and Abelson (1977), we postulated that the motivation was a theme. If such an answer were sufficient, then processing would end there. We would be happy to say that the Russians satisfied the aggressor theme or some such and be done with it.

This is not an adequate answer. As understanders, we seek explanations in terms of our experience. We ask ourselves, “What prior experiences do I have that are like this?” People need to relate what they are currently processing to what they have already processed in order to feel satisfied that they have really understood what was going on. Telling someone the facts of a situation never gives them the picture that a story that embodies those same facts would. This is why Carter encoded his message the way he did. It follows then, that people must have the ability to find experiences in their episodic memories by searching some set of structures that encode those episodes.

Whatever structures are available in memory to help here, it is clear that they must be written in the most general of terms. For the slumlord example to remind you of Munich, either an organizing structure that contains expectations such as aggressor wants more must be available, or one must have the ability to generate such a structure when needed. To put this another way, in order to learn across experiences that have different contexts, noncontextually-based structures must exist in memory. The expectations derived from such a structure must be made in terms with a fairly general scope. That is, it cannot be that a memory structure containing expectations about slumlords will somehow happen to contain the Munich episode within it.

One problem here then is finding such a structure. We could make the argument that both Russia and slumlord are somehow pre-categorized as aggressors. If this were the case, then aggressor could be a thematic structure that functioned in the same way that we have suggested that goals and scripts function, as organizers of actual episodes.

When is slumlord categorized as an aggressor? The answer is, after he has done the aggression—and thus after the reminding experience of Munich has already come to light. That is, it was the reminding that classified the slumlord as an aggressor. The input itself contributed to the categorization.

The real commonality here is the resultant prediction. That is, in each case we expect a certain outcome, and these outcomes are the same. We
expect that the actor who only wants a little now, will want more in the future. In processing both the Russia case and the slumlord case, we are considering the goals of the actors. As we speculate about future goals, we ask the question “When will it stop, why won’t they want more?” This question expresses an expectation about future actions that is contained in the abstract structure that has been activated at that point. This question serves as an index within that structure that causes the Munich experience to come to mind. We do not ask this question in the Dutch case because a different structure is active in processing that story. Thus, no reminding occurs.

We are saying that reminding across contexts can depend on speculations about possible outcomes. Whereas before, the index to memory that found relevant memories was an explanation of odd behavior, here the index is a question or speculation about future actions. In failure-driven reminding, we sought explanations because an incorrect expectation had been generated by an operating knowledge structure. We sought an explanation for our error. Here there is no error, merely an inquiry to know more. Thus we must concern ourselves with the following issues:

1. Why do we worry about predicting outcomes?
2. What structure in memory is directing processing at the point where the predictions are made?

The answer to the first question depends upon our conception of the nature of the understanding process. We have claimed that expectations are the key to understanding. In many instances, these expectations are sitting in a particular spot in memory, awaiting the call to action. Frequently they are prepackaged like scripts. That is, the expectations have been made before and are waiting around to be made again.

Often, however, generating relevant expectations is not so simple. Sometimes we are on relatively new ground. That is, on the basis of prior experience, it is not always all that obvious what to expect. Now, there are two possibilities here. In such situations we can simply not expect anything. We can just take what comes. Alternatively, we can work hard at creating expectations by whatever means we may have available.

The former possibility is quite feasible. It is quite reasonable to suppose that some people do go through situations having no idea what to expect and just taking it as it comes. While it is certainly possible to expect nothing, it seems likely that there is great value to generating expectations in novel situations because it facilitates learning from those situations. Learning means altering existing structures. If we have no expectations, we cannot easily notice that our prior view of the world was in error and needed to be corrected. That is, we will not alter any memory structures as a result of a given experience.

What we want to do, then, is attempt to figure out what will happen in any situation we encounter. To put this another way, when we hear that someone has a goal, we must attempt to figure out why they have that goal, what goal they might have next, what pattern their behavior implies and so on. In a sense then, we are plotting possible scenarios in our heads about everything we see. We are attempting to imagine what will happen next. To do so, we must construct a model of how things will turn out. (This model can often be quite wrong, of course.) Sometimes, during the construction of this model, we come across memories that embody exactly the state of affairs that we were constructing. When we reach those experiences we have an instance of Outcome-Driven Reminding.

So, the answer to the first question above is that such an inquiry is made whenever the events that are taking place are perceived to have a possible effect on the understander (or a person the understander cares about or identifies with). That is, when we hear about goal-directed behavior, we will attempt to predict an outcome of that behavior if it can possibly affect us. To do this, we must have asked ourselves about the goals that were being pursued, found the plans that seemed to be operating, and used them to assess the likely outcome of those plans.

The real problem here is how to generate a question such as When will their demands stop? and how to use that question to find a relevant memory. For our knowledge of goals, plans and outcomes to be accessible at the right times, that knowledge must be stored in a processing structure. Thus, a processing structure must be capable of providing us with possible outcomes for the set of situations organized by that structure. In order to find a relevant memory in a processing structure, we must select an appropriate structure first. The question that we formulate about outcomes then, must enable us to find a relevant memory that is organized in terms of a processing structure that is already active. It would be of little use if we queried memory for relevant experiences on which to create expectations if those experiences were stored in structures different from those we were looking in at the time. The kinds of structures we imagine are ones that organize outcomes in terms of goals.

To see what structure we could possibly have here, we need to examine what information it is that we know at this point. First, we know that an actor has taken something that he wanted. Second, and most important, we have assessed that actor as having evil intentions with respect to what he wants to do with what he now possesses. When these two features are identified, we claim that a high level structure has been found under
which memories are organized. (We call this structure a Thematic Organization Packet or TOP. TOPS will be explained in Chapter 7. Here we will simply note some of this particular TOP's properties.)

We shall call the TOP-level structure that is active here, Possession Goal: Evil Intent or PG:EI for short. The first problem we have in using any knowledge structure is selecting it. In this case, all we have had to have been doing is noting goals and speculating on the reasons for those goals. In the slumlord story we are told those reasons. For Russia, we would need to have Russia precategorized as an actor with evil intents.

Once such a structure has been found, we expect that it will function much like any high level knowledge structure. That is, it will be a source of predictions about what we can expect will happen within the context of that structure. What expectations are we likely to find organized by this TOP?

Any TOP is a collection of information about what usually happens within a certain high-level context. In general, three kinds of information are stored within a given TOP. First, we have expectational information. TOPs provide a set of expectations about what may happen next under various circumstances within that TOP. Second, we have static information. This is knowledge of the state of the world that describes what is happening when that TOP is active. Thus, for example, we know about the feelings and attitudes of the participants in the TOP. Third, we have relational information. This includes characterizations of the world that help us link a TOP to other structures in memory. For example, the word bully naturally comes to mind in the TOP being discussed. This characterization of an actor as a bully may serve to link information similarly characterized but stored in different TOPs. Most of all, of course, a TOP is a set of memories organized by the TOP.

TOPs are searched in order to create a variety of expectations, including predictions about the outcome of the event being processed. We make a prediction about outcomes by supplying the relevant TOP with some index that gets us to notice a relevant memory organized by that TOP. That memory gives us something with which we can make a prediction about an outcome. Here there is no failure of any kind in the processing of the input. What failure there might be is present in the memory that one is reminded of; that is, our failure to plan adequately last time (in the Munich experience). Thus, the problem here is not one of error-correction. Rather, an understander must use his knowledge of past experience to help him through a situation. In other words, he needs to assess a probable outcome because he is being called upon to make a decision of some type. Getting reminded of a relevant experi-

Cross-contextual reminding

ence will help recall that process. Thus, outcome-driven reminding can be an active part of planning.

Outcomes and reminding

To see the kind of reminding I have in mind here, consider the following four cases. Note that these cases have in common that they are cross-contextual. That is, their similarities are best expressed by common themes or patterns of goals, rather than by similar locations or scripts. It is these kinds of remindings that are most relevant to the prediction of an outcome, and hence to planning.

E. Romeo and Juliet

When watching the play West Side Story it is quite common for people to be reminded of Romeo and Juliet.

F. Munich and Afghanistan

(This is what we have been discussing.)

G. Nixon and the Mayor of New Haven

In New Haven politics there are sometimes strained town-grown relations. The past mayor was Yale-affiliated. The current mayor ran on a more anti-Yale platform but after his election he established better relations with Yale than his predecessor had. This reminded X of President Nixon's anti-communism stance and his ability to make friends with both Russia and China.

H. Back Street

The movie Back Street describes an affair that began when old lovers who had intended to marry, but couldn't due to a mishap, met after many years. When the mishap occurred, X was not reminded of Romeo and Juliet. When the lovers discussed the accidental situation, X found himself saying well he should have informed her of his plans. This reminded X of Romeo and Juliet.

