Repertory Actors' Memory for their Parts

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Most theories about how people perform everyday tasks and skills assume that knowledge is organized in memory so that related information can be activated or selectively retrieved as large structures. Entire constellations of knowledge (e.g., scripts or frames) are thought to be primed or activated in much the same way that words are primed by semantic associates. The idea that our memories are organized into large structures seems in agreement with our everyday experience. We have all experienced how memories suddenly rush into consciousness after brief encounters with once familiar material, like old lecture notes. Although there is no complete agreement on how memory is organized, it is generally agreed that many skills (e.g., chess, Chase & Simon, 1973) and language comprehension (e.g., Schank, 1982) require rapid access to very large amounts of information that has been previously acquired over periods of months or even years. Most laboratory studies of memory, however, look at memory for small amounts of material following brief learning episodes.

After speaking to several actors, it occurred to us that actors' memory for their parts provides an opportunity to study retrieval from large memory structures. Much of the information learned for parts is exactly specified by the scripts the actors studied. And it was evident from the performances that the actors gave on stage that they had learned their scripts very well. By knowing the content of a part, we could test the accessibility of information we knew the actors' had in memory.

Actors in repertory companies, must often remember parts from different plays and perform them during the same period of time. It is tempting to think that an actor's memory for different parts form distinct and very large memory structures. When an actor performs different roles, it is vital that the parts are remembered so that there are no confusions among them. Actors report to us that when they perform a particular role other roles in their repertory are completely blocked out, or, at least, not consciously accessed. In this sense, several parts in memory may be thought of as disassociated from one another.

The size of a memory structure corresponding to a part would have to be very large. To perform a major role, an actor must remember hundreds, even thousands of words spoken by his or her character. After studying and rehearsing a part, the actor must know what movements, gestures, and intonations of voice are to accompany almost every word spoken on stage. These details about the meaning and subtle nuances of performance are enacted in a very stereotyped way from one performance to the next, implying that these details are very well learned. Figure 1 represents schematically some of the information from an actor's part. Notice that the actor may represent information about his or her character or a scene somewhat apart from the actual wording of the part. Other information about specific gestures or emotions may be more directly encoded with the actual words spoken on stage.

It is not clear what information in memory actors must rely on to recall their parts. An actor may first have to recall what a speech is about, and then the meaning of the individual sentences in order to recall the exact words spoken on stage. In an extreme case, memory for a part might be context dependent (Godden & Baddeley, 1975) so that to recall the part efficiently the actor would have to be on stage interacting with other characters. Alternatively, actors might depend on a process of successive scanning (Rubin, 1977) where words or phrases would be cued by the words or phrases just uttered. In this case, the words would simply follow one another in much the same way that letters seem to automatically follow one another when we recite the alphabet. Notice that these different retrieval processes require that the actor be aware of differing amounts of information represented in

