CSs and serves as a yoked control for the other CS. The other S has a punishment contingency on one CS and serves as a yoked control for the other CS. The complete package of these four experimental cases permits Church's bias to be studied in all of its possible permutations, since careful analysis shows that it may contribute to an observed effect via a single cell of the four-fold table in the first two cases mentioned above, via two cells additively in one of the latter two cases (the last), and via none of the four cells in one of the cases (the third). Additional applications in other research areas may prove even more fruitful.

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NOTES

1. Even in studies using skeletal responses such as the eyelid reflex there is no assurance that the performance level achieved by avoidance Ss will be so high as to preclude conditioning of yoked controls (Moore & Gormezano, 1961).
2. This study is the second author's Ph. D. dissertation research.

Free association, free recall, and stimulated recall compared¹

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Three primary methods of recall (free association, free recall, stimulated recall) and two modifications of them (modified free association, modified stimulated recall) were defined by use of three variables: (a) presence or absence of prior laboratory training, (b) presence or absence of E controlled test stimulation, and (c) test instructions to free associate or to recall. Data obtained from approximately 300 Ss and an earlier set of 600 revealed the differential effectiveness of all three primary methods in recall and misrecall.

Behaviors of free association and retention share considerable variance (Bilodeau, 1966; Bilodeau & Howell, in press). Until recently it was commonplace for word association and word-recall behavior to be treated as if they were only weakly related: no study has yet been performed which provides a systematic evaluation of the communalities and differences among what appear to be three major ways of looking at the problem of word retrieval in recall. This experiment will provide such an evaluation.

FREE ASSOCIATION, FREE RECALL AND STIMULATED RECALL COMPARED

The standard method of free association presents a test stimulus to which there has been no prior formal training in responding. In free recall, a test is introduced only after the deliberate manipulation of formal laboratory training, but the test itself deliberately omits the use of a stimulus. This differential stress upon the training or test environment should not be allowed to blur the idea that both methods tap memorial processes. In the case of free association, it is memory for materials acquired over the span of time prior to S's appearance at the laboratory. In the free-recall experiment, S may respond as a function of pre-experimentally or experimentally acquired word-association habits and whichever component is the stronger depends upon E. In the case of free recall, E can achieve a purchase upon such behaviors by the selection of training materials which are pre-experimentally associatively related (e.g., Deese, 1959a, b). Where E deliberately varies the stimuli within the recall environment, proacting pre-experimental associative processes can exert even more powerful influences upon S's recall or misrecall than training variations. This phenomenon was demonstrated by Bilodeau, Fox, & Blick (1963), who combined features of the methods of free association and free recall, thereby creating the method of stimulated recall. The combination was effected by training S on word material drawn from a pool of 100 R₂ items tabled in the 1954 association norms of Russell and Jenkins (an R₂ is the second most frequently occurring associate in the hierarchy of free-association responses), and testing for recall of R₂ in the presence of the stimulus term. The essential features of stimulated recall are: (a) a standard laboratory training session, (b) a test instruction to recall, and (c) introduction of stimuli into the test period which are pre-experimentally rather than experimentally related to the words of training.

The independent variables defining free association (FA), stimulated recall (SR), and free recall (FR) are outlined in Table 1 along with two important variants. Rows represent the independent variables and columns identify the retention methods. The manipulated variables include (a) prior experimental training or not, (b) type of recall instructions and, (c) presence or absence of stimuli during recall. When stimuli are present in recall, they can be explicitly brought to S's attention (as in standard SR), or as in the case of modified SR (MSR), the recall instructions may make no mention of such stimuli and their employment.

For modified FA (MFA), the operational accent is on the presence of a training period prior to testing. Bilodeau et al

Table 1
Summary of Operations Defining Five Methods of Recall

Variable	Primary Methods			Modified Methods	
	FA	SR	FR	MFA	MSR
Prior Training	No	Yes	Yes	Yes	Yes
Instruction to Recall	No ¹	Yes	Yes	No ¹	Yes
Test Stimulus	Yes	Yes	No	Yes	Yes ²

¹No is actually an instruction to free associate. The stressing operations are italicized.

