PSYCHOLOGY

Short-term Recognition Memory for Normal and Whispered Letters

WHEN a subject is asked to recall a list of items, he is asked to recall only certain relevant features of each item. If presentation is visual, subjects are usually not asked to recall the exact size, position, brightness, texture, etc., of the items. If presentation is auditory, subjects are usually not asked to recall the exact frequency, intensity, stress, etc. of the items. Features which are not to be recalled may be termed 'irrelevant'. However, it is important to note that a logically 'irrelevant' feature is not necessarily irrelevant to the memory trace for relevant features. Previous studies have shown that 'irrelevant' items in the presented list produce a considerable amount of interference in short-term recall of 'relevant' items, even when subjects have complete knowledge of which items are to be ignored[1,2].

The present experiment is concerned with an 'irrelevant' feature of an item, rather than with 'irrelevant' items, and it is concerned with short-term recognition memory, rather than short-term recall. The 'irrelevant' feature is voicing (normal versus whispered pronunciation of letters), and the purposes of the experiment are: (*a*) to determine whether recognition memory is better when the presented items and the test item are both normal or both whispered than when one is normal and the other is whispered; (*b*) to determine whether the retroactive interference produced by an interpolated list of letters is affected by its similarity to the presented and test letters in the 'irrelevant' voicing feature. The term 'voicing feature' will be used throughout to mean all of the frequency, intensity, durational, etc., differences between normal and whispered voice.

One sec after a 'ready' signal, subjects listened to a list of five different letters presented at the rate of 0·5 sec/letter, followed by a 1-sec tone, followed by an 'interference' list of eight different letters presented at a rate of 0·5 sec/letter, followed by a 1-sec tone, followed by a recognition test letter. The subjects were to decide whether the test letter was in the original list of five letters, answering 'yes' or 'no' and giving their confidence on a scale from '1' (least confidence) to '5' (most confidence). They were given 18 sec in which to answer 'yes' or 'no' and indicate their confidence. The eight interference letters were always different from the five letters to be remembered. The test letter was either the same as a letter in the original list of five or else different from any in the original or interference lists. Letters from the interference list were never used as test letters. To reduce rehearsal and ensure attention to the interference list, subjects were required to copy the interference letters as they were being presented. The subjects were also required to copy the test letter, and only correctly copied test letters were scored for correct recognition. The entire experiment was recorded on tape.

There were two groups in the experiment. In group N all original lists were pronounced with normal voicing. In group W all original lists were pronounced with whispered voicing. Within each group there were four conditions representing the four combinations of normal versus whispered interference lists and normal versus whispered test letters. Within each of the four conditions there were two subconditions determined by whether the test letter was or was not from the original list, correct or incorrect test letters, respectively. Correct test letters could come from any one of the five serial positions, and each serial position was represented as a test letter equally often. Incorrect test letters occurred 3/5 as often as correct test letters in all eight subconditions. Within each group all conditions were given to all subjects. Conditions were randomized in blocks of $4 \times 8 = 32$ trials. All four interference and test voicing conditions were combined with three incorrect test letters and all five serial positions for correct test letters, in each block of 32 trials. There were 3 blocks in the experiment for a total of 96 trials.

Each trial required about 30 sec, and the experiment lasted around 50 min. Group testing was used. The subjects were undergraduates in this Institute taking psychology courses, who participated in the experiment as part of their course requirements. Thirteen subjects were run in group N and 18 subjects in group W.

To each test item a subject must respond with one of ten decision-confidence pairs. Let $i = 1, 2, \ldots, 5, 6, \ldots, 10$ represent 'yes' with confidence '5' (greatest confidence), 'yes' with confidence '4', . . ., 'yes' with confidence '1' (least confidence), 'no' with confidence '1', . . ., 'no' with confidence '5'. Let $f_i(x)$ represent the total frequency (over all blocks and all subjects) with which response i occurred in condition x. Let $r_i(x) = f_i(x)/\sum_{i=1}^{10} f_i(x)$ represent the relative frequency with which response i occurred in condition x. Let $R_i(x) = \sum_{j=1}^{i} r_j(x)$ represent the cumulative relative frequency with which responses 1 through i occurred in condition x. The memory operating characteristic (MOC curve) is a plot of $R_i(x)$, the (correct) recognition rate for some condition in which the test item is the same as the presented item, against $R_i(y)$, the (false) recognition rate for some condition in which the test item is different from the presented item.