These four cases have in common the failure of a predicted outcome. In E, we predict that Romeo and Juliet will live happily ever after due to her clever plan to take false poison.
In F, we predict that giving in to the Nazis will let them get what they want and stop bothering us.

In G, we predict that a politician running on a platform of anti-Y, goes after Y upon election.

In H, we note that the hero predicted that his friend would arrive and they would get married, but she never arrived.

The above cases provide a view of processing that has an understanding continually searching for how it will all turn out in the end. It is not sufficient to just say that we are attempting to predict outcomes. We must look at how we could predict an outcome.

The first problem again, is establishing what high level knowledge structure is being employed.

Let us consider case E, the problem of West Side Story reminding a viewer of Romeo and Juliet. Adopting the point of view that:

1. We are constantly searching for outcomes
2. Outcomes are to be found by an index in a TOP

then in order for West Side Story to remind someone of Romeo and Juliet he must have been using a memory structure which contained the Romeo and Juliet memory while understanding the story.

Thus we can ask:

1. What patterns are around to be noticed?
2. What TOP is used?
3. What indices are used in that TOP to find the outcome?

Here again, a good way to approach these questions is to see what else might remind you of Romeo and Juliet. There seem to be a number of key factors that might contribute to a Romeo and Juliet reminding. These are:

1. young lovers
2. objections of parents
3. an attempt to get together surreptitiously
4. a false report of death
5. the false report causes a real death of one of the lovers

Now, one thing to do here is to attempt to change some of these factors to test our intuitions about whether the reminding would occur. For example, suppose the lovers were of the same sex. This might be considered a gay Romeo and Juliet so sex is probably not a relevant index to the TOP, nor a relevant part of the TOP. Suppose the lovers were old and it was their children who objected. Or suppose, for young lovers, their respective ethnic groups objected. It seems reasonable to suppose that we would still get the Romeo and Juliet reminding. (In fact, one of those is West Side Story.)

Suppose we didn’t have lovers, but say had business partners. Even there, if the rest of the story followed, Romeo and Juliet might come to mind.

Suppose there was no attempt to get together; then there is no story clearly, so that is crucial. Similarly, suppose there was no false report of death. This seems critical, but, for the business partners, suppose this were transformed into a false report of a merger or bankruptcy. In that case, the Romeo and Juliet plot might still be there. The impossibility of righting things afterwards seems rather important, though. The death, although it probably could be changed to some figurative death (like bankruptcy) seems critical.

So what are we left with? We have two people trying to get together, being thwarted by outside opposition, eventually resulting in a false report of a tragedy that results in an actual tragedy for the other.

Let’s call the TOP here mutual goal pursuit against outside opposition. Two indices are false report of tragedy and tragedy resulting from false report. Either of these indices can be used to find the Romeo and Juliet memory. Thus, the outcome could be predicted by false report. Another index is the outcome, so it can also serve to produce the reminding experience.

Now, we will attempt to merge all this with the notions we discussed in the last chapter. Roughly, the algorithm presented for Failure-Driven reminding was:

1. Process according to knowledge structures
2. Detect prediction failures
3. Explain failure
4. Create alternative account
5. Access memory through belief

In the cases we have been discussing, the TOPs selected were PG:EI and Mutual Goal Pursuit Against Outside Opposition (MG:OO). Comparing this to the failure-driven cases discussed in Chapter 3, we can see that the indices must be different. In those cases explanations were created to account for expectation failures. Those explanations were the indices to memory. Here, as we shall see, the indexing mechanism works differently.

Once a TOP has been selected for processing, we begin to generate expectations. Expectations are generated by using appropriate indices to find specific episodes organized by that TOP. The indices are selected through a variety of techniques (described in Chapter 10) by examining
various features of the input story, or by asking oneself general questions about the TOP, the answers to which can serve as indices. The trick in generating this latter type of index is to ask questions that have answers that have already been used as indices. One method for doing this is to attempt to solve the problem of the TOP. Since TOPs are collections of goal combinations in various circumstances, they have, associated with them, a problem. In PG:EI it is how to react to the evil actor. In MG:OO it is achieving the mutual goal. Imagining a particular solution can bring to mind specific episodes that tried that solution in the past.

In case E, once MG:OO has been selected as the relevant TOP, any number of indices that describe specific, unusual features of West Side Story, will help to pull out the Romeo and Juliet episode from memory. One of these indices, for example, is false report of death of the co-planter. This gives us the actual memory, i.e., the path to Romeo and Juliet is provided by that index. Thus the prediction here is that any story employing the above TOP and the above index will remind you of Romeo and Juliet. The advantage of being reminded of Romeo and Juliet here is that one can speculate, on the basis of that past episode, how the current episode being processed will turn out. In watching plays this is of little import, but in real life situations knowing how a similar set of circumstances turned out can be extremely significant.

Now let's consider case F (Munich and Afghanistan). The TOP is PG:EI as we indicated earlier. In this case we are attempting to formulate a reasonable response to the PG:EI. PG:EI is, by its nature, a TOP that we must respond to. Expectations within PG:EI thus involve possible responses and the outcomes of those responses. For Romeo and Juliet, we need do nothing other than observe, but in this case Carter wanted to take action and have the American people approve. The understanding tasks are different here. In essence, we are trying to remind ourselves of the most relevant memory we have to help us react to this situation. To do this, we must create indices that will lead us to the potential solution paths. In this way we can mentally try the solution and see what memories we are reminded of that employed that solution. In other words, in cases where we must compose a response to someone else's action that can be characterized by a TOP, we postulate conditional outcomes that we mentally try out as possible responses.

In case F, one possible plan, and therefore one possible index to PG:EI, is the null plan: Provide no opposition. Using this as an index in PG:EI will help retrieve the memory of the Nazis and Munich. That is, it is as if the question were posed to memory, "When an aggressor has asked for more territory and no opposition was provided, what has happened?"

Memory answers the question by providing a prior episode whose outcome was a series of escalating demands. From this memory we can then predict future failures if provide no opposition is the course chosen.

The moral here is that if you want to influence people's thinking indirectly, give them a situation that can be characterized by a TOP, and a possible index to that TOP. People will use that index to find a memory. If that memory has negative consequences, they will then begin to believe that a course of action other than the one expressed by the index should be taken. In a sense then, the point of getting us to think about provide no opposition as a possible plan is to cause us to counterplan. Provide no opposition fails, so something else must work.

After an index has yielded a bad effect, if the problem we are processing is our own, we try to create an alternative plan. To do so, we must identify the causes of the failure of the original episode. Clearly for Romeo and Juliet this is of little use for us to do as understanders. Yet, many people find themselves incapable of not doing it. We tend to try to create an alternative plan by negating one or more of the conditions in the failed plan. In F, the obvious thing to do is to negate provide no opposition by making it provide opposition. This new plan is equivalent to an explanation for the failure of the prior plan. Thus, for this kind of reminding, explanations are the last item produced since they are post hoc.

Now let us consider case G. This reminding came about because X was being asked to evaluate the performance of the mayor of New Haven. X was forced, in attempting to analyze the mayor's performance, to rely on previous information. In other words, X tried to find an episode in memory that would provide a valid analogy.

In G then, it appears to X that X was asking himself to evaluate the behavior of the mayor. The TOP achieve success, utilize power is active. That TOP predicts that the mayor will plan to do what he has said he would do. Hurt Enemies is one thing that is expected. It is thus a plan, that, in conjunction with the index of political power through elective office brings the memory of Nixon to mind. But Nixon did not hurt his ideological enemies in the international sphere; he only bothered with his personal political enemies. This information is then used to note the similarity with the mayor of New Haven and to start the process of post hoc explanation. In other words, upon evaluation of these two inputs, a new memory structure might be created that provided expectations about certain types of candidates for office.

The most important thing we must do in Outcome-Driven Reminding is create a new belief or conclusion that will better enable future under-
standing. Here, we must be able to create a belief like Those who get elected attacking Y are good people to make friends with Y. It is this conclusion that is most obviously drawn from the two instances and it is this kind of creative generalization that we seek to make. The creation of new structures from old ones that have failed is an important part of learning.

Finally, let's consider case H. The movie *Back Street* has little in common with *Romeo and Juliet*. When X saw that movie he was not reminded of *Romeo and Juliet*, at least not initially. The basis of the plot of *Back Street* is a marriage plan. The hero does not inform the heroine of the plan. They fail to meet at the appointed time. Subsequently, they each marry someone else, and then end up having an affair when they meet later in life. When X thought about their initial failure to meet, well after the actual scene, he found himself saying to himself “Well, he should have made sure that his plan was known to his lover, and then it would have worked out.” It was this explanation of what had gone wrong that reminded X that that was the conclusion he had come to about what went wrong for Juliet. That is, both stories lead one to the same conclusion about planning in a MG;OO.

