{slide 2}

We have discussed how information is transferred from sensory memory to STM, and we have discussed how information is maintained in STM. We have also explored the assumption of the modal model that retrieval from STM is very accurate. This assumption accounts for the recency effect in the serial position curve.

However, we have not discussed the nature of retrieval from STM. That is, once an item is represented in STM how is this information retrieved?

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This is the question asked by Saul Sternberg, who was research scientist at Bell Laboratories in NJ. Bell Labs were the research arm of the phone company at the time, as they invested a lot of money in making communication systems better. At the time, they were exploring the use of computers, and a key question concerned retrieving information, and sought guidance from human information processing.

The procedure that he used has become known as the *Sternberg Paradigm (1968; 1969)*

-- Subjects study lists of items of various lengths from 1 to 6 items. This keeps the list length under the magic number 7.

-- The memory task is old-new recognition, whereby memory is tested by presenting either an old item that was studied or a new item that was not. The subjects task is respond Old to targets and New to foils.

-- The dependent variable is reaction time. Why? Remember retrieval from STM is very accurate, and even more so when tested with old-new recognition. Thus Sternberg wished to avoid ceiling effects, and changes in the speed of performance can be observed even when accuracy is at ceiling.

 -- Sternberg entertained three hypotheses.

The first hypothesis was the Parallel Search Hypothesis. It states that all the items in STM are compared to the test item simultaneously or in parallel. If a match is found, the response is “Old”. If a match is not found the response is “New”. Of course, it doesn’t matter how many items are in STM according to the Parallel Search hypothesis, and thus RTs would not be predicted to change as a function of list length. In addition, the RTs for Old and New responses should be the same.

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The next hypothesis was Serial Self-Terminating Hypothesis. It states that the items in STM are compared to the test item one at a time in a serial fashion. As soon as a match is found, an Old response is made. If after all of the items in STM have been searched and no match is found, then a New response is made. In this case, it should take longer to find matches or search the entire contents of STM as the number of items in STM increases. Therefore, the Serial Self-terminating Hypothesis predicts an increase in RTs with increases in list length. Moreover, the Old and New response functions should be different. Just as in the case for the visual search task that Schneider and Shiffrin used, the slope of the Old response function was predicted to be half the slope of the New response function. You will recall this because on average one only needs to search half of the items in order to find a match, but in order to determine whether a test item was not studies, all of the items need to be searched.

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The last hypothesis that Sternberg considered was the Serial Exhaustive Search Hypothesis. Like all serial hypotheses, it states that the items in STM are compared to the item one at a time in a serial fashion. However, in this case, an exhaustive search of STM is always made. The important implication of this hypothesis is that even after a match is found, the subject continues to compare the test item to the remainder of the items in STM. Only, then does the subject make an Old response. Of course, this hypothesis predicts an increase in RTS with an increase in list length. However, this prediction differs from the one made by the Serial Self-terminating hypothesis in that the RT function for both old and new responses should be the same, because subjects always search all the items in memory

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Here are the results of the Sternberg experiment. RTs are plotted as a function of list length. It is clear that they increase. Moreover, there is no difference in the slope of the Old and New response RT functions. These findings provided compelling support for the Serial Exhaustive Search Hypothesis.

But isn’t this hypothesis strange? Sternberg thought so too. He only entertained it because he was a good scientist and he want to explore all the possibilities. However, the engineers at Bell Labs were totally consistent with their principles of efficiency. They noted that while comparisons needed to made, fewer decisions to halt the search needed to made, and thus the Serial Exhaustive Search was actually more efficient that the Serial Self-Terminating search.