In common-sense terms, it is relatively meaningless to compare conditions with respect to correct recognition rate (correct 'yes' responses), unless you also compare the conditions with respect to false recognition rate (incorrect 'yes' responses). If one can obtain correct recognition rates for several different values of the false recognition rate, then one can plot an MOC curve for a condition and compare that curve to the MOC curve for another condition. If one curve lies above the other curve, then recognition memory is better in the condition with the higher MOC curve. The confidence judgment technique allows one to determine one point on the MOC curve for each possible cut-off along the decision-confidence continuum. In this experiment there were ten decision-confidence pairs, hence nine cut-offs and nine points on the MOC curve for each condition.

The MOC curves for each of the four conditions in group N are presented in Fig. 1*A*. The conditions are represented by three letters—*NNN*, *NNW*, *NWN*, and *NWW*—the first letter representing the voicing of the original letter, the second representing the interference letters, the third representing the test letter. Fig. 1*B* presents the MOC curves for the four conditions in group *W*—*WNN*, *WNW*, *WWN*, and *WWW*.

The general shape of all eight MOC curves is very similar—smooth curves of continually decreasing slope that are symmetrical about the main diagonal. Such MOC curves could be very closely fitted by a theory of recognition memory formally isomorphic to signal detection theory. This theory assumes that the strengths of the memory trace for correct and incorrect items are represented by two overlapping normal distributions, correct items having a higher average trace strength than incorrect items. Symmetry about the main diagonal implies that the strength distributions for correct and incorrect items have equal variance. The theory assumes that a subject responds with decision confidence pair i when the trace strength of the test item is greater than some critical cut-off strength, c_i, and less than the cut-off, c_{i-1}, for decision-confidence pair i–1. Signal detection theory applied to recognition memory is described in more detail by Egan[3] and Norman and Wickelgren[4].

The MOC curve for normal presentation averaged over all interference and test conditions was virtually identical to the average MOC curve for whispered presentation.

But the ordering of the four interference and test conditions was very different for normal as opposed to whispered presentation. The voicing of the interference letters had no consistent effect on the MOC curve, other things being equal. However, the voicing-similarity of the test letter to the presented letters had a moderate, but consistent, effect on the MOC curve. The average MOC curves for test letters with voicing identical to, or different from, the original letters are shown in Figs. 2*A* and 2*B*. Short-term recognition memory appears to be better when the original letters and the test letter are both normal or both whispered than when one is normal and the other is whispered.

This finding implies that normal and whispered items are not coded identically in short-term memory. If they were, there could be no difference in retrieval contingent upon the voicing-similarity of the test item to the original items. On the other hand, it seems rather likely that the internal representative of a normal item has a lot in common with the internal representative of a whispered item, accounting for the fact that recognition memory is far better than chance when the original letters and the test letter have different voicing. One could assume that the internal representatives of normal and whispered letters have nothing in common and that long-term associations have been formed between them in the past, although intuitively this seems unlikely.

