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Expectancies as a determinant of interference phenomena

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One version, by Lockhart, Craik, and Jacoby, of a levels-of-processing model of memory asserts the importance of the role of expectancies about forthcoming information in determining the elaborateness of a memory trace: Expectancies that are subsequently confirmed are presumed to result in less-elaborated traces (via an abbreviation of the required number of cognitive operations) than expectancies that are disconfirmed. The present experiment was a test of the extension of this model to account for the buildup of and release from proactive interference seen in the Brown-Peterson task. The results of the experiment do not support this extension and particularly cast doubt upon the assumption that disconfirmations of expectancies result in especially elaborate memory traces.

The idea that special forms of processing are induced whenever there is a mismatch between an expectation and an outcome has been put forward to account for phenomena seen in various fields of psychology, including cognitive development (Kagan, 1970), social psychology (Brickman, 1972), information processing (Kahneman, 1973; Neisser, 1976) and animal and human learning (cf. Rescorla and Wagner, 1972; Rudy, 1974). Indeed, a recent revision (Lockhart, Craik and Jacoby, 1976) of the levels of processing model (Craik and Lockhart, 1972) also places some emphasis upon the importance of expectancies and their disconfirmations in human memory.

Lockhart, Craik, and Jacoby (1976) argue that expectancies are a potential source of processing efficiency because they provide a structure for incoming information that reduces the number of perceptual and "cognitive" operations required to encode a stimulus, at least if that stimulus confirms the expectancy. If however, the stimulus disconfirms the expectancy, more elaborate processing, or a greater number of operations, are required (cf. also Kahneman, 1973). It should be noted that within the framework of a levels-of-processing analysis of memory (cf.

Craik and Tulving, 1975), it is the elaborateness of the memory code that determines its accessibility. Unexpected events, with their elaborated memory traces should then be remembered better than expected events.

Among the various memory phenomena to which Lockhart et al. extend this aspect of their model is the buildup of interference seen in the Brown-Peterson task (cf. Lockhart et al., p. 99). The following is an elaborated version of their discussion. As the subject processes the initial triad of items at the semantic level, he or she encodes their categorical relation. This then becomes part of the expectancy the subject forms about the semantic aspects of items to be presented on future trials. As long as the category remains the same, this expectancy will be confirmed and the processing of items will be accomplished more efficiently than was the case on the first trial because of the reduction in the number of operations required to place the new item in a structure. This efficiency will, however, result in an increasingly sparse memory trace — an event reflected in the decline in performance across successive Brown-Peterson trials. One must also assume that there are a minimum number of cognitive operations required to match an incoming stimulus to an expectancy and consequently a maximally sparse memory trace to account for the fact that recall asymptotes after several trials in this task.

Such an explanation can easily be extended to account for the increased recall seen on category-change trials: A category change results in a mismatch between the expectancy and the outcome, requiring the subject to include the categorical identification stage in his analysis of the new triad. This more elaborate processing then results in a richer memory trace than would be expected were there no such mismatch. Note that this explanation of the buildup and release from interference does not depend upon the category change as its critical component; rather, it depends upon the number of cognitive operations required to assimilate the new information. Instances representing a new category require at least one, if not more, additional levels or stages of processing (the identification of the category itself) than do instances representing a category that has already been identified on the basis of previous experience and whose label had formed part of the expectancy device. This increase in the number of operations required to assimilate information will occur if the category is "new" to the subject in the context of the experiment or if the category is one that the subject is not expecting on a particular trial.

One should thus be able to vary the level of recall seen in the Brown-Peterson task by influencing the number of operations required to assimilate information. Indeed it should be possible to simulate "release," or an increase in recall, by increasing the number of operations required, whether or not the category changes. One should also be able to maintain stable performance, by holding constant the number of operations required, again whether or not the category changes.