To understand *Back Street*, it is necessary, at one level of understanding, to figure out why what went wrong in a person's life went wrong. Clearly, it is not absolutely necessary to do this in order to understand; it is necessary if one wants to understand well, however.

In the course of understanding *West Side Story*, we had to get reminded of *Romeo and Juliet*, so to speak. In following the course of events in the story, we get reminded as we access a TOP and attempt to predict an outcome. In case H, we do not even realize that a MG;OO is present because it is not obvious to the viewer of the movie what the hero's plan is. Later, when we realize that things have gone awry, we could decide to think about why if we want to, but that is not necessary. When we attempt to understand what we are hearing or seeing at a deeper level, that is, when we decide to ask ourselves why some event occurred, we then must access the relevant TOP, find the plan that was used, and note the outcome. When we seek to explain the outcome, we come upon related memories, as before, that have been indexed in various ways. Here we see that one possible index is the conclusion that we draw from the experience. That is, X realized that the hero should have been sure his coplanner was informed in a MG;OO, and that being the conclusion he came to for *Romeo and Juliet*, he was reminded of that story. Thus, conclusions can also be indices.

**Cross-contextual reminding**

**Drawing conclusions**

To predict outcomes we must be able to draw conclusions from what has happened. One way to do this is to take two memories that we have found to be in common by reminding and to create from them a new rule that can be used in the understanding process. We want to learn from prior failures. We attempt to predict an outcome, and, coming upon a related prior memory, draw a conclusion that causes us to modify our behavior in order to avert the same problem we encountered last time.

In general then, what we want to do is make a generalization from any reminding example that will help us next time around. Consider then, the generalizations that might be drawn from the examples cited above:

F. When dealing with an agressor who wants more, draw the line quickly.
G. If you want peace with X, support politicians who are anti-X.
H. Be sure that your coplanner is informed of your plans.

In each of these examples then, what we want to do is derive a rule that can be placed at an appropriate point in memory to aid us next time. To do this we must isolate the reason for the outcome related failure and index in terms of that reason.

Simply stated, then, we are proposing that in Outcome-Driven Reminding the task is to find a memory that will help in planning a reaction to a current problem. This kind of reminding is much more intentional than Failure-Driven Reminding. Here, we are not only trying to understand why someone did what they did, we are also trying to modify plans for achieving goals. Thus, while FDM is driven by expectations involving actions, ODM is driven by expectations involving plans and goals. The consequences for a system that learns from such reminders are thus more profound in ODM since such reminders can affect generalizations that cause us to avoid possible dangers caused by bad planning.

Reminding is the key to our understanding. When we find a memory during the course of processing, the act of finding that memory forces us to modify our existing knowledge structures. This modification takes the form of changing the expectations in the structures, or of creating new structures. Since structures and their expectations are forms of generalization in memory, this alteration process is a component part of an overall process of generalization.

In the remainder of this book, therefore, we have three significant issues to address:
1. What structures are there in memory?
2. How are these structures altered to modify expectations and create new generalizations?
3. How can we find the right structures and memories held in those structures so as to begin the process of expectation and reminding?

We will attempt to answer these questions in what follows. The conclusion so far is this: Reminding is a ubiquitous phenomenon in memory. Often, a reminding is illustrative of previous processing in memory that has attempted to record failures of various kinds together with the explanation of those failures. Such failures come from expectations that we make about the way things are likely to happen, and from our desires about the way we want events to turn out. These expectations are created at all levels of processing. People are constantly trying to figure out what will happen and what to do about it. They look for patterns and attempt to solidify those patterns by creating structures in their memories that encode various sets of expectations.

Any theory of memory therefore must concentrate on the nature of the memory structures that encode expectations. We consider that issue next.

Part II

Structures in memory
The nature of understanding

The kinds of structures in memory
of understanding, is to find out what the requisite high level memory structures might look like.

How do high level structures get built?

To answer this question let us digress for a moment to the topic of how scripts or similar structures might come to exist in the human mind.

Children, as we have noted in Schank and Abelson (1977) and as Nelson and Gruendel (1979) note, learn scripts from a very early age. We hypothesize that the basic human understanding is what we have termed the personal script. Personal scripts are our private expectations about how things proceed in our own lives on a day to day or minute to minute basis. In the beginning, a child's world is organized solely in terms of personal scripts, i.e., his private expectations about getting his diaper changed or being fed or going shopping. Such expectations abound for children and children can be quite vocal when these expectations are violated. The child who has gotten a piece of candy at every grocery store visit will complain wildly when he does not get it at the current grocery store. These expectations are not limited to such positively anticipated experiences however. Trifles such as taking a different route to the same place or not being placed in the same seat as last time are very important to children and serve as reminders to us of the significance of personal scripts in children's lives.

As time goes on children begin to notice that other human beings share some, but not all, of their expectations. When a child discovers, for example, that his personal restaurant script is also shared by other people, he can resort to a new method of storage for restaurant information. He can rely on a standardized restaurant script with certain personal markings that store his own idiosyncratic points of view. That is, he can begin to organize his experiences in terms that separate what is peculiar to his experience from what is shared by his culture.

For example, adults know that getting in a car is not part of the restaurant script. However, this may be a very salient feature of a child's personal restaurant script. It is very important for a child to learn that the car experience must be separated from the restaurant experience so that he can recognize a restaurant without having gone there by car and so that he can understand and talk about other people's restaurant experiences. Thus, the child must learn to reorganize his memory store according to cultural norms.

Adults do not abandon personal scripts as important organizational entities. We still expect the doorman to say good morning as he opens the door or expect the children to demand to be played with immediately after dinner or whatever sequences we are used to. We may no longer cry when these things do not happen, but we expect them nonetheless. These expectations pervade our lives just as they did when we were children.

We continue to reorganize information that we have stored indefinitely. New experiences are constantly being reorganized on the basis of similar experiences and cultural norms. The abstraction and generalization process for knowledge acquired through experience is thus a fundamental part of adult understanding. When you go to the dentist for the first time, everything in that experience is stored either as a single, isolated chunk, or in terms of experiences (with doctors perhaps) that seem similar. Repeated experiences with the same dentist or other dentists, and descriptions of other's experiences with dentists serve to reorganize the original information in terms of what is peculiar to your dentist, dentists in general, yourself in dental offices, and so on. The reorganization process never stops. When similarities between doctors and dentists are seen, a further reorganization can be made in terms of health care professionals. When doctors' and lawyers' similarities are extracted, yet another memory organization point emerges. The key to understanding this continual creation of new high level structures where the essential similarities between different experiences are recorded.

In this view, one's concept of an event is simply the collocation of one's repeated encounters with that event. After only one trip to the dentist, the dentist who treated you is your prototypical dentist. Over time, your concept of a dentist evolves. Similar or identical parts of the various dentist experiences you have had are abstracted into structures representing the generalized prototype. New experiences are then stored in terms of their differences from the prototype.

To begin our look at the kinds of high level structures that there must be let us consider a possible story about a trip to the dentist.

The first question we wish to address with this example is what knowledge is used in processing the various parts of the story. The second question is what memory looks like after this story has been processed.

Since memory structures and processing structures are the same thing, it should be clear that any story has the potential for altering memory, especially if it differs from the prototypes that are being used to process it. In particular, any failures of expectations arising from those prototypes will in some way cause an alteration to memory.

Previously (Schank & Abelson, 1977), we have said that the structure that would handle a visit to the dentist was the DENTIST script. The DENTIST script would contain a list of events normally found in visits to
the dentist, connected together causally. In addition, we allowed tracks of such a script to represent the alternative sequences of events that could take place. Under this conception of a script, the script's primary role was as an ordering of scenes, each of which in turn served to order events within those scenes. Each action encoded in a script thus served as an expectation that memory was making about incoming input.

What of all this do we wish to keep in our present conception of things, and what do we believe to be missing? The first change that we have been suggesting transforms the notion of a script from a passive data structure from which expectations are hung, to an active memory structure that changes in response to new input. The failure of expectations derived from a script will cause indices to be placed in the script at the failure point. When similar failures are noted, the memory indexed by them directs processing at that point. We have already discussed this to some extent previously and will have more to say about this self-organization process in Chapter 8. The key point here is that scripts are active memory structures.

What else is missing from our prior conception of scripts? As we discussed in Chapter 1, there is a serious problem that was demonstrated by the Bower, Black and Turner (1979) experiments, namely the problem of determining the right level of information to be stored in scripts. It seems reasonable to suppose that what we know about dentist's waiting rooms is just what we know about waiting rooms in general, and is not specific to dentists. A waiting room in a dentist's office is likely to be more or less identical to that of a doctor's office. An event that occurs within the setting of a waiting room is more likely to be remembered as an event that occurred in a waiting room than one that occurred in a dentist's office. Similarly then, we can expect that what we know about waiting rooms may apply in a great many other circumstances: lawyers' offices, for instance.