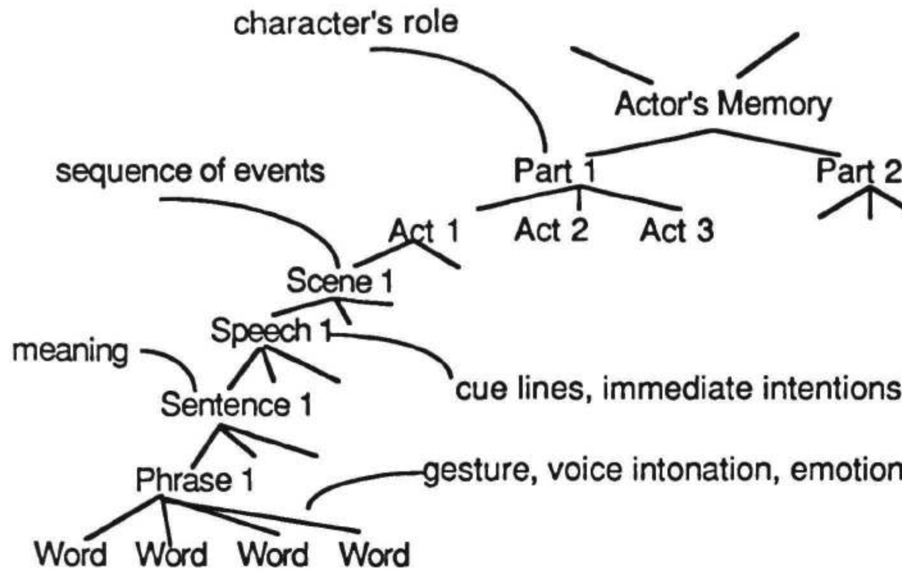

FIGURE 1. HYPOTHETICAL REPRESENTATION OF A PART

Figure 1 when he or she is recalling the verbatim wording of a part.

The subjects who participated in the present experiments were recruited from a local Shakespeare Festival held each summer in Boulder, CO. All of the subjects have received academic training and have considerable acting experience. We specifically recruited actors who either had very large parts (3000 or more words) or several reasonably large roles (1000 or more words). Before the experiments, we checked how accurately the actors could recite their parts from memory. We have found that the actors' memory of their parts is very exact, with only a very few words emended or substituted.

EXPERIMENT 1--DIRECT ACCESSIBILITY

The experiments we report in this paper used cued recall tasks to find out what information actors rely on to access the wording of their parts. We were surprised to find in our early studies that actors could respond correctly to probes consisting of only a few words taken at random from their parts (Oliver & Ericsson, 1984). These probes were so brief that they could provide little context or meaningful information for the subjects as retrieval cues. We will briefly describe a representative experiment in which the number of words in the memory probes was systematically manipulated.

Three actors participated in the experiment, each currently performing a large role. Equal numbers of one-, two- and four-word probes that occurred only once in the actors' parts were selected. The same line of text was never sampled more than once. An additional constraint required that no intervening punctuation appeared between any of the probe words or between the final word of the probe and the next word in the text, which served as the target word. Examples of some of these probes that were responded to correctly are shown in Table 1.

Probes were presented to subjects on a video display connected to a computer. The subjects were to respond out loud with the appropriate words from their parts as quickly as possible when the probes appeared on the screen. The elapsed times between the appearance of the probes and the voice responses were timed with a voice-actuated switch. On half of the trials the subjects were asked to report what they remembered thinking prior to responding to the probe. Unfortunately, we will not be able to discuss the analyses of these verbal reports in this brief paper. The subjects were given a maximum of 15 seconds to respond at which time the display went away and, depending on the condition, the subjects either gave verbal reports or quietly waited for the following probes.

TABLE 1. EXAMPLES OF PROBES FROM EXPERIMENT 1

born
for scaled
part of this anatomy

We found that longer probes were retrieved more successfully within 15 seconds than shorter probes, $F(2,360)=16.85$, $p<.001$. The one-, two-, and four-word probes were accurately retrieved .77, .91, and .99 per cent of the time respectively. There was also an effect of probe length on log-transformed reaction time, $F(2,276)=9.60$, $p<.001$, with the one-, two- and four-word probes being retrieved in 2.18, 1.93 and 1.67 seconds respectively.

These results indicate that very minimal cues can be used by actors to directly access their lines for many of the probes. Because the responses are extremely rapid, it is unlikely that large amounts of the parts are scanned, unless one assumes scanning times much faster than the usual scanning rates of approximately 38 milliseconds per item observed in Short Term Memory experiments (Sternberg, 1966). This direct accessibility came as something of a surprise to the actors themselves, as many of them claimed before the experiments that they would be unable to do the task. The additional words in the probes facilated performance by either providing additional surface structure or additional meaning to the subjects. It is important to reiterate, however, that the amount of information provided by a four word probe is minimal and that the probe could convey to the subject only fragmentary information about the speech it came from. Thus, the actors clearly need not depend on a context-dependent retrieval process.

