I'm going to talk about memory from the perspective of a psychologist. In considering how to get started, I originally thought I might enumerate some of the uses of our memory. But that quickly proved an unending task since I couldn't think of many mental activities that couldn't be said to rely on our learning and memory.

Perhaps a good way to highlight the importance of memory is to ask you to try to imagine what your mental life would be like if you had no memory at all, if you had complete amnesia for everything. What would that be like? Basically, you would become a vegetable, with a few simple inborn reflexes. You would live on the thin edge of the present moment, unable to look back because you would have no sense of the past, nor would you have any conception of the future. You couldn't get around in the world, would never distinguish friend from foe. Of course, there would be no reason for going to school or lectures. You would lose your past and with it your personality. You would lose your sense of personal identity—you would lose that unique past that gives you a sense of continuity, definition, and coherent individuality.

Though it is exceedingly rare to find someone with complete amnesia for their past, a more common form is someone who has lost the ability to learn new things. This occurs with certain brain injuries. The nature of the problem is shown schematically in the first slide. The patient can remember his life up to about the time of his injury, but the events since then are totally missing from his
memory. For instance, one of my acquaintances, Wayne Wickelgren, interviewed a young soldier who'd suffered such a brain injury; the soldier could carry on an apparently normal conversation except he was unable to remember anything from a few seconds before. When Wickelgren first introduced himself, the soldier said "Wickelgren, that's a German name, isn't it?" No. "Is it Irish?" No. "Scandinavian?" "Yes, it's Scandinavian." After a five minute conversation, Wayne left to go next door to get some equipment. When he returned a few minutes later, the soldier said "Who are you?" and acted as though he'd never seen Wayne before. Wayne introduced himself again, whereupon the soldier said: "Wickelgren, that's a German name, isn't it?" No. "Irish?" No. "Scandinavian?" Yes. Exactly the same sequence as before. Wayne tried to carry out some memory experiments with the soldier but he couldn't remember the instructions long enough. When asked "Are you ready to start?", he would say "Ready to start what? Did you want me to do something?"

For patients such as this, time stopped when their brain injury occurred. Everyday is like a fresh, new first day after the accident: they seem unable to learn where they are, who their doctors are, what has happened since their brain injury. Events since then have simply been dropped into an abyss. They live on the thin edge of the present, and their life is a bland, senseless tragedy.

(SLIDE OFF)

I think that gives you some appreciation for the role of memory in your mental life. I'm going to talk to you about memory from two different perspectives—I'll be telling you some facts about memory considered just as a scientific puzzle or object for analysis; this is for the scientists among you, and I'll also be talking about practical ways to improve your memory.
The first slide lists the basic 8 topics I intend to cover. First, I will briefly mention what I mean by memory, what its uses are, and mention how it's studied in the experimental laboratory. Second, I will talk about the two different memory systems we all have, called short-term and long-term memory. Third, I'll discuss how information to be remembered is transferred from short-to long-term memory. In that context, I will bring up my fourth point concerning how our memory develops from childhood onwards, and how this memorizing process can go wrong—the pathology of memory. Fifth, I will discuss several memorization techniques designed to help students remember more in a short time, including appointment schedules, shopping lists, lists of facts, foreign language vocabulary, and names with faces. Sixth, I will talk about what people remember from language inputs, what they get from the spoken or written word. This is of central concern since so very much of our formal learning comes about through hearing or reading language. Seventh, I'll answer a few common questions about forgetting; and eighth, I'll discuss some distortions or illusions of memory that arise in eyewitnesses to crimes, particularly the role of leading questions, and how these distortions can be magnified as a story is recalled by person after person when a rumor spreads through a community. This will take me about 80 minutes, so you should set your internal clock for that finishing time. (SLIDE OFF)

To get started with some basics, let's consider how psychologists study memory and what are the major phases they identify in a learning episode. As with most scientific endeavors, in order to analyze memory in the experimental laboratory, we try to strip away the many complexities of everyday life, so we simplify matters and study the learning and retention of simple events such as presentation of an unfamiliar picture, a letter series, a number series, or perhaps a simple sentence or simple story. The complexities at even such an elementary level compel us to
simplify our experiments in order to control things that we know are important to the results.

The next SLIDE shows a flow chart describing the important happenings within a study trial of a memory experiment. It also shows the theoretical terms that we use to talk about the various parts. Beginning with a prior assessment or presumption about a subject's state of knowledge or ignorance, we then present some selected event X, which results in perception, or what I've called registration and "trace formation." We then have a retention interval during which other events may occur, and we end sometime later with a memory test during which we present some kinds of retrieval cues which hopefully will cause the person to remember or utilize the trace of event X. The memory trace is whatever is the internal representation of the specific information stored at the time of presentation of the event. It is not observed directly but is rather an inferred construct we use to rationalize how an input event can operate over time to cause a particular set of performances at some later time.

The performance one observes depends, of course, on what question is put to the subject at the time of retrieval. The input might be my telling you a factual proposition, for instance, that the population of Austin is about 250 thousand people. I might ask you later to repeat that, or tell me the sum of the 3 digits or tell me what color ink the sentence was printed in; or, knowing that about one-fifth the population of Austin are Mexican-Americans, to tell me approximately how many Mexican-Americans live in Austin. Because of that tremendous computer in your head you'll of course give entirely different answers in these several cases—-but they all depend upon your remembering the physical event of my presenting you with that fact.
EVENTS

0. Assess Ignorance

1. Present Event X

2. Experience of X

\[ \downarrow \]

\( n \). "Altered" State of Knowledge

\( n+1 \). Retrieval Cues (Test)

\( n+2 \). Answer/Response

TERM

"Pretest"

\( \{ \)

Registration +

Trace Formation

\( \} \)

Trace Retention

\( \} \)

Trace Retrieval

\[ \} \]

FIG. 2
So to summarize here, the three phases of memory are registration, trace retention, and trace retrieval or utilization. Successful remembering requires that all three processes run off successfully, and failure or loss at any stage will result in failure in performance. Psychologists have researched a number of factors that influence one or another of the 3 stages.

I've just illustrated how psychologists study memory in the laboratory. I'll now begin laying out more detail on this business of registration and trace formation. So, to begin with my second topic, the memory system appears to be divided into two components—a short-term and a long-term memory. Short-term memory is thought of as the current contents of your awareness to which you have immediate access, whereas long-term memory refers to everything else in memory that typically can be retrieved only more slowly.