The same thing is true of many of the other activities involved in a visit to a dentist. Paying the bill or getting to the dentist's office involves knowledge sources and hence memories that may not involve dentists at all. We use what we know about these two things to help us understand a visit to the dentist, but there is no reason to assume that the memories and memory structures that we use in these situations are stored in any way that connects them intimately to what we know about dentists. To drive to a dentist's office we do not need to know anything about dentists except how to get to that particular dentist's office.

What we are proposing, then, is that a lot of that knowledge that we would previously have stored as part of the dentist script is, in reality, part of other memory structures that get used in understanding a story involving a dentist visit. Such a proposal has two obvious ramifications. First, this view implies that scripts do not exist in the form we had previously proposed. While it may be possible to collect all the expectations we have about a complex event into one complex structure that contains everything we know about visits to the dentist, such a structure does not actually exist in memory. Instead, the expectations are distributed in smaller, sharable units. Second, if a diverse set of memory structures are used for processing a story about a visit to a dentist, and if memory structures are the same as processing structures, then it follows that a story about a visit to the dentist will get broken up by memory into several distinct pieces. That is, whatever happens in driving to the dentist's office, if it is of interest to memory, it will be stored as a modification of what we know about driving, not dentists. Each event will be processed by, and stored in terms of, the structure that relates most closely to that event.

Such a scheme has the negative effect of forcing us to use a reconstructive memory to help us recall events that have happened to us. (And, of course, we may not be able to reconstruct everything.) But this negative effect is more than outweighed by the powerful advantage of enabling us to learn by generalizing from experiences by noticing their commonalities. We shall discuss this trade-off more carefully in the remainder of this book.

A third important implication is that there must be some memory structures available whose job it is to connect other memory structures together. In order to reconstruct what has happened to us, and in order to have the relevant structures available for processing when they are needed, memory structures must exist that tie other structures together in the proper order. Even though we have learned to dissociate memories about WAITING ROOM from those specific to DENTIST, we still need to know that dentist visits involve waiting rooms.

Information about how memory structures are ordinarily linked in frequently occurring combinations, is held in a memory organization packet for what we shall henceforth call a MOP.

In order to account for reconstructive memory, and the ability to generalize and learn from past experience, I am proposing that a memory structure exists that I call a MOP. It follows from what I have said so far that a MOP is also a processing structure. As a memory structure, the role of a MOP is to provide a place to store new inputs. As a processing structure, the role of a MOP is to provide expectations that enable the prediction of future inputs or inference of implicit events on the basis of
previously encountered, structurally similar, events. A MOP processes new inputs by taking the aspects of those inputs that relate to that MOP and interpreting those aspects in terms of the past experiences most closely related to them. Many different high-level memory structures can be relevant at any given time in processing an input, i.e., any of a number of different MOPs may be applicable at one time.

We said in Chapter 1 that scenes hold memories. Scenes are general structures that describe how and where a particular set of actions take place. WAITING ROOM or AIRPORT RENT-A-CAR COUNTER are possible scenes. Scripts (in our new formulation of them) embody specific predictions connected to the more general scene that dominates them. Thus, an individual might have a DOCTOR JONES' WAITING ROOM script that differs in some way from the more general WAITING ROOM scene. Scenes, therefore, can point to scripts that embody specific aspects of those scenes. Scripts can also hold memories that are organized around expectation failures within that script. In this view of scripts, a script is bounded by the scene that contains it. Thus scripts do not cross scene boundaries.

MOPs differ from scenes and scripts in the amount of knowledge they cover and the generality of that knowledge. A script must be limited to a sequence of actions that take place in one physical setting. Similarly, a scene is setting-bounded. But a MOP can contain information that covers many settings. Furthermore, a MOP has a purpose that is not readily inferable from each of the scenes or scripts that it contains. Because of this, memory confusions can take place when it is forgotten which MOP a particular scene-based memory was connected to. This is like remembering what you did without remembering exactly why you were doing it.

Some examples of this include remembering an incident that took place while you were driving and being unable to recall where you were driving to, or remembering a waiting room without being able to recall exactly why you were there.

Now it is important to consider how MOPs function in the understanding process. Let us consider the information relevant to a visit to a doctor's office. The primary job of a MOP in processing new inputs is to provide relevant memory structures that will in turn provide expectations necessary to understand what is being received. Thus MOPs are responsible for filling in implicit information about what events must have happened but were unreported. At least two MOPs are relevant to processing memory, and understanding of what a visit to a doctor's office entails. They are: M-PROFESSIONAL OFFICE VISIT and M-CONTRACT.

Each of these MOPs organizes scenes and scripts relevant to the processing of any story involving a visit to a doctor. WAITING ROOM, for example, is one of the scenes in M-PROFESSIONAL OFFICE VISIT (henceforth M-POV).

The primary function of M-POV is to provide the correct sequencing of the scenes that provide the appropriate expectations for use in processing. In order to create the proper set of expectations, we must recognize what MOPs are applicable. How do we do this? Consider the following story:

I went to the doctor's yesterday. While I was waiting in the waiting room, I noticed a patient who was taking my place. The doctor will probably still charge me!

Previously, in our script-based theory we would have said that the first line of this story could be called a comprehensive doctor script. We are currently postulating that no such entity should exist in memory as a prestored chunk. A memory that used a high level structure such as doctor visit would not be able to take advantage of similarities across experiences. A system that used such structures could never apply what it found in one context to help in another. Thus it would not learn in any truly interesting way. We must be able to remember an experience by retrieving the memories of the pieces that comprised that experience. The alternative (memory storage that contains entire experiences as a distinct unit) would preclude learning across contexts.

In processing the first sentence of this story, what we must do is call in the relevant MOPs so as we can determine them, and begin to set up expectations to help in processing the rest of the story. This is done as follows: The phrase went to the doctor refers to "doctor", which is something about which we have information. Doctor is a token in memory. For every token in memory, there exists information attached to that token that tells us where to look for further information. Attached to the doctor token is, among other things, information about the MOPs that a doctor, in his role as doctor, is likely to participate in.

The information attached to the doctor token that is relevant to this example is a combination of MOPs and information about the conditions in the world that tell us when those MOPs are likely to be active. This information includes parsing information about what words or concepts in the context doctor may help to tell us what MOP may be active. In this case, PTRANS to doctor (PTRANS is a primitive action underlying go, and other verbs; see Schank, 1975) activated the MOP that refers to going to a doctor's office for his professional services. Thus, this activates M-POV. (Saying "John is a doctor" would not activate that MOP. The activation process is actually more complex than this, but this will suffice for our purposes here.)
M-POV has information attached to it concerning what other MOPs might also be active when M-POV is active. In addition to what we know about visits to a professional's office, we also know quite a bit about why the actors in the various scenes of that MOP do what they do. Knowing this allows us to predict further actions not explicitly part of M-POV. It is in no sense a requisite part of M-POV, for example, that people pay for the service they get. Services can, of course, be free (as doctors' are in various countries). Included as part of M-POV then, is information that, in this person's experience, the MOP M-CONTRACT is activated when M-POV is activated. That is, we know that an implicit contract has been made by patient and doctor and that a bill will be sent as a result of this contract, that the patient will be sure if he doesn't pay and so on. All of this information is part of M-CONTRACT, not M-POV. Thus a MOP carries it with at least two kinds of information: an ordered set of scenes (or placeholders for scenes) and other MOPs that frequently co-occur with it.

A MOP serves to organize a set of scenes and scripts commonly associated with a goal in memory. Thus M-POV organizes what we know about what ordinarily takes place in a visit to a professional's office. It would not have in it anything specific to the higher level goals involved in such a visit. That is, we know that people go to doctors to pursue health-related goals. But that information is not contained in M-POV. Rather, M-HEALTH PROTECTION is also activated by "Possession of doctor." As we shall see later on MOPs tend to come in threes. The three active in a doctor visit then are M-HEALTH PROTECTION, M-CONTRACT, and M-POV. These correspond to personal, societal, and physical MOPs respectively. This three-part division is quite significant and will be explored further in subsequent chapters.

A scene defines a setting, an instrumental goal, and actions that take place in that setting in service of that goal. These actions are defined in terms of specific and generalized memories relating to that setting and goal. For example, ordering in a restaurant or getting your baggage at an airport are scenes. As long as there is an identifiable physical setting and a goal being pursued with that setting, we have a scene. Two kinds of information are present in a scene. First, we have physical information about what the scene looks like. Information about what was in one's line of sight can be part of one's remembrance of a scene. Second, we have information about the activities that go on in a scene. (We shall look at scenes in more detail in Chapters 6 and 9.)