EXPERIMENT 2--HIERARCHICAL ORGANIZATION

An actor's part is organized in way that would be expected to influence how it is represented in memory. A part itself is a unit distinct from other parts and is subsumed by the role the actor plays. The part is divided into acts and scenes, the scenes into speeches, the speeches into sentences, the sentences into phrases, and the phrases into words. This organization is shown schematically in Figure 1. Using the probe latency task, we have obtained evidence for the hierarchical organization of a part in memory. We will describe an experiment that extends some of our previous findings (Oliver & Ericsson, 1984).

All probes used in the experiment were four words in length and were drawn from the largest roles performed by the subjects. For half of the probes the subjects were to retrieve the words from their parts that immediately preceded the probes and for the other half they were to retrieve words that immediately followed the probes. Underlined blank spaces preceding or following the probes indicated to the subjects which words from their parts were to be retrieved. The first grouping of probes were all adjacent to sentence boundaries (demarcated by periods, question marks, and exclamation points) in the actors' parts. Sentence boundaries were selected randomly without replacement so that no more than one probe was ever associated with the same sentence boundary. Equal numbers of probes were selected such that they either immediately preceded or followed sentence boundaries or they were shifted one word to the left or right of the sentence boundary. For the second grouping of probes, equal numbers of four-word strings were sampled from the beginning and ends of speeches. When the probes began speeches, the subjects were to retrieve the last word of their immediately preceding speech; and, likewise, when the probes ended speeches, the subjects were to retrieve the first word of the speech that immediately followed. Figure 2 illustrates the various probe types. The probes were presented in a random order and the subjects were asked on half of the trials to give retrospective verbal reports.

It is clear from the examples given in Figure 2 that well-formedness of the probes differs systematically among the conditions. We expected that responding to well-formed probes in the forward direction (Forward-Within 1) would be the fastest condition and that retrieving backwards across

Forward-Across:
......then he was when you sought him. **I** am........

Forward-Within 1:
Do thou but close **our** hands with holy...

Forward-Within 2:
My dreams presage some joyful news at **hand**.

Backward-Across:
......think it were not **night**. See how she leans her......

Backward-Within 1:
Show me a mistress that is passing fair.....

Backward-Within 2:
......and in **that** sparing makes huge waste.

Forward-Across Speeches:
......to rejoice in splendour of mine own. [speeches by others] **Give** me a.....

Backward-Across Speeches:
...ground I cannot **move**. [speeches by others] I am too sore enpierced......

FIGURE 2: EXAMPLES OF PROBES IN EXPERIMENT 2. THE PROBES ARE UNDERLINED; THE TARGET WORDS ARE IN BOLD LETTERING .

sentence boundaries (Backward-Across) would take much longer. Retrieval of the less well-formed units within sentences would fall somewhere in between, depending to some extent on whether retrieval was in the forward or the backward direction. Finally, we expected that subjects would be relatively slow at retrieving across speech boundaries. The experimental procedure was the same as in the earlier experiment.

The actors retrieved the correct responses 91 percent of the time. Due to a ceiling effect, analysis of accuracy is not particularly revealing. Analyses of reaction times, on the other hand, show clear differences between the boundary conditions, $F(7,206)=39.93$, $p<.001$. The mean reaction times for the different conditions are shown in Figure 3. Retrieving across sentence boundaries (Forward-Across and Backward-Across) was slower than any of the Within conditions. The reaction times for the different Within conditions did not greatly differ from one another. Crossing speech boundaries, particularly backwards, required a fair amount of time. It is interesting to note, however, that jumping to the first word of the following speeches took approximately the same amount of time as to go backwards across sentence boundaries to immediately adjacent words.

