Advantages of recall over anticipation methods

In verbal learning¹

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The standard paired-associate anticipation procedure previously has been argued to be inferior to recall (Battig, 1965). Anticipation performance measures provide contaminated and inaccurate estimates of S's current learning level, reflecting the unnecessary confusion produced by requiring S to do too many things at once. The present paper shows these arguments against anticipation procedures to apply equally to other types of verbal-learning tasks. Even stronger advantages of recall over anticipation procedures are demonstrated for serial learning, wherein recall additionally displays a markedly greater sensitivity to the effects of relevant manipulated variables, and does not result in the classical bowed serial-position curve that has proved so difficult to understand under serial anticipation.

In verbal-learning research, like many other areas of psychology, determination of "standard" experimental procedures has often been on the basis of convenience or accident, rather than appropriateness or sensitivity with respect to the purposes of the experiment. Such a situation, and the potential difficulties created thereby, are especially well illustrated by the standard adoption of an "anticipation" procedure, wherein the correct response is presented to S immediately following his attempted anticipation of it, in the vast majority of experiments using paired-associate, serial, or verbal-discrimination learning tasks.

It is often assumed that the standard use of such anticipation procedures reflects their historical priority. In point of fact, the first experiments in both serial and paired-associate learning made use instead of a recall procedure. With this method each trial begins with the presentation of the entire list for learning followed by a "test" series in which S attempts to give the correct responses in order and/or to their proper stimuli with no informative feedback as to correctness of his responses. In paired-associate learning, such a procedure was used almost exclusively until the late 1930s (Pennington & Waters, 1938). In serial learning, the anticipation method was introduced somewhat earlier (e.g., Finkenbinder, 1913), although here too the pioneering research used a modified form of recall (Ebbinghaus, 1964).

Despite its predominant usage, several serious deficiencies and limitations for research and measurement purposes (which argue rather convincingly for their replacement by recall or other types of procedures) have recently been noted for anticipation procedures in verbal learning. These difficulties have previously been described in detail with reference to paired-associate learning (Battig, 1965), and are summarized briefly and updated in the following section. The primary purpose of this paper, however, is to extend these arguments to research in serial learning, where the anticipation procedure has recently been shown to suffer from additional defects even more serious than those operative in paired-associate learning.

Paired-Associate (PA) Learning

Our previous case against the anticipation method in PA learning tasks (Battig, 1965) was based upon the fact that

performance measures thereunder provide indices of S's learning that are both inaccurate and contaminated; in addition, there is considerable confusion induced in S by requiring him to do too many things at the same time. These shortcomings represent direct and inevitable consequences of the alternate presentation of stimulus terms for attempted response anticipation, each followed by presentation of the preceding stimulus term paired with its correct response. Thus, S's anticipation performance on any trial necessarily represents what he has learned on the preceding rather than on the present trial. Any performance measure obtained by E therefore lags one trial behind what S has actually learned, and any learning taking place during a given trial can only contaminate rather than represent S's performance during that trial. It thus becomes impossible to specify S's current level of learning in terms of his actual performance. This produces serious problems for retention and transfer experiments, where it has led to erroneous conclusions and interpretations (e.g., Underwood, 1954), and the consequent development of a variety of indirect techniques for estimating S's terminal learning level following PA anticipation learning (e.g., Runquist & Joinson, 1968; Underwood, 1964).

The alternation between stimulus terms alone for response anticipation and the presentation of stimulus-response pairs forces S to shift alternately with each new item presentation between (a) performance of what he has learned previously by anticipating the correct response when the paired stimulus term is presented alone, and (b) trying to learn the pair during its subsequent presentation, as well as comparing it with the preceding anticipation to determine its correctness. This concurrent requirement of performance, learning, and informative feedback functions, with continual shifting between them, could hardly help but confuse S and interfere substantially with performance. Viewed in this light, it should come as no surprise that PA performance under procedures (e.g., recall, prompting) that minimize this confusion for S has been demonstrated repeatedly to be at least equal to and often superior to PA anticipation. This has been demonstrated despite the alleged advantages of the immediate "reinforcement" provided by the latter (e.g., Aiken & Lau, 1967; Battig & Brackett, 1961; Cofer, Diamond, Olsen, Stein, & Walker, 1967).