A script, in our new, narrower sense, is a sequence of actions that take place within a scene. Many scripts can encode the various possibilities for the realization of a scene. That is, a script instantiates or colors a scene.
memory confusion. An event that takes place in WAITING ROOM will be stored in WAITING ROOM and thus will be linked to M-POV. But M-POV can be linked to a variety of different situations (doctors, accountants, lawyers, etc.) that use M-POV. Thus, an event that takes place in a WAITING ROOM may easily become disassociated from which particular waiting room was used. A person may be able to recall that the event in question occurred in a waiting room, but think it was the doctor’s when actually it was the dentist’s.

So the disadvantage of sharing memory structures is that it creates possibilities for memory confusion. This is outweighed, however, by the advantage gained in allowing generalizations. At the cost of being unable, on occasion, to remember what waiting room a certain event occurred in, or where a certain instance of paying took place, we gain the advantage of having all the knowledge we have acquired from all our professional office visits, or from all the situations in which we have had to pay for something, available to us to deal with a new situation.

The sharing of scenes such as PAY complicates the relationship of MOPs to the scripts that frequently occur in them. For example, there are many ways of doing PAY (i.e., there are many methods of payment). These methods are represented by various scripts which can be used to color pay, such as SASH REGISTER, BILLING, etc. The various scripts associated with PAY are organized by PAY in memory. After one particular method of payment takes place, PAY is augmented to contain the information that the event occurred. In the case of payment associated with the doctor visit, two links are added. One says that this event in PAY was part of M-CONTRACT, and one that says that it was part of M-POV. (Actually, more links than this are needed because there are more MOPs active here, but this simplification will do for this example.) These links allow the retrieval of the particular scripts which have been used to color the scene in previous instances of a particular MOP. For instance, this would allow us to recover the fact that in most instances of M-POV, the payment script used is BILLING. Thus the indexing of scripts under scenes allows us to remember variations on general scenes which are specific to a certain MOP, while still retaining the ability to make generalizations based on components of the scene which are common to all occurrences of it.

At the point in understanding when M-POV has been accessed then, we are ready to add new events to the memory structures that M-POV organizes. Further, we can use M-POV to fill in implicit information between steps in a chain of events by assuming that intermediate scenes not explicitly stated actually took place and should be processed. As we have said, the first sentence, “I went to the doctor’s yesterday,” gets us to look at what we know about doctors. Some of what we know are the MOPs that are activated by a visit to a doctor. Thus we activate M-POV and M-CONTRACT as we said before. This allows us to predict generally what sequence of events will follow. Now when the sentence “While I was reading a magazine I noticed that a patient who arrived after me was being taken ahead of me’ is encountered, it can be interpreted in terms of knowledge stored in M-POV about WAITING ROOMS. What we have here is an expectation failure from the script of customer queueing that is organized by WAITING ROOM. We can understand that there is a potential problem here because of our failed expectation for what normally happens in WAITING ROOM. This expectation was activated by M-POV, which activated WAITING ROOM, which activated SCUSTOMER QUEUEING, which held the actual expectation.

The final sentence “The doctor will probably still overcharge me!” refers to the PAY scene of M-CONTRACT.

So, seen all at once, what we have in a “doctor visit” are three MOPs, each of which connects to the various scenes that contain the expectations necessary for processing, and in terms of which memories will be stored. Seen temporally, each scene follows the next, so the end product looks very much like a script (in the old sense). But, we have no reason to believe that any structure that represents such a linear combination of scenes, ever exists in memory as one whole piece at one time (Figure 2). Actually, there are some other MOPs relevant here too. For example, a trip of sorts is involved in this visit and that is a TRIP MOP. Similarly
there are MOPs active for the doctor’s motivations and for higher level issues.

Some perspective

We have, to this point, used three different kinds of memory structures in our discussions. What are the general characteristics that these structures share?

Any structure in memory that can be used as both a container of memories and of information relevant to processing new inputs must contain the following things:

- a prototype
- a set of expectations organized in terms of the prototype
- a set of memories organized in terms of the previously failed expectations of the prototype
- a characteristic goal.

A MOP organizes such structures. A scene is a general description of a setting and activities in pursuit of a goal relevant to that setting. A script is a particular instantiation of a scene. Ordinarily, there are many scripts attached to one scene. (That is, a scene that had no scripts the instantiated it, would not look in any way different from a script, as it would have only one set of expectations about how things would happen.)

Given the above definitions, let us now consider how the memory and understanding process might work. An episode does not enter memory as a unit. Various knowledge sources are used in the processing of any episode. During that processing, those knowledge sources are changed by the information in the episode. What we know about a subject is altered by new information about that subject. Any episode we process provides such new information. Since a new episode carries information of many different types, this implies that the initial episode has been somehow broken up, with its various pieces being assigned different locations in memory depending on the knowledge used to process them.

According to this view then, memory would seem to have a set of knowledge structures, each of which contains pieces of various episodes. However, it seems unlikely that this is exactly the case. Under some circumstances when an episode breaks into pieces, each piece is useless in retrieving the other pieces of that episode. At other times, an entire episode is retrievable through a piece of that episode.

This difference is related to the problem of reconstructive memory. Consider an argument that one has with one’s spouse in a car. Is it possible to retrieve the purpose or destination of the trip, or what happened prior to entry into the car? The answer depends upon the reconstructability of the episode given a scene from that episode. An episode is reconstructable if there are events or objects present in a scene from that episode that in some sense depend on prior or subsequent scenes. Such dependence can be of two types. The dependence may occur because a particular element is present in the given scene that directly correlates with a specific element in a prior or subsequent scene. Or, the dependence may occur because general information is available by which the prior and subsequent scenes can be figured out.

In the latter case, we have an instance of the use of MOPs. MOPs provide, among other things, the temporal precedences among scenes in a standard situation. We know that an airplane trip involves arrival at the airport, followed by checking in, followed by waiting in the waiting area and so on. This information is all part of M-AIRPLANE TRIP.

We can use this information to reconstruct episodes based on the memory of some portion of them. That is, given a scene, by examining a MOP that it might belong to, we can infer what other scenes must also have occurred. When any memory structure is considered as a possible holder of a memory that we are seeking, we can search that structure by using indices that were found in the initial scene. We are claiming, then, that episodes are broken apart in terms of the structures employed in understanding them, stored in terms of those structures in memory, and are reconstructable by various search techniques. Episodes are not remembered as wholes but as pieces.

What are the limits on the range and kinds of structures that MOPs order? Also, what kinds of orderings are there on MOPs?

Using the goal classifications given in Schank and Abelson (1977), we can see that MOPs relate strongly to the achievement of a certain level of goals. There are MOPs that attempt to achieve almost all these goal types. For example:

- Satisfaction: S-goal
- Enjoyment: E-goal
- Achievement: A-goal
- Preservation: P-goal
- Crisis: C-goal
- Delta: D-goal
- Instrumental: I-goal

One point here is that it is not easy to find clear examples of MOPs that realize achievement goals. A-goals are at a higher level than the other goal types mentioned above. Notions such as M-SUCCESS, M-POWER, or M-REVOLUTION simply do not make sense at the level we have been
Dynamic memory

discussing. MOPs order scenes (where scenes are defined as settings plus relevant scripts) in the service of simple low level goals (where simple low level goals are defined as those listed above, but not A-goals). Since scripts are merely stereotyped plans, MOPs also serve the function of ordering plans. Thus MOPs relate to what we termed Named Plans in Schank and Abelson (1977). Further, since plans are intended to realize goals, really what we are doing here is attempting to uncover the elaborate goal classification and organization system used by the mind. In other words, we are suggesting that goals are the basis of memory organization. We remember an event primarily in terms of the goals to which it pertains.

An example

Consider the problem of recalling the details of a particular visit to a city that one has frequently visited. No one structure in memory contains all the details of this trip. There is, however, likely to be a node in memory that contains some of the details of the trip directly and through which much of the trip can be reconstructed. The following things seem to be true:

1. Some details of the trip may be recalled apart from the purpose of the trip.
2. The purpose of the trip may be recalled apart from details of the trip that were not connected with that purpose.
3. Incidents that occurred on the trip that had nothing to do in principle with the trip (i.e., reading a certain book) may be recalled completely apart from the trip (that is, no connection is even available).
4. Scenes normally associated with trips can be reconstructed, but many of their details will be missing.
5. The trip may be recalled through some conclusion or generalization drawn from it at an appropriate time (i.e., “That reminds me of the time I took a trip and had no expectations for it and everything worked out perfectly”).
6. The trip may be recalled through some malfunction in the ordinary flow of the trip.
7. The trip may be recalled by any of its scenes being brought to mind.
8. Scenes that were part of one trip may get confused with similar scenes that were part of other trips.
9. Results or effects of the trip may serve as cues for recalling different scenes of the trip.

There are other issues that could be stated here as well, but these will do for now. Anything that can be remembered in its own right, apart from the trip itself, is a candidate for consideration as a structure in memory. Thus, since the purpose of the trip (a meeting, say) can be recalled apart from the trip itself, that purpose is a structure. Similarly if the airplane ride can be recalled apart from the trip, there must be a separate structure for it. Additionally, since some structures clearly package other structures in a way as to allow reconstruction, there must be such structures available in memory as well.