The relatively long times required by the subjects to cross speech and sentence boundaries indicates that processes beyond direct retrieval processes are sometimes required to retrieve words adjacent to the probes. Words within the same sentences can be retrieved quickly suggesting that they are encoded as part of the same unit that can be directly retrieved. These findings can be accounted for by assuming that the verbatim memory representation of a part is segmented into sentences and speeches. Sentences may in turn be segmented into phrase units or chunks, though additional findings or ours indicates that boundaries within sentences are not easy to identify. When the subject must retrieve a word from a chunk that is adjacent to the one the probe falls in, he or she must first retrieve the adjacent chunk and then unpack it. When normally reciting a part, associations between chunks, presumably in part mediated by meaning, permit orderly retrieval of the lines. Retrieval of the

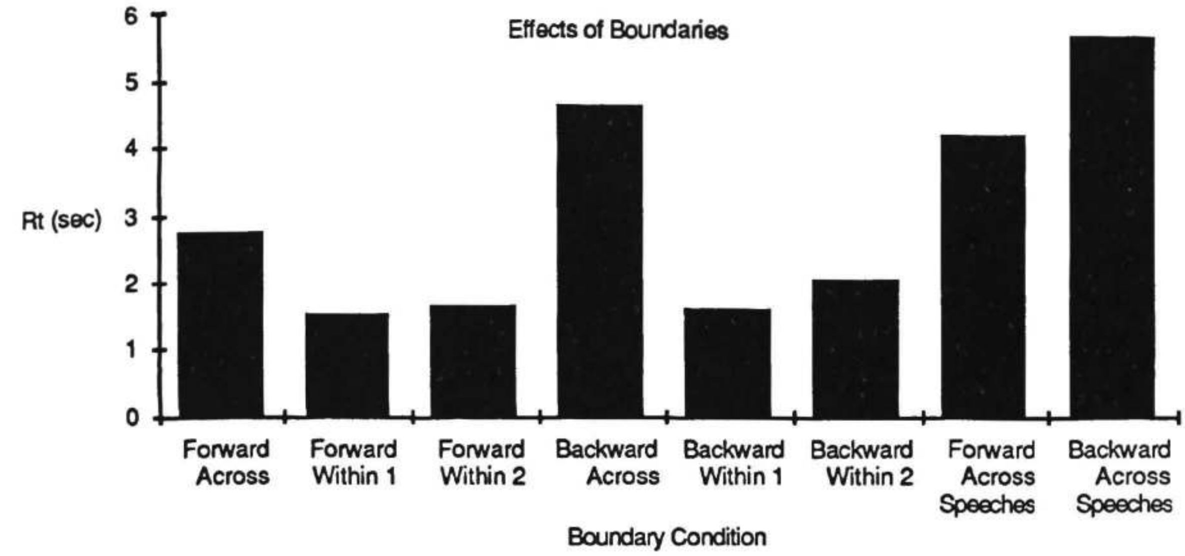

FIGURE 3. MEAN RETRIEVAL TIME AS A FUNCTION OF BOUNDARY CONDITION

beginnings of speeches, however, sometimes requires accessing organizing information in memory, such as cue lines spoken by other actors, action and positioning on stage, and so on. Thus, the hierarchical organization of the part shown in Figure 1 has clear consequences on retrieval, provided that the task requires that the subject make use of this organization, as, for instance, when jumping to the next sentence or speech. However, it appears that several words can cue recall of individual phrase units without mediation of other information in the hierarchy. The results from the present experiment also suggest that sequential scanning for information in parts must be a slow and effortful process because time-consuming retrieval processes are required to cross sentence and speech boundaries.

EXPERIMENT 3--INTERFERENCE BETWEEN PARTS

Thus far we have shown that actors can directly access very local, verbatim representations, i.e., phrases or sentences, of a single part on the basis of minimal cues. A natural extension to this line of research would be to look at retrieval of verbatim wording from more than one part in memory. In the first two experiments, subjects always knew what part the probes were drawn from, and thus could focus their search. By repeatedly retrieving from the same part, the memory for the part may have been activated or primed. The next three experiments that we will describe sought chronometric data to support our expectation that thematically organized information--in this case, parts and scenes-- might form memory structures that could be selectively searched or activated.