A typical flow diagram is shown in the next slide, which illustrates the stages during a learning episode. Beginning with presentation of some event which is to be learned, the person must attend to and observe it with some care; the more closely he observes it, the more information he'll be able to recall about the event. Most of the available information is lost at just this point, due to poor observation. Many people will say they have poor memories when it would be more accurate to say they are poor observers. We are generally poor observers because we have become jaded and sophisticated; we readily categorize things in our surroundings at only the superficial level needed to get by, but we avoid the extra work required to notice and build up a unique description of each thing around us. Thus, for example, you categorize the person sitting in front of you, say, as a young woman, and that's good enough for most purposes since you'd rather pay attention to other thoughts. But the casual classification
is not good enough if you're later asked to make an eye-witness identification of her. To take another familiar example, if you want to improve your ability to remember people's names, then the first step is to make a special effort to really attend carefully to the person's face and catch his name when you're being introduced. Without that, you don't have a fighting chance.

Continuing with our flow chart, the incoming stimulus is looked up in long term memory, the question being whether something is already known about it. That is, the brain tries to recognize, classify, or identify the event in terms of known patterns. For instance, if we see a series of letters we automatically first look-up in our memory whether we've already learned these as a word. That is, the brain tries to "attach meaning" to what it's seeing.

The ease of learning something depends, of course, on whether it falls into a familiar pattern. To illustrate, suppose that I were the victim of a hit-and-run driver, and as I lay stunned by the curbside I want to memorize the license plate of that fast-receding maniac. If it were XVN796, as shown in the next slide, I would have no meaningful associations to those, so the only thing I could do is to merely code the license in terms of the names of the letters and digits and rehearse the names as I lapse into unconsciousness. The sound of each letter would then be a kind of translation or "code" for the visual letter. This kind of sight-to-sound translation of verbal materials often occurs in short-term memory, and it shows up in the substitutions, confusion errors, and mistakes people make in remembering. The mistakes from short-term memory are typically items that sound like the correct ones. X might be misremembered as F or S, V as B or T, N as M.

With names of people, we will mistakenly recall Mr. Morgan as Mr. Organ, Rosenfield as Rosenfield, Miss Wall as Miss Wald, and so on. Supposing on the other hand that the license plate were GH8750: that is a 3-letter combination I know (my initials) and a number I know (it's my house address), so learning that license will be very
easy for me since I merely have to connect up two familiar units rather than six. The idea here is depicted in the next slide which shows the chunking of the series into two units.

The point of this last illustration is that the perceptual system first segments the incoming stimulus into the largest familiar subparts or chunks that it can, and then treats these large chunks as units that are entered into short-term memory. So in the first case there are 6 chunks, which creates difficulties because it overloads the capacity of short-term memory, whereas in the easy case there are only 2 chunks which are easily accommodated. Now, the capacity of short-term memory appears to be limited to about 5 to 7 chunks, although the size of the chunks seems to be relatively unimportant. To illustrate, after one presentation you can recall in order about 7 chunks and that is true whether the chunks are binary digits, decimal digits, letters, one-syllable words, two-syllable words, or well-known phrases like "ice cream cone" or "grandfather clock," etc. The physical size of the vocabulary from which the symbols are drawn seems unimportant: simply the number of chunks is critical in immediate memory.

Now, this chunking is one of the automatic strategies the brain uses in trying to store incoming information. It tries to understand the incoming pattern in terms of simple rearrangements or footnotes to familiar patterns. To illustrate the power of such understanding versus blind rote learning, suppose that you had to quickly learn the two series written on the next slide.

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>M</th>
<th>I</th>
<th>T</th>
<th>A</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>816</td>
<td>44</td>
<td>93</td>
<td>62</td>
<td>51</td>
<td>69</td>
</tr>
<tr>
<td>19</td>
<td>41</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

These seem like utter nonsense and would be hard to learn. But they have been made hard by deliberately camouflaging the known chunks, by misleading segmentation. Thus, Series #1, is just a poorly segmented series of the familiar abbreviations...
IBM, FBI, TWA, and JFK. Series 2, when put into pairs, is seen to be $9^2$ then $8^2$ then $7^2$ and so on. Such a reorganization makes the nonsense understandable and highlights the importance during memorization of trying to relate the input to known material. (SLIDE OFF)

To return to our flow chart describing formation of the memory trace, it is supposed that the internal codes of the material will reside in STM only temporarily, for several seconds, because we must soon attend to and deal with new happenings. For example, at a party, we get introduced to a second and then a third person before we've had time to totally learn the first person's name. In entering this new material into short-term memory, we seem to bump out or lose the earlier material. So, it is of utmost importance while material is in immediate memory that we transfer as much of that information as we can to long-term memory. Failing to do so, we will lose or forget it within a matter of seconds, almost as soon as it goes out of our conscious awareness. So, the motto while learning is: Make hay while the sun shines. Get it while you can, cause it'll soon all be gone!

So, this business of transferring information to long-term memory is critically important, and many of the differences in memory between people occur at this point. For example, the brain-injured patients I mentioned earlier seem to have their problem at just this point of transfer: their short-term memory is okay and they can also retrieve facts about their lives from long ago, but where they fall down is in placing new facts into long-term memory.

Most of the facts we store in long-term memory are simply an incidental consequence of our observing events and understanding enough of what's going on to respond appropriately. For instance, we don't deliberately try to memorize what we're eating at dinner, yet simply because we spend a certain amount of time attending to it, we can recall for the next day or so what we ate. That is, we
learn many things incidentally, without trying. Of course, we also fail to remember a tremendous amount of the things that we notice or use only incidently in passing. For instance, all of you have used the dial telephone hundreds of times but I'll bet that very few of you could tell me what letters correspond to which numbered holes in the telephone dial. With all-digit dialing, the letters have become strictly irrelevant and we hardly even notice they are there. Moreover, it seems like just an arbitrary assignment of letters to numbers, with no rhyme or reason, therefore, it is never learned at all.

Now, when people intend to memorize something, they call upon some kind of memorization strategy which they apply to the material to be learned. This is like selecting a method to help solve a problem, namely, the problem of preparing for a later recall test. It takes a certain maturity to anticipate and prepare for the future, and very young children, 3 to 4 years old, seem unable to do this. I'll talk now about my fourth topic, how children's memory develops. Kids 3 to 4 years old seem not to understand the difference between an instruction to "look at these animal pictures" versus an instruction to "memorize these animal pictures for a later recall"; no matter how you word the instructions, such little kids don't seem to act differently when told "look at these" versus "learn these." With repeated experience at remembering, of course, they gradually get the idea that "memorize these animal pictures" means "do something now that will enable you to reproduce the names of the animals later in the absence of the pictures."