The present experiment is an explicit test of the extension of the Lockhart et al. expectancy hypothesis to the buildup and release of interference in the Brown-Peterson task. After a series of Brown-Peterson trials in which subjects' category expectancies were confirmed, a critical trial was introduced in which half the subjects had their category expectancies disconfirmed and half had them confirmed. This presumably required the former group of subjects to engage in at least one more operation — the discovery of the unexpected category — than was the case for the latter group of subjects. For half of the subjects in each of these two groups there was a category switch, for half there was not. If category expectancies determine the number of operations that in turn determine the richness of the trace, those subjects who receive a disconfirmation (and so have to add at least one operation) should show "release," or at least some increase in recall, whether or not the category changes, while those who receive a confirmation (and so may continue to do without a category abstraction stage at the time the triad is presented) should show less release, or perhaps even none, whether or not the category changes.

The present experiment was then a stringent test of the extension of the Lockhart et al. model to the Brown-Peterson task. In the obverse of the usual situation, a disconfirmation of a category expectancy was induced for subjects who continued in an old category and a confirmation was induced for subjects who received a new category. Comparing the performance of these conditions with that of the more typical "release" and "control" conditions enabled us to attribute release to the number of operations required by the confirmation or disconfirmation of an expectancy concerning the category membership of the forthcoming words, to the category-change operation or to both potential processes. The answer was quite clear: Category change was the sole determinant of performance.

In the present experiment the critical expectancies were induced by explicit instructions given to subjects concerning the category membership of the group of 3 words they were about to see. Thus in contrast to the usual Brown-Peterson task, subjects had 2 sources of information from which to form expectancies: experience with items on prior trials and the instruction. While it is conceivable that an instructionally induced expectancy is not the equivalent of an experientially determined one, it is unreasonable to assume that those provided by the experimenter have no psychological consequences. Were this so, weather reports, look outs and other verbal warning systems would be useless in aiding the processing of information. In the psychological literature, there are verbal set effects that may be seen in both the perceptual (Neisser, 1976) and problem-solving literatures (Bourne, Ekstrand, and Dominowski, 1971). For example, a verbal instruction about the contents of a picture is as beneficial to processing speed as is having seen the actual picture (Potter, 1975). Nonetheless, various procedures were adopted to increase the validity of the experimenter-provided expectancy.

METHOD

Procedure

All subjects were tested on a series of ten 3-word Brown-Peterson trials, with the tenth trial, to be discussed later, serving as the critical experimental trial. The first 9 trials were divided into blocks of 3 successive trials whose instances were from the same taxonomic category. Thus category changes occurred on trials 4 and 7. The major change in procedure between the present study and others occurred in the introduction into the task of an overt, experimenter-induced category expectancy. This was effected by preceding each of the first 9 trials with correct information about the category membership of the succeeding instances.

One may assume on the basis of the Lockhart et al. model that a category name that precedes by several seconds a set of representative items will be processed both perceptually and cognitively, including, no doubt, on the semantic level. The likelihood of such processing was increased in the present instance by the use of familiar categories. This experimenter-provided expectancy should then serve in much the same way as the expectation subjects are presumed to derive on their own on the basis of a single trial in the standard version of the Brown-Peterson task. That is, it eliminates the need to process the category membership of subsequent representative instances. It should be noted here that Lockhart et al. suggest that expectancies can come from any of several sources, including immediate experience, previous experience, set, and instructions.

In order to increase the validity of the experimenter expectancy, and the likelihood that the subject will use it, two procedural decisions were made on the basis of pilot investigations: One was to allow the subject sufficient time for the category label to be assimilated; the other was to allow the subject sufficient experience with the confirmation of this expectancy (9 trials) prior to the introduction of a critical disconfirmation trial.

Each trial was comprised of the following series of events, the timing of each of which is shown in parentheses: an expectancy slide, which instructed the subject to expect instances of a particular category (5 sec); a blank slide (5 sec); the 3 category instances (2 sec); the distractor-task slide, containing a randomly chosen 3-digit number from which the subject counted backwards by three's (15 sec); a test slide, indicating to the subject that she or he should recall the category instances studied on that trial (15 sec). The subject was required to read the category instances aloud and to count aloud.

Prior to the first experimental trial, all subjects were fully informed of the details and timing of the procedure. They were then given a practice trial, paced at the experimental rate, with items from a category not used in the experiment proper. They also received practice in backward number counting. The materials were presented on slides by an externally timed projector. All subjects were tested individually.