Thus, we would expect structures such as M-ATTEND MEETING, M-TRIP, M-FLIGHT, M-RENT-A-CAR, M-HOTEL to exist. Some of these structures point to others. M-TRIP would include M-FLIGHT, M-RENT-A-CAR, and M-HOTEL, for example. Within these MOPs would be various scenes such as check into the hotel, coffee break at meeting, and so on. Some of these scenes are retrievable through others and some are retrievable only directly. Thus, it might be possible to reconstruct what hotel one stayed in and therefore the check out scene by recalling information about the physical surroundings in the discussion scene in M-ATTEND MEETING. On the other hand, it is rather unlikely, unless something peculiar occurred there, that the rent-a-car bus scene would be easily recalled by anything other than direct search. To recall such a scene it is almost always necessary to get to it via the MOP that it is a part of. In other words, to answer a question such as:

What was the seat configuration in the rent-a-car bus?

it is necessary to go from M-TRIP to M-RENT-A-CAR and then to the right scene, in order to answer the question. There really is no other way to get to that scene. Such information can only be found by finding the one scene that stores those low level details.

Other MOPs, and therefore other scenes, can be related to such a trip, of course. For example, one might also use the structures M-ROMANCE, M-BUSINESS DEAL, or M-PARTY. Further, the juxtaposition of various MOPs and goals associated with those MOPs might cause one to place certain aspects of a particular trip in special structures.

The point is that many things can go on in one’s life at one time. A trip to attend a meeting can have an unexpected business deal, a romance, a travel screw up and so on as part of it. These would tend to get disassociated from the original experience because of “mushing” in scenes and reconstruction from scenes. But they do not get forgotten, merely placed in different structures. Each of these things would be remembered in its own structure, disassociated from the particular trip, and involved with others of their kind (i.e., romances with other romances, business deals with other business deals).

The connection in memory between these items can come in either of two places. One possibility is that since they were a part of the flow of
events, their place in time can be retrieved in the reconstruction process. This assumes the view that reconstruction in memory means going through a scene, finding what MOP or MOPs it was part of, and then searching other scenes organized by that MOP with indices derived from the original scene.

The other possibility is that a TOP has been created for them. A TOP is a high level structure in memory that stores information independent from any particular domain. TOPs represent generalizations or conclusions having to do with abstractions from actual events. The plot of Romeo and Juliet would be stored in terms of a TOP about mutual goal pursuit. Similarly, a belief that happenstance business deals result from trips whose main purpose is a meeting of another sort might be stored in terms of some fortuitous circumstances TOP. TOPs will be discussed in Chapter 7.

Memory then, is a morass of complex structures, related by the episodes they point to and the temporal and causal connections between them. Our task is to sort out the morass by identifying the place and purpose of a set of memory structures that would account for various memory phenomena.

**MOPs**

**Scenes**

A MOP is an orderer of scenes. To better see how MOPs function therefore, it is necessary to have a good grasp of what a scene is. A simple definition of a scene is:

A memory structure that groups together actions with a shared goal, that occurred at the same time. It provides a sequence of general actions. Specific memories are stored in scenes, indexed with respect to how they differ from the general action in the scene.

The above definition needs some more fleshing out, and we shall provide that shortly, but it will do for now.

Scenes organize specific memories in terms of their relationship to the general structure of that scene. MOPs do not explicitly contain memories. Rather, they organize scenes that contain memories. Scripts represent common instantiations of a scene. Thus, a scene consists of a generally-defined sequence of actions, whereas a script represents particular realizations of the generalizations in a scene. Specific memories can be organized under scripts, in terms of expectation failures. This follows from the above, since a script is no more than a scene that has been colored (particularly instantiated) in a given way.

The scenes we have discussed in previous chapters relied upon physical settings for their basis. We left setting information out of the definition of a scene given above, because, as we shall see, some scenes are not physically defined. Goals are a better candidate for centrality in the basic memory structure, given their significance in memory. Yet setting seems to be intrinsic to the nature of many of the scenes we have discussed so far. We call such scenes physical scenes:

A physical scene is a scene that has a physical setting as its common thread. Thus, put all together, a physical scene has a setting, delimited by the range of one's
visual field, a defining goal, and a common time, all of which contribute to delimiting and packaging a set of actions.

Most of the scenes we have used so far are physical scenes. They represent a kind of snapshot of one's surroundings at a given time. Memories grouped in physical scenes provide information about what happened and how things looked. But not everything we know and care about is physical. Ordering of memories can occur if the memories are made up of information that is not physical in its basis. Thus, for example, we can know something about how an event can manifest itself societally. This is the essence of M-CONTRACT, the MOP that we mentioned earlier as a part of a doctor visit.

M-CONTRACT organizes some scenes that are not physically bounded. Entities such as AGREE, or DELIVER, while behaving very much like scenes in a physical MOP, have no specific physical instantiation. They can happen anywhere and can take a great many different physical forms. Nevertheless, M-CONTRACT is a MOP. It functions in every way like M-POV. It points to an ordered set of scenes. These scenes are the holders of memories indexed in terms of expectations that have failed. Thus, a failure to deliver agreed-upon services will be indexed under the DELIVER scene in M-CONTRACT. In this way, a failure of a department store to deliver a package that was paid for might remind one of a restaurant that required pre-payment and then failed to serve the desired food. Such reminding can only be accounted for by a memory organization that has scenes that are not exclusively physically bounded. That is, there are also societal scenes:

Societal scene definition

A societal scene is a scene that has a social setting as its common thread. A social setting is defined as a social relationship that obtains between two people for some particular purpose. Thus, a societal scene has a social setting that involves two people, each pursuing a goal that the other person is a necessary participant in, at a common time, with a communication link between them. The actions comprising the interaction between the participants defines the scene.

A societal scene, then, expresses a generalization about how people will interact in some socially-defined situation. But how can the boundaries of a socially-defined situation be established? For example, a restaurant or a doctor's office can be viewed as one large social situation or a set of smaller ones. Any decomposition into a set of scenes has potential payoff from the point of view of learning and generalization. What makes restaurant and doctor's office visit too large to be one scene is that they contain multiple interactions between people for different low-level goals.

MOPs

Thus, the defining characteristic of a societal scene is that it is organized around the pursuit of a single goal by one of the characters in it.

The third and last kind of scene is what we call the personal scene. It is responsible for idiosyncratic behavior that is personally defined:

A personal scene is a scene whose common thread is a particular goal that belongs to the person whose scene it is. Any private plan to achieve one's own ends that is liable to repeat itself frequently is a possible personal scene. Settings, both physical and social, may or may not enter into personal scenes. There can be no more than one setting and one time per scene. Personal scenes are heavily idiosyncratic. They form one's private plans to achieve goals.

MOPs defined

We are now ready to define a MOP:

A MOP consists of a set of scenes directed towards the achievement of a goal. A MOP always has one major scene whose goal is the essence or purpose of the events organized by the MOP.

Since memories are to be found in scenes, a very important part of memory organization is our ability to travel from scene to scene. A MOP is an organizer of scenes. Finding the appropriate MOP, in memory search, enables one to answer the question, "What would come next?" where the answer is another scene. That is, MOPs provide information about how various scenes are connected to one another.

The distinction we made at the scene level creates a parallel distinction in MOPs. Most of the MOPs we have discussed so far have been Physical MOPs. Physical MOPs can contain scenes that seem societal in nature, but what is actually happening is that one event is being governed by two scenes. Thus, for example, both M-CONTRACT which is a Societal MOP, and M-AIRPLANE, which is physical, share a PAY scene. But each relates to different aspects of that event. In other words, paying can be seen as both a physical event and also as a societal event. Different MOPs provide expectations in each case. Events confirming those expectations will be remembered in terms of both of the scenes that were active.

Personal MOPs are idiosyncratic sets of scenes that can include both personal scenes and either physical or societal scenes. To some extent, all MOPs are idiosyncratic of course. Personal MOPs have the added feature that they may have no relation to how someone else might behave. Thus, we may have our own way of pursuing goals on a date with a member of the opposite sex, that bear no relationship to the way anyone else behaves. Any planned behavior that is entirely self-motivated and self-initiated, without regard to how others may make plans for similar goals, would be
encoded in a personal MOP. Some personal MOPs can be a variation on a
more standard MOP, where some personal scenes are added to, or replace,
one or more standard physical or societal scenes. It is also possible to have
personal MOPs that are made up exclusively of personal scenes. These
might relate to one’s own particular way of getting what one wants. Per-
sonal MOPs are goal-driven, as are other MOPs, but they tend to be used in
pursuit of higher level goals than the others. For very high level goals, even
personal MOPs can become relatively standardized. Thus, health preser-
vation for example, would relate to a personal MOP for dealing with this goal
that might be quite a bit like everyone else’s method. The important point
in personal MOPs is how they are related to high level goals. People tend to
be more idiosyncratic in pursuing high-level goals than in pursuing mundane
ones. As a result, personal MOPs tend to be those which relate to
high-level goal pursuit.