The things to be done will be called memorizing strategies; these develop slowly as children mature; the strategies become quite varied and elaborate as they grow into adult learners. The next slide lists some methods children use, say, to memorize a small collection of object-pictures such as animals, foods, toys, and people. We would see the following methods: first, they simply stare at each
picture as long as they can; second, they say a single name over and over; third, they may say the names of the series of pictures in repetitive sequence; fourth, they may classify and rearrange the objects into classes, such as collections of animal pictures, food pictures, and toys. These maneuvers improve the child's recall of the series. As he matures, he's more likely to use some learning strategy rather than none, and the one he uses is more likely to be more powerful and efficient. This seems to underlay some of the improvement in memory ability as a child grows up. The use of memory methods also seems to be the advantage normal kids have over mentally-retarded kids when they are compared on simple learning tasks. The retarded kids act like normals who have only primitive learning methods at their command. If the retarded kids are taught more powerful memorizing methods, their learning of simple tasks improves considerably so they about equal the normal kids.

The other memory ability that undergoes development is self-testing as a check on one's knowledge. Little kids seem to have relatively inaccurate knowledge about the power of their memory. For example, they give you gross over-estimates of how much they think they can memorize in a brief sitting. Like they'll predict that they'll be able to remember a series of 12 pictures whereas in fact they can do only 3 or 4 without errors. Also they can't tell when they've studied something long enough to be able to reproduce it from memory. For example, you tell a 4 year old to study a series of six objects until he's sure he can recall them to you in correct order. He'll name them quickly—"That's a dog, a car, a chair, an apple, a ball, and a frog. Okay, I'm ready to go!" Then the experimenter removes the pictures and says "Okay, what were they?" and the kid says "Duh, I forget." With maturation, the child learns to test himself, to look away from the pictures and try to say their names over to himself—he learns
how to check the correspondence between his recall and the objective series, how to correct his recall, so he comes to discriminate when he knows the material well enough to stop studying. This ability to monitor our memory develops to a high degree in adults, so that we know when we know something. In fact, we can be quite accurate in judging that we know something even though we cannot at that moment recall it. (SLIDE OFF)

Having pointed to the role of memorizing methods in the development of a child's memory, let us consider methods which adults either use or can be taught to increase their memory over and above simply staring at the items to be memorized.

As noted before, the earliest and most primitive memory strategy is rote rehearsal, saying or thinking the names of the items over and over in sequence. This is an all-purpose strategy for memorizing any material that is easily named. Although it is all-purpose, it does not produce very rapid learning. So, let me introduce you to a few memorizing techniques that are more successful. These techniques are called "mnemonic devices"—they are procedures that mentally elaborate on the material to be learned, investing it with more meaning, so that it can be more readily learned. As you might expect, the kind of elaboration that works best depends somewhat on the material you have to learn.

First, let us consider how to learn meaningless material such as letter sequences like car licenses, if one is forced to do so. With letter sequences the standard trick is to convert the sequence to a meaningful word or phrase. You insert other letters so as to make up a real word. For example, the license plate on one of my cars has the letters FSH, which of course I remember as "FISH with the I missing." My other car has a license beginning CNN can be converted to the sound-alike word canoe or to the phrase "the Car Never Used." It is then easy to remember that my one car is a fish and my other a canoe!
Now, what about numbers such as historical dates, telephone numbers, addresses, populations, social security numbers and so on? The trick here is to first break-up a long number into a series of two or three digit numbers, and then use a digit-to-letter dictionary to convert each number to a letter. You then make a meaningful word out of the letters. To do this, you first have to learn a digit-to-consonant letter conversion table. A table frequently used is shown in the next slide.

- 1 = t or d  
- 2 = n  
- 3 = m  
- 4 = r  
- 5 = L  
- 6 = j, ch, sh  
- 7 = K or C  
- 8 = F or V  
- 9 = P or B  
- 0 = Z, S

The way to use the conversion is illustrated in the next slide. Thus, apartment #32 of my friend converts to MN while the phone extension of a colleague, 8741, converts to VCRD.

The second rule of the system is that any silent letters and vowels may be freely inserted as needed in order to make up a word from the consonants. Thus, 32 of mn can be converted to MAN or MOON so I remember that my friend lives on the moon, while 8741, converted to VCRD, can go to VICE RAID, which I can easily associate to this rogue.

When you want to recall the number, you just bring back the meaningful code words, pick out the consonants, and then convert them back into the number using the dictionary.

Now, it takes some practice to become adept at these conversions; it is an elementary skill which requires practice like any other skill. And you might wonder whether it's worth all the effort. But the answer for some people is a definite Yes. It clearly pays off in case you have to remember a lot of numbers;
the little extra time spent in learning the number is well repaid by the time it saves from looking up a lot of numbers when we need them.

So to summarize here, the strategy for memorizing meaningless materials like letter strings or numbers is to adopt a simple rule for converting them into meaningful words, and then to learn these code words, perhaps through visualization.

Now, let's consider some methods for learning difficult associations between two items. One such problem arises in learning foreign languages.

Learning vocabulary is more than half the battle in mastering a foreign language. In recent research, mnemonic devices have been used to improve vocabulary learning in college students learning German, Spanish, and Russian. The basic idea is to find a linking English word that sounds like the foreign word, and which is then to be associated through imagery to the translated meaning of the foreign word. This linking word is called the "keyword", and some examples from Spanish are shown in the next slide. At the top is a mnemonic for the Spanish word caballo (coh-eye-yo) which means horse. The keyword is EYE which is contained in the sound of caballo, and the picture links eye to horse by showing the horse kicking a giant eye. At the bottom, the Spanish word pato ("pot-o") means duck; the keyword is pot and the linking image is of a duck with a pot on its head. The teacher displays the word and pronounces it at the same time as he relays the keyword and translation. In some experiments, a mnemonic picture is shown for each pair; in others, the subject is told to make up his own mental image to associate the words. The criterion always is the ability of the students to recall the English translation when they see and hear the Spanish word.

Using this method, you can usually almost double the amount you will recall after one exposure to a vocabulary list. Moreover, the learning advantage for
the method is retained over a long time. When you give a vocabulary test
six weeks after the learning sessions, the students learning with mnemonics
still retain about one and a half times as much as students who learn by what-
ever random methods they can stumble upon.