All of the aforementioned problems associated with the PA anticipation procedure are substantially reduced or eliminated by what we have termed the PA recall procedure (also variously labeled as the study-test, pairing-test, blocked, or alternate-study-and-recall procedure). Because the entire list of pairs is always presented prior to any of the stimulus terms alone for attempted response-term recall, this procedure completely separates temporally the presentation of pairs for learning from subsequent performance measurement. Learning can occur only during the first half of each trial, with performance being measured during the last half, as contrasted with the concurrent involvement of both functions throughout each PA anticipation trial. Not only does this make it a less confusing procedure for S, but performance measures obtained by E reflect directly what S has learned during that trial. With anticipation performance lags one trial behind S's learning.

Other investigators (e.g., Richardson & Gropper, 1964; Underwood, 1964) have argued that substantial additional learning occurs during the recall phase of the PA recall trial, and that this makes the resulting performance measures inaccurate

estimates of S's learning level at the conclusion of the trial. Our earlier refutation of this claim (Battig, 1965) has been strengthened considerably by more recent experimental evidence, which merits brief discussion here. It has been convincingly demonstrated that the recall phase of the PA recall trial substantially increases what is learned by S during the pair-presentation series of the subsequent trial (Berry & Battig, 1966; Izawa, 1967). However, these investigators and others (e.g., Reynolds, 1965) have found no consistent or significant change whatever in performance on successive recall trials without intervening pair presentation. Further support for the latter conclusion derives from the finding of Cofer et al (1967, Experiment VII) that neither 10-min nor 24-h retention measures depend upon whether or not the last pair-presentation series had been followed immediately by a recall series. Thus, performance on each PA recall trial provides a far more accurate index of S's level of learning at that point than can be obtained from the PA anticipation procedure. Certainly any errors or biases therein are of lesser magnitude than those admitted to be inherent in the variety of indirect techniques for estimating this value under the PA anticipation procedure (Runquist & Joinson, 1968; Underwood, 1964).

Battig (1965) failed to mention an important practical advantage of the PA recall over the anticipation procedure, i.e., its amenability to written as well as to oral responding and thus to the simultaneous collection of data from groups of more than one S. Under PA anticipation, even careful monitoring may not prevent Ss from writing down responses after, rather than before, they have been shown the response term. With PA recall, however, presentation of stimulus terms during the recall series, either printed on the recall sheet or projected on a screen in front of the Ss, permits accurate and uncontaminated written records of Ss' performance. Any possibility of "cheating" is readily precluded simply by arranging for these recall sheets to be available to S only during the recall series of each trial.

Serial Learning

All of the arguments marshalled in the preceding section against the PA anticipation procedure are at least as applicable, if not more so, to the corresponding "standard" anticipation procedure for the study of serial learning. Serial anticipation differs from the PA procedure principally in its requirement that S do more things at once, with greater consequent confusion. More specifically, serial anticipation requires that during every item presentation, S must anticipate the next item at the same time that he is trying to learn the one being presented, and, of course, he must compare it with his preceding anticipation to determine its correctness. Thus, simultaneous performance, learning, and informative feedback functions are required of S during each serial anticipation item presentation. This clearly exceeds the PA anticipation requirement that S alternate between performing by anticipating when stimulus terms alone are presented, while learning and informative feedback processes occur during the subsequent pair presentation.

In addition to and perhaps because of the added confusion induced thereby, serial anticipation differs from serial recall in other important ways not applicable to the anticipation-recall comparison in PA learning. Whereas PA recall need differ from anticipation only in the sequence in which stimulus terms and stimulus-response pairs are presented, serial recall must also differ from serial anticipation either in presentation rate or total time per trial, most typically the latter. Consequently, the anticipation-recall performance comparisons that have contributed so much to the increased use of the PA recall procedure have not been and cannot meaningfully be made, nor can they clearly be interpreted within serial learning.