²The stimulus, though present, is not called to S's attention.

(1963), have asked if their patterns of recall and misrecall in SR represented more than mere free associations following a laboratory training experience. It may be said that such a training experience primes recalls of R_2 in SR (Cofer, 1967), thus changing the response pattern independently of actual interference and/or facilitation produced by the stimulus. MFA will enable the testing of the assertion that SR is not a construction process but only a variation of FA; other hypotheses are embedded in Table 1.

The triangles in Fig. 1 display word-retrieval probabilities for R_2 , R_1 , or R_{3-n} obtained under FA, SR, and FR in earlier research. The SR and FR values of Fig. 1 are adapted from the data of Bilodeau et al (1963), in which R_2 s represent correct recalls and R_1 s and R_{3-n} s are misrecalls or extra-experimental intrusions. The FA data are taken from the Russell & Jenkins (1954) norms for the same hierarchies and words. Figure 1 clears up several points. Most important is that FA, FR, and SR yield widely different levels of recall. The two modified methods have been arranged on the triangle in terms of their estimated involvement in recall processes because no data are available to post.

Although the primary methods are placed at the corners of a triangle, they are presently conceived as delimiting areas of operation, not simple points. The triangular representation is only a first approximation to the complex interrelationships among retention methods that are at issue here.

METHOD

Subjects

Basic airmen trainees at Keesler AFB were used. Of 305 Ss, 10 were voided for failure to follow directions and five others were dropped so as to achieve equal Ns, or 58 for each of five groups.

Procedure

The five methods are described in Table 2 where the major events of training and testing are outlined. The words studied on Pages A and B were all R_2 s. Training consisted of two lists to

study (except for FA), only one of which S was asked to recall.

(1) *Free Association* (FA). The first three pages of the booklet (events A through C) called for vowel cancelling for Group FA. This busied S during the times when the other groups were being trained. Page D presented the FA task itself and displayed five printed stimulus words and typical FA instructions: "This page contains five words. Look at a word and write the first word it makes you think of. You must fill in every line. Do not look back to the previous pages."

(2) *Modified Free Association* (MFA). With the exception of events A and B, MFA was like FA. Five R_2 words were exposed on pages A and B, each list for 20 sec, and S was instructed to "Study the words shown below." Free association on Page D was to the five stimuli which normally evoke the R_2 s of Page B in earlier norms. MFA combines the typical training experience of a recall experiment with FA instructions.

(3) *Free Recall* (FR). Training was identical to MFA. Page D contained five blanks for recall, no word stimuli, and the following instructions: "A while ago you studied some words on two pages, A and B. Write down the words that appeared on the second page, Page B. You must fill in every line. If you cannot remember, write in the first word that you think of. Do not look back to the previous pages."

(4) *Stimulated Recall* (SR). Training on events A and B was the same as for MFA and FR. Event D differed in that the Ss were instructed to recall the words of Page B in the presence of the five stimuli. In addition, the instructions to recall brought the printed stimuli to S's attention as follows: "A while ago you studied some words on two pages, A and B. The words below may help you to remember those words. Write down the words that appeared on the second page, Page B. You must fill in every line. If you cannot remember, write in the first word that the printed word makes you think of. Do not look back to the previous pages."

(5) *Modified Stimulated Recall* (MSR). The training and VC pages were identical to those of MFA, FR, and SR. The form of the recall page was the same as SR except for one matter: the instructions were identical to those of FR. Thus, the stimuli were present in recall but no mention was made of them.

Table 2
Experimental Design and Sequence of Events

Group Name	Event A	Event B	Event C	Event D
1. (FA) Free Assoc.	VC	VC	VC	Free assoc. to 5 stim. words
2. (MFA) Modified Free Assoc.	Study 5 R_2 s	Study 5 R_2 s	VC	Free assoc. to 5 stim. words
3. (FR) Free Recall	Study 5 R_2 s	Study 5 R_2 s	VC	Free recall of Page B
4. (SR) Stim. Recall	Study 5 R_2 s	Study 5 R_2 s	VC	Stim. Recall of Page B with standard instructions
5. (MSR) Modified Stim. Recall	Study 5 R_2 s	Study 5 R_2 s	VC	Stim. present for recall of B, but not mentioned, i.e., FR instructions
Time in sec	20	20	120	120

Fig. 1. Recall probabilities for three positions in the associative hierarchy for FA, SR, and FR.