A number of questions have been researched about this method, and let
me quickly tell you a few facts about it. First, as you might suspect, there
are good and bad keywords—good ones have a sound that is quickly learned to
the foreign word, and good keywords are readily put in a striking image with
the translation. Second, students do better if they must actively generate their
own linking image from the keyword to the translation rather than having an image
suggested for them; on the other hand, learning is improved if the instruction
booklet suggests a good keyword rather than leaving this task to the student.
Third, if you learn your vocabulary only going in the Spanish-to-English direction
with the mnemonic, you are still better off than controls who learn to the same
degree when both of you try to produce the Spanish word corresponding to the
English word—that is, if I asked you what Spanish word means horse or what's
the Spanish word for duck. So, the mnemonic learning seems more able to be run
in the opposite, English-to-Spanish direction.

These laboratory experiments have been sufficiently promising that mnemonics
are now being field-tested in teaching some languages to students at Stanford.
They appear to be working out fairly well and their use will probably grow over
the years.

Consider now a second case of difficult association, namely, learning
people's names and associating them with their faces. This is difficult and
we all constantly fail at it. Let me give you a quick demonstration of name-
face learning. Here's some people I want you to remember (5 slides and names).
Now, the problem of remembering a name-face association seems to break down into three separate subproblems—remembering the face, the name, and the connection. These three phases are shown in the next slide. First, to remember the face, you should observe it carefully and then concentrate on some very distinctive feature of the face such as bushy eyebrows or a cleft chin. Pick out something you’re sure will attract your attention the next time you look at the face. Second, to remember the name, look for a meaning in it; if this fails, find a meaningful key-word that sounds like a part of the name. Finally, to remember the face-name association, try to imagine or visualize some kind of bizarre interaction or relation between the keyword and the feature of the face. Thus, if Mr. Clausen has bushy eyebrows, think of claws as a keyword for Clausen and imagine large lobster claws ripping out Mr. Clausen's bushy eyebrows. Let me show how this works with some more faces.

6 SLIDES AND MNEMONICS

You've now been exposed to several sets of new faces. Now check yourself silently to see what you've learned. Try to recall silently the name as I show each: who's this? (Pause. "That was Mr. X") [Do 6 times].

SLIDE OFF

You should have shown better recall for those faces for which I supplied a linking keyword and mnemonic. In laboratory experiments when we compare these two procedures in a controlled way, people remember about half again as many faces with the mnemonic as without it. Hopefully, that advantage would improve with practice at using the mnemonic. We also know that the facial feature, the keyword, and the name are all tightly inter-associated in the mnemonic condition. For instance, in one of our experiments, if the subject remembered the facial feature and the keyword, his likelihood of remembering the name was about 90%. The errors here were usually due to poor association of the keyword to the name.
However, if the subject forgot the keyword, his name recall was only 8%; if he forgot the facial feature, name recall was only 3%; if he forgot both feature and keyword, his name recall was absolutely zero. A rough summary of this is to say that if you remember the facial feature and the keyword, you're very likely to remember the name; but if you forget either the feature or the keyword, you'll almost certainly forget the name. So the mnemonic clearly produces an advantage for remembering names with faces. The problem is that it requires some training in the basic skill of converting any name to some memorable keyword. That seems to be the major hurdle in using the method.

Now let's consider some mnemonic devices that are useful for remembering arbitrary collections or lists of facts or items. One which may already be familiar to some of you is called the pegword method, and it is very useful whenever you have to remember many items in an arbitrary series. An example would be learning the items on a shopping list, or a list of errands or appointments. It could also be used to remember a series of historical events, the multiple causes of World War I, a group of laws in science, the cluster of symptoms for a particular medical disease, the plot of a novel, the people met at a party, and so on. What people need in remembering such lists is some efficient way of reminding themselves of all the various items. The pegword method supplies such a list of reminders.

You first learn a list of pegwords corresponding to the first 20 or so integers. The first ten we've used in our research are shown in the next slide.

One is a bun
Two is a shoe
Three is a tree
Four is a door
Five is a hive
Six is sticks
Seven is heaven
Eight is a gate
Nine is wine
Ten is a hen

This list is easy to learn because the pegwords rhyme with the corresponding numbers. These pegwords are used as mental hooks upon which to snag any new items that you want to memorize. This is done by pairing off successive items to be learned with the memory pegs, visualizing the two terms in some vivid, imaginary interaction. Suppose you had to remember a shopping list consisting of milk, matches, bananas, and bread as the first four items. You might thus compose an image of milk being poured over a soggy hamburger bun, then of a match stuck in the sole of a shoe giving someone a hotfoot, then clumps of bananas hanging from a tree, then a loaf of bread sticking like a dagger through a door. If you visualized these pairs for several seconds, they would stick in your memory. When you want to recall that list later, you go through your pegword list, and see what other object you had placed with that peg in your imagination.

The same kind of system works if the pegs are images of locations—say, places along a familiar route as you go through your house or walk through a campus; here one takes the objects to be learned and images them as being placed at successive locations. For example, if your series of memory locations is the successive places you visit as you get up and go through your day, then you might visualize the first item—the quart of milk—in your bed, the second item—the box of matches—in your bathroom sink, and so on through your list. To recall, one then strolls along his imaginary route, noting the objects that he has placed
at his various imaginary locations. This technique relies on our familiar
ability to let words alter our cognitive maps of the way things are laid out
in space—as when I tell you that the main road coming into campus has just
been blocked off. You know how to alter your internal map and re-route your-
self accordingly. (SLIDE OFF)

For example, suppose a bloodied man were to come staggering in here dying
and gasp out, "The administration has just built a moat around the front door of
this building and filled it with man-eating crocodiles." I think we would know
how to enter that information into our cognitive map and to re-route ourselves
accordingly.

Now, these pegword or location techniques produce a truly enormous boost
in memory. Their advantages are obvious: they prescribe how the person should
study each item, namely, learning by visualizing each item in interaction with
the corresponding peg; and the scheme provides a systematic retrieval plan,
telling the person where to begin recall and how to proceed to cue his recall
for each item in turn.

Another efficient way to learn a list of items is to relate each item
to the next one by weaving a narrative story that ties them all together in a
slightly crazy story. For example, to learn the list beginning milk, matches,
bananas, and bread, I would make up the story shown in the next slide. I
might imagine I am a milkman delivering milk to a kitchen when I see a small
child inside playing with lighting matches. This scares me so I try to distract
him by giving him a banana to play with. His mother rushes in, misunderstands
my presence with her child, screams, and hits me over the head with a long
stick of French bread. And so on through the list of items.