The serial-recall procedure most closely comparable to standard serial anticipation begins each trial with successive presentation of the entire serial list exactly as done under serial anticipation, except that S does not attempt to anticipate these items during list presentation. Instead, he subsequently tries to recall as many items as he can in their proper positions during a series of blank intervals equivalent to the number of items in the list. These intervals are of the same duration as item presentation, and S receives no feedback during attempted serial recall. To be counted as correct, an item must be recalled during the blank interval representing its serial position in the list.

Since each serial-recall trial thus takes twice as long as a serial-anticipation trial, the finding of markedly faster serial recall than anticipation learning is in itself of relatively little importance (Battig & Lawrence, 1967). Less contaminated evidence that serial recall is at least as effective a learning procedure derives from its close comparability in performance to a modified serial-anticipation procedure, with a blank anticipation interval interpolated between successive item presentations (Huang, 1969). Nonetheless, the likelihood that serial recall is less confusing to S and thus a more efficient learning procedure pales into insignificance beside another difference emerging repeatedly from several recent comparisons between serial anticipation and recall procedures. This difference, which thus far has been found for no verbal-learning task other than serial learning, is the markedly greater sensitivity of the serial-recall procedure to the effects of other variables manipulated in serial-learning experiments.

This difference in sensitivity to the effects of other variables between serial recall and anticipation procedures was far and away the most important, albeit unexpected, finding emerging from the first reported comparison between the two methods (Battig & Lawrence, 1967). In this experiment, the other two manipulated variables involved (a) use of a single serial order with a constant as compared with varied starting points within this order from trial to trial, and (b) transfer to a second serial order that was either the mirror-image reversal or an unsystematic scrambling of the serial order employed in the first list. In agreement with previous results (see review by Young, 1968), the anticipation technique showed at best a marginally significant superiority of constant over varied starting points and of reversed over scrambled order. Under serial recall, however, both variables produced highly significant effects as well as significant interactions showing, e.g., greater differences favoring a reversed over scrambled order with varied starting points. The overall between-groups F ratio was over nine times as large for serial recall as for anticipation, with the former showing three times as much between-groups variance but only one-third as much within-groups error variance as was obtained under serial anticipation.

Subsequent experiments have confirmed that serial recall is far more sensitive than anticipation to the demonstration of significant effects of relevant experimental variables in serial learning. This holds even when the effects of these variables are measured subsequent to the completion of serial learning, under identical procedural conditions. Whereas serial anticipation produced neither facilitation of subsequent PA learning of pairs of adjacent items from the serial list, nor interference for pairs of nonadjacent items from this list, these respective facilitation and interference effects both appeared quite clearly following serial-recall learning (Battig & Selkin, 1968). Similar results subsequently were obtained for transfer to PA learning of pairs of number stimuli paired with response items from a previously learned serial list. Following serial-recall learning, such PA learning was facilitated when the numbers corresponded to the previous serial positions of these items, and inhibited when they

did not. Again, serial-anticipation learning produced neither PA facilitation nor inhibition for appropriate and inappropriate number-item pairs. That the greater sensitivity of serial recall is not limited to variables relating directly to serial order is demonstrated by Huang's (1969) finding that deleterious effects of required pronunciation of each item during its presentation were found only under serial recall. No significant difference of these "read" from "silent" conditions, however, was found under a serial-anticipation procedure.

Since the aforementioned serial recall-anticipation comparisons were all carried out in the context of the recent controversy over "what is learned in serial learning," they provide a particularly apt demonstration of the erroneous conclusions and interpretations that can eventuate merely from the inadvertent usage of an inappropriate and insensitive experimental procedure. The puzzling and still unresolved controversy over how serial learning takes place (Young, 1968) originated with Young's (1959) report of no facilitation of subsequent PA learning of pairs of adjacent items from the serial list. This result was directly counter to the then prevalent interpretation of serial learning as the formation of sequential stimulus-response associations between adjacent items. The aforementioned Battig-Selkin (1968) experiment, however, showed this result only under serial anticipation. In contrast, their serial-recall results were entirely consistent with a sequential-association interpretation. Thus, if Young and other pioneers in this controversy had used a serial recall rather than an anticipation procedure, it is likely that the controversy itself would not have developed. In fact, the clearest conclusion emerging from an examination of the now substantial literature on this controversy (Young, 1968) is that most of the evidence offered in support of any interpretation of "what is learned in serial learning" really consists of evidence that the serial learning and/or transfer differences that should be produced according to some competing alternative interpretation(s) are not found (Battig, 1969). Thus the apparent inadequacies of, e.g., either sequential or serial-position associative interpretations of serial learning may reflect instead the inherent insensitivity of the serial-anticipation procedure to the effects of variables that these interpretations indicate to be important.