If a part forms a structure that can be strongly focused upon when it is searched in memory, there should be little interference from other parts in memory. Thus, when subjects know which part a probe comes from other instances of the same probe in a different memorized part should not interfere with retrieval. Lack of interference of this kind has been taken as evidence for separate memory structures consisting of thematically related concepts (e.g., Myers, O'Brien, Balota & Toyofuku, 1984) and entire lexicons of bilinguals (e.g., Scarborough, Gerard & Cortese, 1984).

Three actors were recruited for the present experiment who were performing two roles of comparable size in two different plays. Unique words were identified among the combined text of the two parts. In addition, words were identified that occurred exactly once in each of the two parts

(Overlapped probes). Probes were constructed by presenting the name of the part, e.g., DESDEMONA, followed either by the selected word (One-Word probe) or the selected word along with the previous word in the part (Two-Word probe) in equal proportions. The probes were presented in a random order, and the name of the part was presented to the subjects for three seconds before the memory probes appeared. The subjects were instructed to say out loud the words in their parts that immediately followed the probes. We chose to include two-word probes in the design because we were interested in whether two-word cues would form holistic cues that could be easily retrieved despite other occurrences of its constituent words elsewhere in the actors' parts.

The subjects were far less successful at retrieving the Overlapped probes (41%) than they were at retrieving Unique probes (74%), $F(1,82)=9.95$, $p < .005$. There were no main effects or interactions involving the number of words in the probes. Analyses of the response times yielded no reliable effects, perhaps because so few of the probes were retrieved resulting in reduced statistical power. The poor accessibility of the Overlapped probes strongly suggests that the part-information is not useful for retrieval in this task and that the principal cues for retrieval are the words.

EXPERIMENT 4--PART PRECUING

While it appears that actors may not always be able to restrict their search to a single part if instructed to, it is still unclear what role global information plays in the retrieval process. It was possible that telling the subject which part was to be retrieved from reduced, though did not eliminate, interference and that responding was generally facilitated. Global information was manipulated in the present experiment by precuing subjects with the name of the part they were to retrieve from on some trials, and telling them to retrieve from either of two parts on other trials.

The three subjects who participated in the previous experiment and an additional subject participated in the present experiment. From each actor's scripts equal numbers of unique words were selected from each part. Two-word probes were constructed by adding the subsequent words from their parts for half of these selected words. Subjects were shown the name of the part, e.g., VIOLA, or the word EITHER, followed by a one-word or two-word probe. On one half of the trials the part name preceded the probes, and on the other half of the trials the word EITHER preceded the probes. The subjects' task was to respond out loud with the words from their parts that followed the probes.

Probability of recall within fifteen seconds differed only as a function of number of words in the probe, $F(1,272)=18.41$, $p<.001$. The percentage of correctly recalled words were 62% and 86% for the one- and two- word probes respectively. The analysis of the log-transformed reaction times for correct retrievals showed a reliable difference for probe length, $F(1,202)=15.56$, $p<.001$, and the availability of part information, $F(1,202)=6.23$, $p<.05$, but no interaction between probe length and availability of part information. The average response time for the experiment was 2.37 seconds. Providing the part name facilitated response speed by .40 seconds; and providing an additional word to the one-word probes facilitated response speed by .35 seconds. In sum, adding an extra word to the one-word probes both reduced retrieval time and increased the probability of retrieval, whereas providing information about which of the two parts is to be probed only facilitated response speed.

EXPERIMENT 5--SCENE PRECUING

Because the precuing effect found in the previous experiment was relatively small, it is difficult to argue that part-information is important to the retrieval process. Part names may not be very effective cues because a part's representation in memory is too informationally dense (Hayes-Roth, 1977) or complex. Entire parts may simply encompass too many other units, such as speeches and scenes, to be activated as wholes. Scenes, however, may provide units that are better integrated. Reference to a scene might cue memory for constellations of events and emotions that could be held in mind and used as retrieval cues in a way that reference to an entire part could not.