Now, that's a silly little story, but it has action that is woven around
my shopping items and it is memorable.
We examined the power of this narrative chaining technique by asking some college students to study and learn twelve successive lists of 10 items using this method. Other students were asked merely to learn the twelve lists in anyway they could and were given the same amount of study time. At the end of the session, we tested recall by presenting the first item of each list and asking the subject to recall the rest. The results are shown in the next slide, showing percentage of items recalled across the twelve lists for the Narrative-Chaining subjects and the Control subjects. There was a tremendous advantage for the Narrative subjects, who averaged about 93% recall versus about 14% for students in the Control condition who were learning as best they could without special instruction. (SLIDE OFF)

This narrative-chaining method is easily adapted for many things to be memorized, such as sequences of events in history or a novel or a speech. It is better than the pegword method or location methods when you have to learn a lot of different lists. Since you make up quite distinct stories for the different lists, you can keep them thematically distinct and unconfused in your memory, whereas using the pegword method some forgetting and confusions between lists is more likely when many lists have to be learned and retained.

Now, these mnemonics have you putting together unrelated items into meaningful relations, usually by putting them into an action scenario or a sensible sentence. That observation leads you, then, from mnemonics over into a concern with my next topic, namely, how and what people learn from sentences. This issue is of practical concern since so much of formal education in school depends on our learning from what we read or what we're told.

Now, in thinking about what is learned from sentences, you get drawn quickly into the issue of how people extract meaning from sentences. About ten years ago, the prevailing belief was that this process was largely guided by grammar or
syntax analysis. The next slide shows this old approach (at top). The isolated sentence was taken as the formal object for analysis. It was supposed that the listener uses his knowledge of grammar to parse the sentence and figure out what are the logical relationships between words that are being expressed in the incoming sentence. After this identification of parts of speech and grouping of terms into syntactic units in the Deep Structure, the next phase of this mythical process was to look up in memory the definitions of the words, and finally combine these word meanings in some way to come up with the meaning of the sentence as a whole.

One thing that we've learned is that this is a wholly inadequate model of language understanding. The more realistic model that is emerging is shown schematically in the bottom of this slide. This considers the sentence as a communicative act that occurs in a meaningful social context and assumes that the utterance conveys a lot of information, including such things as the speaker's intentions as well as what he presumes that the listener already knows; in this approach, the situational context of the utterance is critically important, and all sorts of world-knowledge--far beyond what one will find in a semantic dictionary--are brought to bear when the listener comes up with his interpretation of what was said to him.

I will review just a few facts we know about memory for sentences which seem to favor this latter view over the former. A summary of these points is given in the next slide.

A first fact is that people rarely remember the exact wording and syntax of a sentence; rather, they remember the meaningful gist of it. They paraphrase the original statement, change the exact words used, and recall its gist. That is not surprising news, of course, but it is a slight embarrassment to the old theory which supposed that syntactic analysis played such a dominant role in language understanding.
Second, a person will use his knowledge of the world to elaborate or fill out a rather complete description of the situation the sentence seems to be about. This elaboration will take the form of the listener unconsciously adding the normal instruments with which actions are done or the normal consequences of actions. For example, if I say that a boy was building a birdhouse, and pounded a nail into some boards, sometime later you will believe that I told you that he used a hammer to pound the nail. If I tell you that a boy was out sailing and fell out of his boat, you'll later believe that I told you that he fell into the water and got wet. That is, you fill in, unconsciously in your memory, the normative consequences of the action or episode described.

A third point is that in understanding the person tends to particularize and instantiate general terms in a manner suggested by the context. For example, if I say "The container held apples," people think of the container as a basket; but if I say "The container held cola," they interpret the container as a bottle. This affects memory insofar as basket will cue recall of the first sentence whereas bottle will cue recall of the second. As another example, you will think of different types of ball as I say to you

Jack Nicklas lost his ball
The quarterback fumbled the ball
Rick Barry dribbled the ball.

Obviously we're using our world knowledge to particularize; but to suppose that one is simply looking up the dictionary definition of ball in these several cases seems to miss the detail of the actual mental representation. Such instantiations apparently arise as a result of the person searching in memory for a known or probable connection between the key terms. Such an intersection search will, of course, yield golf ball as the most probable intersection between my concepts of ball and Jack Nicklas.
A fourth point is that the person will integrate a series of inter-related statements about a given situation into a model of that situation. In so integrating the statements he may fill out and derive many implications or relations that were implicit in the facts given, but which were not specifically stated. For example, suppose I describe to you the spatial layout of objects in a room. I might say imagine yourself sitting on a sofa: the sofa is in front of the fireplace, to your left of the sofa is an end table, left of that is a rocking chair, and so on. Listening to such pair-wise statements, you seem to reconstruct the whole layout; but in so doing, you tend to forget the exact sentences that were said. A typical subject might later think that I said that the rocking chair is to the left of the sofa. That is, he is very likely to think that he heard any statement that is true, regardless of whether precisely it was said. So to summarize this point, our memory integrates related propositions into a model of the situation and automatically draws some limited inferences from them, so that we are later hard pressed to distinguish between a fact we were told directly versus a fact that we inferred.

Incidentally, it is this filling out by unconscious inferences that causes so much unreliability in eye-witness reports about accidents or crimes. The witness may have heard or seen only a few fragmented snapshots, yet he imposes a particular interpretation on the scene and fills in the gaps with his own completions. I'll discuss these tendencies later.

A fifth point is that the old theory of language analysis only provides for literal readings of sentences whereas in a given context an utterance may have one literal meaning but an entirely different conveyed meaning. In such cases, it is the conveyed meaning that is acted upon and that is remembered by the listener. To illustrate, suppose a public lecture drew a large overflow audience, and the chairman in charge of the event before the talk said "Look! There're people
sitting on the floor." Literally, this simply describes a state of affairs. But if the chairman said this to the speaker, the speaker would interpret it as a compliment to his popularity and drawing power. On the other hand, if the chairman said the same utterance to the janitor, the janitor would interpret it as a request for him to bring in some folding chairs for the people who are sitting on the floor. If we were later to ask the two fellows what the chairman had said, the speaker would recall that the chairman had paid him a compliment, whereas the janitor would recall that the chairman had ordered him to bring in some more chairs. There are many other cases, such as sarcasm, in which we say one thing but are intending to convey another meaning entirely, as when we look at a friend who obviously has a horrendous hang-over and say, "Boy, you're looking terrific today!"

The conclusion from these several illustrations is that the psychological interpretation of a sentence depends in a complex way upon the context of its occurrence, upon world knowledge, normative inferences, upon conversational rules for conveying intentions, and so forth. This indicates that any theory of performance is doomed which begins by supposing that the psychological interpretation is computed from a simple amalgamation of the semantic senses of the independent words comprising the sentence.