Under serial recall, on the other hand, significant effects are easily demonstrated for variable manipulations relevant to both sequential and position associations. Unfortunately, the limited evidence presently available is insufficient to determine whether serial recall and anticipation methods differ in the learning processes involved as well as in sensitivity. It is already clear, however, that simple sequential and associative processes are quite insufficient to account for serial-recall learning, and require supplementation if not supplantation by more complicated associative or thought processes (Battig, 1969). The important point for present purposes is that the insensitivity of the standard serial-anticipation procedure makes it clearly inadequate and inferior to serial recall for the investigation of this or other basic questions about serial learning.

The classical bowed serial-position curve, long the phenomenon of primary concern to researchers and theorists in serial learning, also turns out to be limited to the serial-anticipation procedure and may even be merely an artefact thereof. The serial-position curve obtained under the serial-recall procedure shows a marked reduction, if not the virtual elimination, of the progressive improvement over the last few items of the serial list that has been largely responsible for the long-standing interest in and innumerable attempts to account for the serial-position effect. Furthermore, similar differences between anticipation and recall curves are also obtained during learning of a single list by Ss who were required to anticipate the items during list presentation as well as to recall them subsequently (Battig & Selkin, 1968). This

suggests that the differences between serial-position curves for anticipation and recall reflect differential performance conditions, rather than more basic learning differences between the two procedures. In any event, the shape of the serial-recall position curve is much more easily understood without need for the complicated theoretical mechanisms variously invoked to explain the bowed serial-position curve produced under the anticipation procedure. Thus the bowed serial-position curve, along with the extensive research and theorizing produced thereby, appears of importance only when the serial-anticipation procedure is employed, rather than being generally characteristic of serial learning.

These arguments against the serial-anticipation procedure appear far stronger than the case against PA anticipation. Serial anticipation is subject to all of the disadvantages enumerated in the preceding section for the PA anticipation procedure. In addition, serial anticipation suffers from the far more serious deficiency of inadequate sensitivity to the effects of relevant experimental variables. This has produced serious misinterpretations based on behavioral phenomena that are limited to serial anticipation, and are not characteristic of serial learning in general. A further practical advantage of serial recall over anticipation, recently noted by Es in our laboratory with experience in instructing Ss for both types of procedures, is that the serial-recall procedure is much easier to explain to Ss, probably because it has much more in common with the way serial learning is typically done outside the verbal-learning laboratory. Thus, continued use of the serial-anticipation procedure seems justified only if a maximally confusing, contaminated, and insensitive experimental method is appropriate. Otherwise, it would appear that the serial-anticipation procedure should be discarded in favor of serial recall and/or alternative as yet undeveloped serial-learning methods that avoid the serious difficulties associated with serial anticipation, both for S and for E.

Other Verbal-Learning Tasks

The only other type of verbal-learning task where anticipation and recall procedures have been directly compared is verbal-discrimination (VD) learning. In the standard VD anticipation procedure, S must learn to respond with the arbitrarily designated "correct" member within each of a list of nonoverlapping VD pairs, each pair being followed by presentation of the correct item alone from that pair, or some other designation of the correct item (e.g., underlining the correct item in the pair or E saying "right" or "wrong" following S's response to each pair). As in PA and serial-recall procedures, separation of learning from performance functions is accomplished in the VD recall procedure by beginning each trial with the presentation of all correct items alone for learning, followed by presentation of all the VD pairs for performance measurement without any informative feedback concerning correctness.