Materials.

Five R_2 s and their stimuli were selected from the Discrete norms of Bilodeau & Howell (1965) to provide the items of Pages B and D. Selection of items was based upon two associative criteria. First, both R_1 and R_2 ought to be stable or reliably evoked. Another norm (continued association at C_1 or S's first opportunity to associate to the stimulus) served as the check on reliability. This rule maximized the chances for stable hierarchies and provides a reliable base of FA data against which to evaluate changes in the hierarchy anticipated under the other methods. Second, inter-item associations among the words of Page B and among the test stimuli ought to be made low; a mean probability of $p = .00$ being achieved. "Bath," "short," "mutton," "stem," and "man" were the stimuli of page D; the corresponding Page B words or R_2 s were: "water," "long," "sheep," "plant," and "boy." In the Discrete norms, mean $p(R_1) = .46$, $p(R_2) = .15$, and $p(R_{3-n}) = .39$.

Ten word orders per page were generated by the use of two 5 by 5 Latin squares and a different word order for every six Ss within methods. Stimulus placement on the test page always conformed to the word order on Page B. Ten additional words were chosen for filler material on Page A of training, five being used with half of the Ss in each method and the other five used for an equal number of Ss within methods. The experiment was carried out in 3 sessions of approximately 100 Ss with E assisted by 2 proctors.

The 1450 ($5 \times 5 \times 58$) responses were assigned to one of seven categories: position in the associative hierarchy (R_1 , R_2 , R_{3-n}); same-list response (a Page B word written on a different line in the test from that appearing in training); other-list intrusion (an intrusion from Page A); Blank (a failure to respond); and Remainder (none of the previous six).

RESULTS

Correct recall $p(R_2)$

The triangle on the left of Fig. 2 gives $p(R_2)$. The right-hand triangle also presents R_2 but includes same-list responses. As expected, only under FR, where Ss are tested for recall without stimuli, does the difference in scoring matter.

Fig. 2. R_2 probabilities scored by two procedures for the five methods.

Figure 2 clearly reveals the different behaviors obtained under the five methods. For FA, $p(R_2) = .21$. Training S by a brief exposure to R_2 as in MFA has the effect of doubling R_2 (i.e., .44). Identical training conditions, but under instructions to recall in the presence of the stimuli (i.e., methods SR and MSR), leads to a further increase in $p(R_2)$, with over 20% more R_2 s given by SR and MSR than under MFA. This increase for SR argues strongly against the hypothesis that Ss merely free associate following pre-exposure to items during training.²

The performance of MSR is noteworthy for its comparability to SR. In effect, MSR tests the generality and robustness of the SR procedure since it shows whether stimulus specification and instructions encouraging association are necessary to produce data typical of SR. As Fig. 2 shows, the simple presence of the stimuli on the recall page, in itself, was indeed sufficient to evoke comparable retrieval. The frequency distribution in Table 3 emphasizes this finding by showing the number of Ss by group giving 0-1, 2-3, or 4-5 R_2 s in recall. The distributions shift from positively skewed for FA to negatively skewed for SR and MSR, with MFA and FR displaying fairly flat profiles. In terms of the number of Ss, SR and MSR produce extremely similar distributions; no deviation between the two distributions exceeds three Ss for any class of R_2 s, while the form of the distributions for SR and MSR differs markedly from those of FR, MFA, and FA:

Table 3
Number of Ss Giving R_2 s for Each Method of Recall

No. of R_2 s	Method of Recall				
	FA	MFA	FR	MSR	SR
0-1	40	23	19	9	10
2-3	17	21	24	25	27
4-5	1	14	15	24	21