The last point concerning sentence memory is that the most important factor determining whether a sentence will be remembered later is whether the person understands it when he hears it. If you don't comprehend the relations asserted in the sentence, then you probably won't remember it at all. Comprehension surely involves many things, but one of them is being able to imagine a situation in which the asserted relations could be realized. The next SLIDE gives just a few illustrations of apparent "causal" statements that are hard to understand.
#1. The notes were sour because the seams split.

#2. The voyage was delayed because the bottle didn't break.

#3. The haystack saved him because the cloth ripped.

Although these sentences are grammatically well formed, most people are totally puzzled by them: they can't call up from memory a context that will make the causal link in each sentence understandable. And, of course, they will also forget such incomprehensible sentences.

All matters can be rectified, however, by providing the subject with a hint or clue before each sentence, so that he gets that "Eureka" or "Aha" click of understanding. For sentence 1, I tell you this is about a worn-out bagpipe. Sentence 2 is about the christening of a ship. Sentence 3 is about a paratrooper whose parachute ripped. Given such hints, people now readily understand, and will easily remember a large number of such otherwise opaque sentences. They now can call up from memory a plausible situation which corresponds to the target sentence. They now have an explanation for the causal statement. Such illustrations can be compounded with many sentences, which are arranged in a paragraph; yet the person will fail totally to understand the text unless he is told some kind of theme or context against which he can interpret the opaque passage.

Let me read you a particularly opaque passage.

If the balloons popped, the sound wouldn't be able to carry since everything would be too far away from the correct floor. A closed window would also prevent the sound from carrying, since most buildings tend to be well insulated. Since the whole operation depends on a steady flow of electricity, a break in the middle of the wire would also cause problems. Of course, the fellow could shout, but the human voice is not loud enough to carry that far. An additional problem is that a string could break on the instrument. Then there could be no accompaniment to the message. It is clear that the best situation would involve less distance. Then there would be fewer potential problems. With face to face contact, the least number of things could go wrong.
Most people get absolutely nothing out of hearing that and can't remember a thing, like many students at a lecture. But now suppose I show you this picture of a guy playing his guitar to serenade his girlfriend and he's arranged some balloons to float his loudspeakers up to her window on the sixth floor of the apartment building.

Now let's do it again:

If the balloons popped, the sound wouldn't be able to carry since everything would be too far away from the correct floor. A closed window would also prevent the sound from carrying, since most buildings tend to be well insulated. Since the whole operation depends on a steady flow of electricity, a break in the middle of the wire would also cause problems. Of course, the fellow could shout, but the human voice is not loud enough to carry that far. An additional problem is that a string could break on the instrument. Then there could be no accompaniment to the message. It is clear that the best situation would involve less distance. Then there would be fewer potential problems. With face to face contact, the least number of things could go wrong.

It all becomes comprehensible and memorable now because you know what the passage is talking about.

Now, in normal conversation, one rarely encounters such incomprehensible sentences or passages; but that is probably just because the prior conversation provides such a useful context that we never notice that the sentence might otherwise be very obscure.

I have discussed the role of comprehension in remembering sentences, but exactly the same factors operate in remembering pictures or drawings. Look at the drawings in the next slide: suppose I show you a bunch of these and then ask you to recall them. You won't do so well because most are incomprehensible. But I can boost your recall a lot if I give you an interpretation of each. So I tell you that the first is a picture of a midgit playing a trombone in a telephone booth; the second is an early bird who caught a very strong worm. The same principle applies if you have to associate two nonsensical drawings such as those shown
in the next slide. These pairings of picture a with b within a row seem arbitrary until I tell you an integrating interpretation; in the middle row, we see piles of dirty clothes, then soap powder being poured into a clothes washing machine; in the bottom row, is uncooked spaghetti and b is cooked spaghetti and meatballs; thus, in the top row picture a shows the rear end of a pig disappearing into a fogbank and picture b is his nose coming out the other side of the fog. Now, you can remember these pairings very well indeed. This appears to work because my words help you call up from memory some integrated perceptual frames which then fit neatly onto these obscure pictures: you make sense out of what was formerly a puzzle, you see it as an obscure rendition of something familiar. (SLIDE OFF)

Having now reviewed the role of comprehension in memory, I will move on to my next topic, namely, forgetting of information once it has been learned. The layman's theory, that memories just fade over time, sounds intuitively plausible but is a useless explanation. For one thing, the lapse of time is not itself a causal variable; rather, time is only a framework within which other events can act as causes. If I leave a hammer outside, it will gradually rust over time; but it is not the lapse of time per se that causes the rusting, but rather the chemical oxidation of the iron that occurs over time and I can vary that by varying the dryness of the atmosphere. Similarly, in experiments on forgetting, one can fix the time before the retention test is given, and still produce enormous variations in amount remembered according to what events have intervened since original learning and according to the cuing conditions at the time of recall.

It is known that one of the major factors promoting recall failures is the learning of interfering responses. This happens, for example, when we have
to learn to call a thing by a new name. I once had a secretary named Janet Sutherland: after I finally learned her name, she got married and her name became Janet Christianson. I had a difficult time learning her married name so that it would come immediately to mind as I was performing rapid introductions. Eventually, I got it, calling her Janet Christianson all the time; but then I would experience distinct difficulties in ever remembering what her maiden name had been. I could get back to it only by slow searching and testing.

This same kind of interference can cause forgetting of all kinds of specific contents, whenever there is a great deal of similarity in the conceptual framework of several sets of facts to be remembered. For example, suppose that I were trying to teach you sets of biographical facts about two French novelists including items such as where and when they were born, and what had been their father's occupation, who were their siblings, where they were schooled, what novels they wrote, and so on. If I teach you biography A first, then biography B, then ask you much later to recall both, you will get the two sets of details somewhat mixed up—you will have writer A going to B's school, B will become the author of A's novels, and so on. This is an example of how interference can reduce accuracy of recall of specific contents.

Psychologists have learned that the amount of memory somebody demonstrates about an event or set of materials depends very much upon the way you test him. Some ways of questioning a person produce relatively little recall whereas others produce a tremendous outpouring. You have to know how to tap the memory keg. To demonstrate, suppose you try now to recall the small shopping list of items I gave you earlier, but don't use the pegwords. Spend a few seconds doing it now and introspect about what mental activities you're going through. (10 second pause). Okay. Stop. Now, let's try to retrieve that list using your peglist:
recall the first groceries item for which I suggested some image of it with a hamburger bun (pause); then the second picture doing something to the sole of a shoe (pause); the third hanging from a tree; the fourth sticking through a door (pause).