In the present experiment three subjects were told on one quarter of the trials which of two scenes of a part the probe came from (Precue-Unique probes), and on a quarter of the trials they were only told that it could come from either of two scenes (Either-Unique probes). Each probe appeared only once in the entire part. On the remaining one half of the trials, probes were presented that appeared once in a specified scene and once elsewhere in the part (Overlapped probes). Unlike previous experiments, only single words were used as probes. The subjects were always told which scene they were to focus on for these probes. Verbal protocols, as in the first two experiments, were collected on half of the trials. By having three types of probes we sought within the same experiment to see whether scene precuing could both facilitate retrieval and prevent interference.

The probability of successful recall within fifteen seconds did not greatly differ between the Precue-Unique probes (80%) and the Either-Unique probes (78%); however, the Precue-Overlapped probes (56%) were retrieved significantly less often, $F(2, 177)=587$, $p<.005$. An analysis of the log-transformed reaction times showed a similar pattern of results. The average response times for correct retrievals were 3.10, 2.97 and 3.85 seconds for the Precue-Unique, Either-Unique and Precue-Overlap conditions respectively, $F(2,121)=4.38$, $p<.05$. These results indicate that providing scene information did not significantly facilitate retrieval or prevent interference during the retrieval process.

CONCLUSION

The results from the last three experiments we have described taken together suggest that search cannot be focused at will upon a part or scene. The subjects were unable to search their memory for words from a part or scene without associative interference from another part or scene they had memorized. And, information specifying which part or scene was to be probed did not greatly facilitate retrieval. The small facilitation of part precuing on speed of retrieval stands as the single piece of evidence that parts can be separately activated. Further research is called for to better understand the conditions under which the effects of precuing are obtained.

Perhaps the most striking finding from the present study is that in relatively brief periods of time actors learn their parts so that they are directly accessible to minimal cues. A large body of information is simultaneously accessible and attention can be rather diffusely focused on several parts at once without seriously affecting retrieval. This finding is all the more surprising considering that the actors did not learn their parts with the aim of having direct access to individual phrase units.

The present study has focused on the accessibility of the verbatim wording of parts. As we pointed out, information about the plays' events, the characters' emotions, the meaning of all the lines, and so on, are also represented in the actors' memories. In other domains, the representation of knowledge is similarly complex, particularly in those domains where the expert must learn both rote knowledge for procedures and facts as well as knowledge that is used to understand problems. Thus, there may be interesting similarities between actors and experts, such as scientists, in how knowledge of a domain is represented and accessed in memory. We suspect that learning a huge body of directly accessible knowledge plays an important role in acquiring many skills. We should point out that learning this knowledge base may be much more difficult in many domains than it is for actors to learn their scripts for several reasons. First, experts must be concerned with what is worth learning and must invest much of their energies sifting through irrelevant facts. Second, the scripts actors learn do not differ from one study episode to the next, whereas the knowledge an expert must learn is less easily specified and must be learned in bits and pieces over a long period of time.

There are many obvious questions our study raises that we are not now in a position to answer. It is interesting to ask, for instance, whether models of memory can account for our findings. A number of current memory models are able to account for direct accessibility to large amounts of knowledge (e.g., Anderson, 1983; Eich, 1985; Raaijmaker & Shiffrin, 1980). It will be particularly interesting to look at issues of acquisition within the frameworks of these models. Other questions also concern acquisition: What amount of effort is required to learn a part so that it is directly accessible? How many parts can be simultaneously accessible? Yet other questions concern forgetting or maintenance of knowledge: Does memory for parts fade away like memory for isolated facts tend to fade away, or do parts fade from memory more or less as a wholes? At what point does an actor forget enough about a part so that it is no longer directly accessible? What amount of practice is required to maintain a part in an accessible state? And finally, there are many questions about how meaning and affect are represented in actors' memory.

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