Since nearly every episode has a physical, societal, and personal aspect
to it, any episode is likely to have at least three different MOPs that are
useful in processing what goes on in it. These same three MOPs will also
be used for storing the memories that result from that processing. To put
this another way, when a person visits a doctor, his visit can be under-
stood, stored, and later recalled, in terms of its physical aspects—driving,
waiting, being examined, leaving, etc. It can also be understood in terms
of its societal aspects, in this case an implicit agreement to pay for ser-
dices rendered. In addition, the visit can be understood in terms of
the various goals that were being operated on by the participants in the
events. In the patient’s case this is M-HEALTH PRESERVATION. In the
doctor’s, M-JOB controls the action. These personal aspects of an event
also serve in the processing of the event. Further, we would expect that
attempts to preserve one’s health would be stored with similar attempts in
one’s memory. If this were not the case, it would be very difficult to learn
from past experience about what to do when there is a health problem.
Similarly, we expect the doctor to store job related events together with
other events similarly characterized.

The above three-part division is relevant for processing any input
event. Put another way, we are suggesting that for every input, one must
ask the following questions:

What transpired physically?
Where did those events take place?
What societal conventions were employed?
What impact did the events have on the social position of the participants?
What personal effect occurred on the participants?
What personal goals were achieved by the events?

Each pair of questions corresponds to one kind of scene (and MOP)
that is used in processing an event.

Meta-MOPs

The MOPs we have been describing are based on sequences of scenes
organized around an object and its role in the world. That is, MOPs such
as DOCTOR, AIRPLANE, or MUSEUM are simply stereotypical objects or
settings that are used in a stereotypical sequence of events. Further, their
use implies a set of scenes that naturally precede and follow them. Thus,
these MOPs bear a strong similarity to our old definition of scripts. They
are stereotypical sequences of socially-defined patterns. What other kinds
of MOPs might there be?

In Schank and Abelson (1977), we suggested that information about
planning was organized in entities that we called NAMED PLANS. These
entities consisted of units conjoined in the way that MOPs are conjoined.
Thus, we had:

\[ \text{USE (X)} = \text{D-KNOW (LOC(X)) + D-PROX + D-CONT + I-PREP + DO} \]

This meant that a plan to use something (X) was made up of steps,
namely: finding out where X is; getting in contact with X; gaining control
of X; do some preparatory steps defined by the nature of X; and then
doing what one had in mind in the first place.

Is a named plan another kind of MOP? Or, is it right at all? Certainly,
there is a sense in which this sort of structure is appropriate. But, if this is
a MOP, then it is a new kind of MOP, because it does not organize scenes
based in physical settings. Rather, it organizes entities that organize
scenes. Thus, it is a kind of template by which MOPs in general are
constructed. We call this entity a meta-MOP.

In the last chapter we referred to M-TRIP. It is more likely that TRIP is
a meta-MOP, so we will now designate it M-M-TRIP. The distinction be-
tween a MOP and a meta-MOP is not all that hard. We are simply noting
that MOPs organize scenes, whereas a structure that organizes MOPs is
somewhat different. Actually, it is not all that different. There really is a
continuum here. To find memories, as we have said, it is necessary to find
scenes. A MOP can point out what scenes might be relevant. A meta-
MOP points out entities at a higher level than a scene. Particular MOPs
then change such generalized scenes into the more familiar scenes that we
have been using. (Generalized scenes are discussed in Chapter 9.) As we
shall see later on, the difference here depends upon the experience of the
individual whose memory structures these are.
A trip can be described very generally as:

\[ \text{mm-TRIP = PLAN + GET RESOURCES + MAKE ARRANGEMENTS + PREPARATORY TRAVEL + PREPARATION} \\
+ \text{PRIMARY TRAVEL + ARRIVAL + DO} \]

This is a meta-MOP which can be used to reconstruct MOPs that organize scenes that conform to its pattern. Thus it can be used to construct M-AIRPLANE which looks as follows:

\[ \text{M-AIRPLANE = PLAN + GET MONEY + CALL AIRLINE} \\
+ \text{GET TICKETS + DRIVE TO AIRPORT + CHECK IN} \\
+ \text{WAITING AREA + BOARDING + FLYING} \\
+ \text{DEPLANING . . . . .}] \]

There is a natural progression of structures that we have discussed so far that suggests itself:

- meta MOPs
- MOPs
- scenes
- scripts

Meta MOPs describe ordered progressions of abstract generalized scenes. As such they provide the stuff out of which MOPs are made. They do not actually contain memories. MOPs are more specific descriptions of such progressions. They contain actual scenes, which in turn contain specific memories.

**Processing with MOPs**

When we begin to specify what MOPs will be used in processing a specific story, the question arises: what can be a MOP? How many MOPs are there likely to be in a system? Is their number or range fixed?

These same questions necessarily arise in the course of research on scripts and schemata. It has seemed plausible for researchers in this area to answer questions about how a sentence concerning subject X is processed with something like the X script or the X schema. Such an answer implies that any body of knowledge can be a script (or schema). But, if the range of knowledge structures that are potentially used is too large, the problem of deciding upon the correct structure at a given time can be overwhelming.

As we have said, storing all the knowledge one has about X in one chunk prohibits generalization between experiences with X and related ones with Y and Z. With MOPs, the issue of what structures there can be in a system becomes a question of how general a high level knowledge structure can be in its storage of information. If we store things generally,
process what we have not yet seen. This helps us eliminate ambiguities and enables us to pay more processing attention to the unexpected, where it is needed most. To summarize, in our view understanding consists of:

1. Creation of expectations
2. Inference of implicit information
3. Memory modification (learning)

Any memory structures we propose for handling a simple story about Cyrus Vance’s trip to Israel must be useful for the above tasks. To put this more concretely, whatever we might want to know about this trip must have a place to go in memory once we know it. Further, whatever implicit information we wish to glean from what we hear must have been present explicitly in a memory structure that was accessed during processing. We are asking then: What information and memories do we need? In what memory structures are they to be found? How do we access them at just the right time?

Some memory structures that might be active here are given below. (Note that the structures in Vance’s head would normally be different from those in an observer’s head. Those listed below are just some hypothetical ones that are supposed to reflect Vance’s structures.)

(PHYSICAL) (SOCIAL) (PERSONAL)
M-FLIGHT M-TREATY M-CONVINCE
M-MEETING M-CONTRACT M-PATRIOTISM
M-STATE DINNER M-FRIENDSHIP M-ACT-IN-ROLE

The memory structures alluded to above are intended to be illustrative of some of the kinds of knowledge that apply to understanding this situation. Many of the above MOPs may apply at the same time. That is, they may each provide expectations with respect to any given action. They may relate to, or share, given scenes, although MOPs of different types would relate to different realizations of the events. Thus, a meeting for the purposes of negotiation in which each participant was trying to defend the interests of his country would require at least one MOP of each type to help in processing. When Vance stands up at a critical moment in negotiating, it can be seen as a physical act (he gets up to go somewhere); a social act (he wanted to indicate his disgust with the proposals; he wanted to indicate that the United States is not easily pushed around); or a personal act (he felt like he couldn’t take it any more: he had to go to the bathroom). Different MOPs provide various expectations here so that these interpretations can be made at any given point.

Having said that, let us look at Vance’s trip to Israel a bit more care-

fully. From a physical point of view, certain things happened on the trip. Whatever else this story is, it is also a story about an airplane trip. In order to have that knowledge available for use, we must have recognized this fact (and all the other structures that this story is an instance of must be similarly recognized). An event that takes place in an airplane can be recalled by remembering the physical aspects of the situation. Understanding that an airplane was used for transportation may or may not turn out to be important in understanding what went on. Information about airplanes must be accessed for understanding this story. Further, we can expect that anything we are told about the airplane part of the trip would use memories from the M-AIRPLANE to help us in understanding it. Expectation failures from M-AIRPLANE would be stored in M-AIRPLANE. Events that occurred in the airplane, say an important discussion with an aide, would likely be stored some place in memory other than M-AIRPLANE. In that case M-AIRPLANE would simply be background, not of great use for retrieval.