Errors of memory and non- R_2 Associates

Table 4 displays five ways of examining misrecall. FA produces .33 R_1 s, a few more than does MFA. A comparison of Fig. 2 with Table 4 shows that the relative strengths of the R_1 and R_2 terms have in fact been inverted by the MFA procedure. Further, SR gives (a) even fewer R_1 s than MFA, and (b) proportionately fewer than MFA compared to FA. Finally, FR produces no R_1 errors. The results from R_{3-n} are highly correlated with R_1 and they support one another. For Other, Remainder, and Blank, SR and MSR show few while FR shows many.

DISCUSSION

In FA, S produced the designated item (R_2) as estimated from pre-experimental normative response strength. The response pattern took the ordinary hierarchical form of R_1 , R_2 , and R_{3-n} and most but not all responses were located by reference to cultural norms. In the present case, the Bilodeau and Howell norms identified 81% of responses given by FA. By exposing the target words prior to free association, E modified the hierarchy characterizing FA. We expected the training to increase the occurrence of the target items and lower the incidence of non-target items during recall and it did. This is the phenomenon of direct associative priming (Cofer, 1967) and it occurred here with considerable magnitude. While the level of R_2 was greatly increased over standard FA levels, R_1 s did not diminish by an

Table 4
Five Classifications of Misrecall Probabilities
Obtained under the Five Methods

Method	Response Probability				
	R ₁	R _{3-n}	Other	Remainder	Blank
FA	.33	.27	.00	.18	.01
MFA	.22	.20	.02	.10	.00
SR	.13	.15	.03	.07	.04
MSR	.10	.06	.04	.11	.05
FR	.00	.01	.19	.22	.12

equal amount. Instead, prior training on R₂ (as in MFA) served to concentrate the majority of responses in the R₂ and R₁ classes and to reduce the remainders somewhat.

There is little reason to expect that word association processes would play much of a role in FR because no stimuli for association were offered and inter-item associations among the words of training were reduced to zero. Thus, FR represented a minimum opportunity for overt, E manipulated association during recall, and the FR data bore this out when virtually all of FR responses fell outside the associative hierarchy.

The instruction to recall in the presence of test stimuli systematically altered recall compared to FA and MFA. First, SR produced over 20% more R₂s than expected on the basis of free association following training (MFA), and nearly tripled the rate of R₂s produced under FA. Second, extra-experimental intrusions of R₁s and R_{3-n}s accounted for more than one fourth of the responses by SR. This was only moderate when compared to responses in these classes by MFA and FA, but is large relative to the level of such intrusions in the typical recall task (Blick, 1965). When compared, FA, MFA, and SR lead to almost the same number of responses located in the Bilodeau and Howell norms (81, 86, and 86% of all responses, respectively), but it is their distribution which differs. The thesis that SR produces mere word association behaviors following training (i.e., MFA) is refuted in the present data as it was earlier (Fox, in press).

The retrieval patterns characterizing SR hold up very well as a descriptive base for MSR as well. Explicit specification of the test stimulus in SR does not appear to be a critical variable producing the distinctive pattern. Instead, the presence qua presence of the

test stimulus during recall, specified or not, appears the major variable distinguishing SR from FR procedures.

Two conclusions emerge from the patterns of word retrieval resulting from the mixing of the variables of Table 1. First, an account of what words will be produced during the test period should not be restricted to occurrences of the target items, and must include misrecalls. Second, the three primary methods do in fact represent three diverse though related points of departure for the study of recall.

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NOTES

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2. The reliability of the data of Fig. 2 was checked by reference to a prior experiment. The earlier study was identical in all respects except for using only two word orders per page rather than 10. Based on over 600 Ss, approximately 120 per method, p(R₂s) were as follows: FA = .20, MFA = .44, SR = .57, MSR = .51, and FR = .45. The reader should note that, except in the case of MSR, none of these ps deviate by more than .01 or .02 from the value in Fig. 2. This validation is offered as a substitute for F tests with the data generated by the 300 Ss.