For most people, especially those who took the time to actually learn the shopping list with the pegwords, thinking of the pegwords calls the items to mind more strongly than would the simple request to recall the shopping list. That is, the "three is a tree" pegword is a much stronger cue for recall of bananas than is the cue "shopping list." Now, suppose you had forgotten the pegwords for some reason: we could still say that you knew what those shopping-list items were, except that you'd forgotten how to retrieve them, how to cue yourself properly to recall them. To use a metaphor, you can think of your memory for an event as similar to a locked treasure box, and the right retrieval cue is like a key you use to unlock the box and bring forth its contents.

I believe that this distinction between good and bad retrieval cues helps us understand a number of phenomena about remembering, including some of those on which Sigmund Freud and other psychoanalysts based their hypotheses about the unconscious mind and the mechanism of motivated repression. For example, Freud would use psychoanalytic language and say that the shopping-list items were repressed into your unconscious until I released that repression by giving you the pegwords; but I think the facts can be rendered with less fanfare by simply pointing to the differing retrieval effectiveness of the two situations.

Part of the evidence Freud offered for his theory was that under psychanalysis people often recalled many childhood experiences which they hadn't thought of for years. But this exhuming of childhood memories may not be due to the psychoanalyst lifting the patient's repression. Rather it is just as plausible to see the memories as a normal retrieval result of having the patient free associate
about his childhood to an interested listener, to be urged to rummage about among the debris, so to speak, until he finds a retrieval cue that unlocks some of his childhood memories, much like the pegword tree gained access to memory of the item bananas for you. Any one of you can achieve some success at this, say in recalling events of your first year in elementary school, if you simply let your mind wander round the fringes of the sought-for material. You try to cue your memories with questions like: What year was that? Where did I live then? Who were my friends? Who was my first-grade teacher? What did the school room look like? Who sat near me in school? What were my father and mother doing then? And so on. By cuing yourself for related information, you may unlock a few memories and those in turn are associated with others, and so on it goes like a chain of sausages.

I think the same cuing idea explains the results obtained when people are asked to recall when under hypnosis. Although it is commonly believed that people show extraordinary remembering under hypnosis, this seems based not so much on firm evidence as on the gullability of the people observing the recall of the hypnotized subject. The observers seem to want to believe in magic, to believe that hypnosis will reveal all sorts of hidden super-powers of the mind. But alas, there are no hidden powers. What a hypnotized subject recalls about an event, say a childhood experience such as his first day in kindergarten, is approximately what you would normally recall while awake if I motivated you to try hard, to cue yourself about that day and also told you to hazard a few logical guesses about the events. We find that hypnotized subjects make up a lot of plausible-sounding fill-ins, and they tend to mislocate or combine separate events—for instance, they might remember an actual event from a second grade class and misplace it into their recall of events in kindergarten.
Furthermore, the recall is not helped much if you try to get the hypnotized subject to regress back through time and try to relive his first day in kindergarten. Basically what we get here is the behavior of an adult who is pretending or acting the role of a five-year old child as he now conceives of it, except he's modifying that role-play somewhat by memories of his own kindergarten days. I think what is fascinating about this is how good people are at role playing under hypnosis rather than what mediocre memories they continue to have under hypnosis.

The unlocking of the memory chest by a good retrieval cue seems to be a relatively automatic process. One of the best cues for retrieving our memory for an event is a reoccurrence of that event or some information similar to it. This is why performance on True-False recognition tests of memory usually exceeds performance on recall tests such as short-answer or essay tests—a fact well-known to all college students. This same principle of memory cuing explains, I think, the very high frequency with which people report an ESP or extra-sensory-perception phenomenon known as precognition; this is where something out of the ordinary happens today which you had been thinking about yesterday or some time before. This experience, which seems to strike English spinsters and maiden aunts with particular frequency, is typically of the form: "Last night I thought (or dreamt) of Cousin Bertha having an accident and going to the hospital; and just today, Bertha's husband telephoned to say that Bertha had fallen and broken her hip and was taken to the hospital."

If you were a memory psychologist, how would you think about such precognitions? All you need to notice is that our memory has a strong bias to notice the occasional coincidence of events but to forget the massive number of non-coincidences in our premonitions. Thus, the event of hearing that Cousin Bertha has indeed had the accident retrieved the memory that I'd been thinking about something like that a few days before. In fact, the accident report will retrieve memory of almost
any thoughts I've had recently about Bertha, and I'm very prone to reinterpret them so as to see them as predictive of the disaster that in fact occurred. However, I don't notice the fact that I'd had a thousand other premonitions in the past week, none of which has proven true. Nor do I have any real accuracy check on exactly what it was that I thought about Bertha yesterday. A person with true ability at precognition must be accurate; the occasional coincidence doesn't establish the validity of the phenomena claimed. That would be like saying a kid is a great basketball player because he hits an occasional shot. The point is this: the person's memory counts only the hits, whereas the claim for precognition requires that we count the massive number of misses, too.

This discussion of forgetting brings me to my final topic, which is how people distort things when they recall. It is interesting to examine this in terms of the reliability of eyewitness-testimony in criminal cases as well as the distortions in a rumor as it passes from person to person.

Years ago psychologists did many studies on the accuracy of eye-witness reports, such as occurs in courtroom testimony. In these experiments, some kind of staged violent scenario would be played out before a class of unsuspecting students. For example, a graduate student might come rushing in and engage in a violent shouting match with the professor who allegedly flunked him unfairly on his Ph.D. oral examinations; the scene can be embellished in multiple ways, with a friend of the graduate student trying to restrain him, and the scene would build to a crescendo, typically ending with a fight, shooting, or stabbing, then the assailants run out, leaving the moaning professor bleeding on the floor and the audience in an advanced stage of panic. The lecturer then jumps up, dusts himself off, and launches into the lecture he had prepared on eye-witness testimony.
At varying times after the scene, the bystander-witness is called upon to recount the episode as best he can. What became immediately apparent in such studies was the tremendous variability in the details of what various witnesses reported seeing. They would, of course, forget details regarding the appearances of the actors as well as the names of dates mentioned; and they would forget exactly what was said or who said what. They were likely to misjudge the duration of events and to misremember the time order of specific events insofar as those were not dictated by the actors entrance into or exit from the scene. There were often gross distortions in memory for what the actors did or said, with the distortions being such as to recall an actor's behavior as being always consistent with the dominating theme or personality trait which characterized him. For example, the graduate student might be classified as being hostile and aggressive, so that anything he said that was inconsistent with this overall impression (such as friendly overtures) would either not be remembered or would be reinterpreted so that it seemed consistent with his overall character.