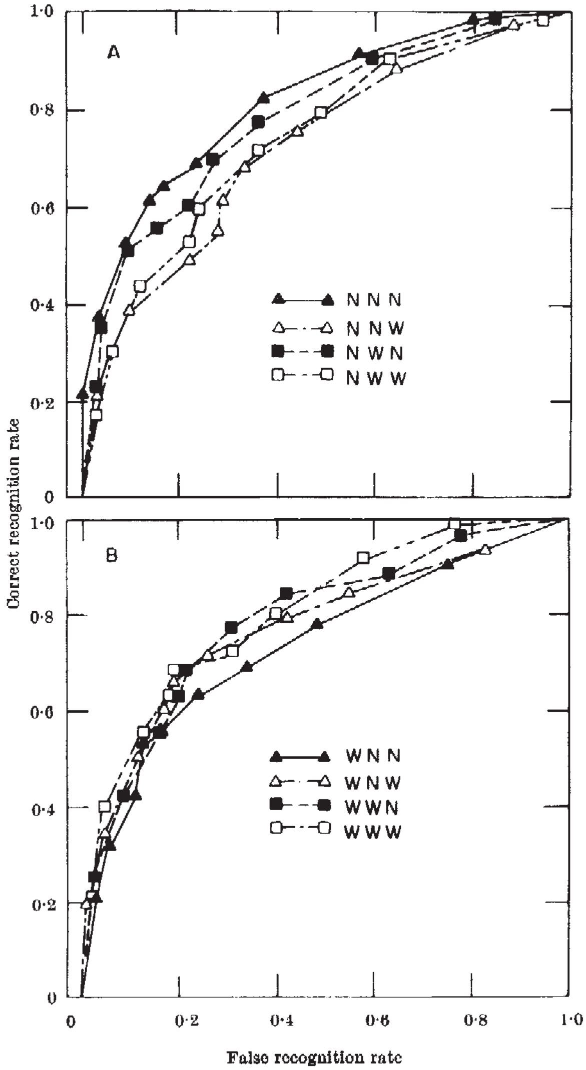

Fig. 1. MOC curves for conditions in groups *N* and *W*

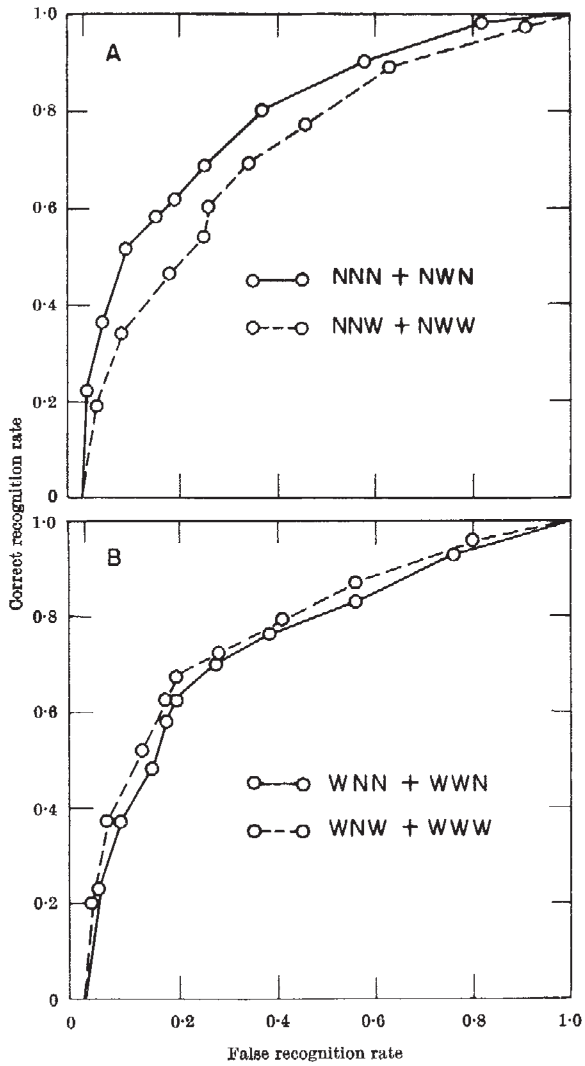

Fig. 2. Average MOC curves for test items similar and dissimilar to the original items in voicing

The voicing feature of a letter is represented in short-term memory, even though this feature is formally irrelevant to correct performance. Recognition memory is superior when the voicing of the test letter is similar to the voicing of the original letters. Within the framework of the strength theory of memory outlined earlier, this implies that the average strengths of the correct and incorrect normal letters are farther apart than the average strengths of the correct and incorrect whispered letters when the original letters are normal. The reverse is true when the original letters are whispered.

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