How do we know to access M-AIRPLANE? This same question can be asked about any of the MOPs. How do we know which memory structures that will be useful in understanding a trip? This is where meta-MOPS play their part. The meta-MOP mM-TRIP tells us that a trip is usually comprised of a set of structures that occur in a certain order. It also tells us what structures are likely to fill those slots and under what conditions. Thus mM-TRIP looks roughly like this:

[make arrangements] + [get to main transport] + [do preparations for main transport] + [do main transport] + [welcome] + [get from main transport] + [do business] + [sleeping arrangements] + [return inner loop bounded by [*]]

In addition, mM-TRIP tells us that long trips require airplanes, that officials of the United States are likely to fly special planes from Air Force bases, and so on.

The role of a meta-MOP then is to point to structures in memory that are likely to be relevant (if we are processing) or to have been relevant (if we are attempting to retrieve information). Thus, mM-TRIP points to M-CAR which contains what we know about driving somewhere. It also points to M-LIMOUSINE. Both of these structures will fill the placeholder [get to main transport] in mM-TRIP. Knowing that Vance lost an umbrella on the trip, and knowing that Cyrus Vance usually gets driven by limousine to airports, allows us to consider searching M-LIMOUSINE to see if we remember him having it there. Knowing where to search is one of the major problems of retrieval in memory. It is the role of meta-MOPs to
point to the MOPs that are likely to have been active in the original processing of a situation and hence are likely to contain the memories of that situation.

Meta-MOPs also play a role in the explanation of people's behavior. We are always attempting to find out why a character is doing what he is doing. The answer to why someone is doing a given action can be on many levels. A person's behavior can be explained by reference to themes that are active in his life for example (Schank & Abelson, 1977). We can understand why someone is doing something in terms of the higher level goals that his actions are an attempt to achieve. But, we can also satisfy ourselves with lower level explanations that refer only to the role of an action in some plan. To answer, "Why did Vance get in his limousine?" with "to get to the airport, to take a plane..." is to give a rather low level explanation for his actions. Nevertheless, we do look for such explanations so we can fit in a set of actions within an overall plan. Meta-MOPs provide these explanations.

MOPs and scripts

We have alluded several times in the course of defining MOPs to the relationship between MOPs and the version of scripts as presented in Schank and Abelson (1977). We have done so because we believe the question of how they relate is both an obvious and important one. Before we leave the subject of MOPs (temporarily) we would like to examine this issue once more in detail.

The question may be put: If MOPs are things like M-AIRPLANE and M-STATE, DINNER, what have we really done that is different from our work on scripts? Have we just replaced a S with an M?

One of our initial motivations for revamping our theory of high level knowledge structures was to account for the possibility of recognition confusions in memory. We were also dissatisfied with several of the scripts used by SAM, for example $ACCIDENT. We were looking for psychologically valid high level structures that could be used for both processing and storage. We wanted appropriate reminders to be accounted for by whatever structures we proposed.

What is the difference between AIRPLANE and M-AIRPLANE?

The difference between MOPs and scripts:
A MOP is an ordered set of scenes.
A script (1977 version) is an ordered set of scenes.

BUT - The definition of scene is different in each case.
with the expectations generated by that script, are to be encoded as failures and indexed within that script.)

This leaves us with a rather impoverished airplane script, but with a much more powerful memory organization. Much of what was in AIRPLANE is now in mM-TRIP. Making reservations, getting to the plane and so on, are handled by MOPs activated by mM-TRIP. M-AIRPLANE fills one placeholder of mM-TRIP, the one we labeled [do main transport] above. It consists of the following scenes:

M-AIRPLANE’s scenes
CHECK-IN + WAITING AREA + BOARDING
+ SIT-IN-THE-PLANE + DEPLAN + COLLECT-BAGS

Each of the scenes used by M-AIRPLANE is constructed as generally as possible. However, the idiosyncratic history of a given person’s memory makes its presence felt here. For example, above we listed as one of the scenes of M-AIRPLANE, something called WAITING AREA. Now it is reasonable to ask, is this the same as the scene we called WAITING ROOM in M-POV? Clearly, the answer to such a question depends upon the experiences a person has had and the generalizations that person has formulated. It is perfectly plausible that a person who had been to a doctor’s and a lawyer’s office and had constructed a scene WAITING ROOM, might upon his first encounter with an airport, see the waiting area as a version of WAITING ROOM. And, of course, he might not.

Our point is that the possibility for such generalizations, for interpreting a new experience in terms of what it believes to be its most relevant old one, must exist for a memory. In order to do this, scenes must be memory structures in their own right, distinct from the structures they are used with in processing. Scripts, in the 1977 version, were too restrictive in this regard. This does not mean that scripts do not exist. Some of the experimental work on scripts relates to MOPs as we have now defined them and some of it relates to our new, more restricted definition of scripts.

One problem is, given a memory with MOPs, scenes, scripts, and other structures, we might assume that we have a set of immutable entities with no flexibility. The most interesting facet of human memory is our ability to take an input and find the most relevant memory we have to help process it. This is done by a reliance on indices derived from expectation failures. In essence, failure is the root of change. Thus, memory adapts successfully by failing often. But one practical problem for a theorist here, is that since the memory structures we propose are so changeable, we will have trouble making definite statements about their specifics.

MOPs

Thus, the issue of what can be a scene or a MOP must await a description of the processes by which memory alters its existing structures. There is no right answer to what can be a scene or a MOP. The actual entities used by a memory vary according to the inputs that have been processed and the generalizations that have been made.

What we can do here is discuss the nature of structures that are likely to be active in an example; so let us return to the question of what we need to process our story about Cyrus Vance. Recall that for any input about a person we must ask physical, societal and personal questions in order to access the requisite MOPs. For this story the physical MOPs needed include:

<table>
<thead>
<tr>
<th>meta-MOPs</th>
<th>MOPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>mM-TRIP</td>
<td>M-AIRPLANE</td>
</tr>
<tr>
<td>M-TRIP</td>
<td>M-HOTEL</td>
</tr>
<tr>
<td>M-MEETING</td>
<td>M-MEETING</td>
</tr>
<tr>
<td>M-STATE</td>
<td>M-STATE</td>
</tr>
</tbody>
</table>

Listing all of the scenes that these MOPs organize would be rather pointless, but it is nevertheless important to get a feel for their level of generality. For example, the scene CHECK-IN is used by both M-AIRPLANE and M-HOTEL. This, of course, can create confusions in recall, but, as we have said, such confusions are the price we pay for learning by generalization. Both M-MEETING and M-AIRPLANE have a strand for [get to place]. This strand is likely to be filled in both cases by the scene DRIVE. Similarly each has the potential scene GREETING after DRIVE is over. The fact that GREETING is optional and frequently absent will nevertheless not ameliorate potential confusions, such as trying to recall where an odd thing that happened while you were being introduced to somebody actually occurred.

The societal MOPs that are likely to be active for this story are:

<table>
<thead>
<tr>
<th>meta-MOPs</th>
<th>MOPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>mM-NEGOTIATE</td>
<td>M-MEETING</td>
</tr>
<tr>
<td>M-DISCUSSION</td>
<td>M-NEGOTIATE</td>
</tr>
<tr>
<td>M-NEGOTIATE</td>
<td>M-NEGOTIATE</td>
</tr>
</tbody>
</table>

This is not intended to be an exhaustive list for this story. We are simply trying to give the flavor of the kinds of structures that it might be necessary to employ here. Note that many of the MOPs listed above are not exclusively concerned with a diplomatic trip. For example, consider that mM-NEGOTIATE can also be used to understand a story about a
劳动关系专家的目标是谈判工资和管理。这种结构是否有相似或可能不同的原因？在可能存在的情况下，我们知道M-PERSONAL和M-PRIEST都是适用的，我们可以在了解它们之间相似性的情况下，讨论它们的共同点。因此，当一个代理人位于一个领域的边界时，它会受到另一个领域的知识的影响。这种现象在牙科故事中表现得尤为明显。

The idea is to use all the relevant MOPs we can find, at the right level of generality, and then color them with scripts when such knowledge is available. Thus, if we know that mM:TRIP and mM:VISIT are both applicable, we can determine that after the plane lands there may be a red carpet and a speech at the airport. We know that [get to place] will likely be filled by a limousine provided by one of the governments involved, and so on.

Thus determining what is likely to happen next is a matter of first determining what MOPs might be active. Then we must decide what level of description of the episode we are interested in. Do we want to know what will happen next at a physical or at a societal level? Usually we wish to know both. Then we must attempt to mix the MOPs we have collected to create specific expectations relevant to the given situation. After an input appears, we must determine which MOPs it relates to and how that input should affect those MOPs. Every input has the potential for changing the MOPs active in processing it if an expectation violation is detected.

The last set of MOPs active in this story are personal:

<table>
<thead>
<tr>
<th>MOPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>mM-CAREER</td>
</tr>
<tr>
<td>mM-PERSONAL RELATIONS</td>
</tr>
</tbody>
</table>

Here we have a view of some of the personal MOPs a diplomat might have. Ignoring most of the details, the point I wish to emphasize is that many different MOPs are potentially active at any given point. Which