A second finding from these testimony studies was the difference between letting the witness freely narrate his recall of the episode versus what you get from him through cross-examination. Over time, a person's narrative account typically becomes shorter as he forgets details, though it does not necessarily become more and more inaccurate. However, much greater errors can be brought out through cross-examination where you more or less force the witness to make definite statements about items that are only on the dim margins of his remembrance. It is in precisely these vague gray areas that suggestions and leading questions can induce the witness to believe in various distorted versions of the episode.

Lawyers are, of course, familiar with the techniques of framing leading or misleading questions, particularly on cross-examination. You phrase a question
in such a way that it presupposes the truth of certain things. The question
"Have you stopped beating your wife?" is obvious in its presupposition that
you have been beating your wife. But there are much more subtle ways to insinuate
conclusions. Consider just the slight difference in the questions "Did you see
the professor hit the student?" versus "Didn't you see the professor hit him?".
The second one strongly suggests that I know that the action happened just as
does the phrase "Don't you remember seeing the professor hit the student?".
Even more subtle are questions that use definite articles to insinuate a pre-
supposition. If you ask "Did you see the pistol in the student's pocket?", you
will get more "Yea-saying" that if the question is phrased with the indefinite
article, "Did you see a pistol in his pocket?" You can insert quantitative
or size presuppositions in the subtle wording of questions. For example,
police and lawyers get bigger estimates if they ask "How tall was your assailant?"
rather than "How short was he?", or "How old was he?" versus "How young was he?".
After watching two cars collide in a traffic accident, witnesses were asked
"About how fast were the cars going when they smashed into one another?". They
gave estimates averaging around 40 mph. Other witnesses were asked "About how
fast were the cars going when they bumped into one another?" and they gave
estimates down around 30 mph. So the "smashed" question insinuates a higher
speed than does the "bumped" question. The influence of such subtle suggestions
can apparently be quite substantial. Then, of course, once you've got the witness
committed to one false presupposition, for example, that the friend had a pistol,
then the poor witness can be led by suggestion along a road of vague agreements
as to what must have been so, given that presupposition.

One of the subtle and insidious influences of leading questions is that they
can alter your memory of the original event you witnessed. Basically, you tend
to integrate into your memory, say of a car accident or a crime, any presupposi-
tions of questions you were asked soon after the event. For example, suppose soon
after viewing a car accident film, I ask you "about how fast was the sports car
going as it ran the stop sign and turned into the intersection?", and you give me
some estimate. A week later, if I test your memory for the sequence of episodes,
you are very likely to say that you saw a "stop sign" when in fact none was there
at all. You would have taken the presupposition about a stop sign in my earlier
question and incorporated it into your memory for the auto-accident you saw.
The same integration can be seen with the "smashed" versus "bumped" question I
mentioned before. Several days later, I ask you, "Did you see any broken glass
at the scene of the car accident?" You are more likely to say you saw broken
glass if you had earlier been asked the "smashed" question than if you'd earlier
been asked the "bumped" question. In other words, the witnesses who got the
early "smashed" question integrate that presupposition into their memory, so
that they remember it as a smashing accident. And, "broken glass" is more
consistent with a "smashing" accident than with a "bumping" accident. The
witnesses in these experiments are totally unaware of their swallowing the pre-
suppositions insinuated in the leading questions. They don't realize that their
later memory is a hodge-podge mixture of the original event plus later inputs
from leading questions or remarks from other witnesses.

The distortions of truth through leading questions were found to be partic-
ularly horrendous when a young child was the witness (under 8). The investigators
found that children were very unreliable witnesses, that their testimony was so
readily influenced by suggestion as to be almost worthless under normal courtroom
cross-examination. Perhaps it was such knowledge which led to the ruling that
children's testimony is inadmissible as evidence in a trial.
The distortions found in eye-witness reports of a happening can be compounded by passing the report from one subject to another, who repeats the story to another subject, and so on through a whole chain of people. This makes for an enjoyable party game. It is, of course, what happens when rumors are spread through a community. Because each person in the chain is exposed not to the original but only to the version of the rumor as told by his contact, there are multiple opportunities for distortions. As rumors circulate from one link in the chain to the next, the length of the report shrinks as all sorts of details are lost. There is also a great simplification of the story, a suppression of the unfamiliar or strange, a sort of collective effort after understanding.

There's a tendency to attribute motives to the characters, to see them acting according to our stereotyped beliefs about them, and we invent causal reasons to connect two events of the rumor that might appear otherwise unrelated. There is a great striving for explanations of events, especially if they have emotional significance for us.

Good examples of such distortions have been seen in atrocity rumors that circulate during wartime. Occasionally, these are even picked up and printed in the newspapers. To illustrate such a snowballing effect, consider the way an item in a German newspaper during World War I was picked up and gradually distorted as it was passed along from one European newspaper to the next. The original item about the fall of Antwerp to the German army in November 1914 was reported in the Kolnische Zeitung as

"When the fall of Antwerp became known, the church bells were rung."

It was understood, at least by the German readers, that the church bells throughout Germany were rung.
This item was picked up and next appeared in the French newspaper Le Matin as

"According to the Kolnische Zeitung, the clergy
of Antwerp were compelled to ring the church
bells when the fortress was taken."

Next the London Times picked it up as

"According to what Le Matin has heard from Cologne, the
Belgian priests who refused to ring the church bells
when Antwerp was taken have been driven away from their
positions."

Then in the Corriere della Sera, the story became that the priests were sentenced to hard labor for their resistance. The final capstone was a later report in Le Matin which read

"According to information to the Corriere della Sera from
Cologne via London, it is confirmed that the barbaric conquerors of Antwerp punished the unfortunate Belgian priests for their heroic refusal to ring the church bells by hanging them as living clappers to the bells with their heads down."

The sustaining motive here is obviously hostility which combines with the overwhelming stereotype which expected soldiers of the German army to perform barbaric atrocities. The whole thing sort of begins with a simple mislocation of where the church bells were rung, and then you see the process of working out an explanation of how that might have happened, which then becomes elaborated.

The conclusion from such rumor studies is that rumors provide a great field for psychological studies but they simply should never be believed in detail.
Now before ending my talk here today, let me practice what I preach and subject you to some mnemonic devices to aid your memory for what I've told you. After all, you'll need something to go on when you get home and someone asks you what you've heard. So to prevent the spreading of false and malicious rumors, I've organized the seven main sections of my talk into the pegword mnemonics in the next figure.