In the single reported comparison between VD anticipation and recall procedures (Battig & Switalski, 1966), there was significantly faster learning with the latter. Unlike serial learning, however, VD recall and anticipation did not differ at all in subsequent transfer to PA learning of pairs of correct VD items, such transfer not being significant for either procedure. During the writing of this paper, another VD anticipation-recall comparison was completed in the Colorado laboratories by B. R. Ekstrand and L. J. Ingison with very similar results. Performance under VD recall was consistently superior to anticipation, although this difference failed to achieve statistical significance. Also, the recall procedure was, if anything, insignificantly less sensitive than anticipation to the two major manipulated variables of presentation rate, and mode of presentation of correct items

(presentation of correct item alone vs pair with correct item underlined).

Thus the limited VD recall-anticipation comparisons appear closely comparable to results and conclusions emanating from the more extensive comparisons in PA learning. So criticisms of the PA anticipation procedure seem also applicable to VD anticipation learning.

As for free-recall learning, the fourth major type of verbal-learning task, the requirements of the task itself virtually force the use of a recall procedure. This task requires S to learn a list of individual items, but not in the order in which they are presented, which typically is varied unsystematically from trial to trial. In this case, S is permitted to give these items in any order that they occur to him. Thus, unlike other verbal-learning tasks wherein an anticipation procedure has become standard, there is no way in which "anticipation" can meaningfully be used in free-recall learning. To make this comparable to other verbal-learning anticipation procedures, each response given by S would need to be followed by presentation of that item, whereas all items not recalled would have to be presented following those occasions when S gave no response or an erroneous response. Extremely sophisticated or computer-controlled instrumentation clearly would be required to present S with an item immediately after each response when the item to be presented is determined by the response S has made. Even so, such an "anticipation" procedure would make little or no sense for the investigation of such learning. At least as much confusion as in PA and serial-anticipation learning would result from, e.g., giving an erroneous or no response and having this followed by presentation of some quite different item S was then supposed to learn. In any event, there are no reported attempts to apply an anticipation procedure to the study of free-recall learning. In fact, it is not unlikely that the coincidence of the period of predominance of PA and serial-anticipation procedures with a dearth of research in free-recall learning, as noted by Tulving (1968), may reflect at least in part the inappropriateness of the anticipation technique to the free-recall task. If comparable types of procedures are to be used across all types of verbal-learning tasks including free-recall learning, this clearly will have to be a recall rather than anticipation procedure, thus providing still another important advantage of recall procedures in verbal learning.

A Terminological Note

As noted previously, considerable semantic confusion presently exists, particularly within PA learning, due to the multiplicity of labels applied by various investigators to refer to exactly the same procedure. Although our appellation of this as the PA recall procedure (Battig & Brackett, 1961) seems to be used with at least comparable frequency to any single alternative label, the total usage of other commonly used labels (e.g., study-test, pairing-test, alternate study and recall) is probably greater than for recall.

It thus appears high time for verbal-learning researchers in general, and PA researchers in particular, to agree upon a single label for the commonly-used alternative to the anticipation procedure. The main advantages accruing to the PA recall label appear to be that (a) it is shorter than any of the alternatives, (b) it alone is comparable to "anticipation" in describing what kind of performance is required of S, and (c) it represents the label typically applied to the comparable procedure in other types of verbal-learning tasks. Any confusion between these various types of recall is readily eliminated by continuing the already common practice of preceding the term "recall" by some indication of the type of recall (e.g., free, serial, PA, response,

stimulus, modified free, modified-modified free, etc.). Since there is no hesitancy to refer to any of the latter as recall methods, even by those who refuse to apply the term PA recall, it is puzzling indeed why the multiplicity of labels and consequent severe semantic confusion should apply only to the PA technique. We have yet to hear a convincing argument against calling this the PA recall procedure, in contrast with the advantages enumerated here for this over alternative labels. Hopefully, these will be sufficient to bring about universal adoption of the PA recall label and to eliminate the considerable current semantic confusion over what to call this procedure.

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