The 4 critical experimental conditions occurred on the tenth trial where one-half of the subjects received a disconfirmation of their experimenter-induced expectancies. Those subjects who received a disconfirmation were divided into 2 groups differing in the way the disconfirmation was accomplished: For one subgroup of subjects it was effected by introducing items from a new category when the expectancy slide indicated they were to remain in the old category (disconfirmation + change); for the other subgroup of disconfirmed subjects it was effected by maintaining the previous category when the expectancy slide signaled a category change (disconfirmation + no change). Similarly, the subjects who received a confirmation of their expectancies were divided into 2 subgroups that differed in the source of the confirmation: One subgroup expected and received a category change (confirmation + change); the other expected and received no category change (confirmation + no change). The design of the critical trial can be conceived of as a 2 × 2 factorial combination of the category variable (change versus no change) with the expectancy variable (confirmation versus disconfirmation).

Materials

The materials were selected from an earlier study that used 12 triads from each of 4 categories: body parts, foods, clothing, and animals (Hasher, Goggin, and Riley, 1973). Four triads from each category were selected at random for use in the present study. Across all 4 experimental conditions the sequence of categories was counterbalanced such that each category served equally often in each of the 3 blocks comprising the first 9 trials. The 4 categories were also represented equally frequently on the tenth, critical trial. In addition, in order to make certain that performance on the critical trial was not determined by the unique triad presented, across all 4 conditions each of the 4 triads from a given category served in this position equally often. Within each condition any given category occurred on the final test trial for 12 subjects, with subgroups of 3 subjects receiving the identical triad. This assignment procedure required 48 subjects per condition. For all other trials the particular sequence of triads within a category was randomly determined.

Subjects

The subjects were Temple University undergraduates who received course credit for their participation. Several subjects were initially discarded because of mechanical failures while others were because they failed to follow the counting directions. A few subjects had to be discarded because they either could not or did not read the 3 stimulus items in the 2-sec presentation interval. After the data collection phase was completed, with 48 subjects in each of the 4 conditions, we discovered that one subject had to be discarded because of an experimenter error on the tenth, critical trial. Thus there were 48 subjects in 3 of the conditions but only 47 subjects in the disconfirmation + no change condition.

RESULTS AND DISCUSSION

The dependent measure was the number of items, out of three, recalled on a given test trial. The means for each condition on the first 9 test trials may be seen in Table 1. All significant results are so at or beyond the .05 level.

Comparability of groups

On the first 9 test trials, all 4 groups of subjects were treated identically, and it was important that there be no performance differences among groups on these precritical trials. That this was the case, with the possible exception of trial 9 is clear from an inspection of Table 1. Despite appearances, however, there were no differences among the groups on trial 9, $F(3, 187) = 2.36$. The trial 9 data were also analyzed by sorting the groups into the treatment conditions they were to receive on trial 10. This 2 (confirmation versus disconfirmation) by 2 (category change versus no change) analysis revealed effects of borderline significance, at the .05 level, for the dummy confirmation manipulation, $F(1, 187) = 3.24$, $MS_e = .85$, and for the dummy category change manipulation, $F(1, 187) = 3.87$. Although all groups were treated identically on trial 9, the 2 groups that were to have their expectancies confirmed on trial 10 performed slightly better on trial 9 (2.18) than did the 2 groups that were to have theirs disconfirmed (1.94). In addition, the 2 groups that were to continue to receive the same category on trial 10 recalled more words on trial 9 (2.19) than did those groups that were to receive a new category (1.93). Why this pattern should appear on trial 9, given that all subjects were treated alike on this and on all preceding trials and also given that performance differences prior to trial 9 were minimal, is not obvious. These differences do not, however, invalidate the comparisons of interest on trial 10, although they must be considered in any interpretation of those results.

Table 1. Mean number recalled in first nine test trials

	Test Trial Number								
Condition	1	2	3	4	5	6	7	8	9
Expectancy confirmed									
Category change	2.65	2.52	1.98	2.71	2.29	1.92	2.52	2.19	2.04
No change	2.69	2.21	1.94	2.60	2.29	2.10	2.58	2.04	2.31
Expectancy disconfirmed									
Category change	2.52	2.15	1.94	2.56	2.23	2.00	2.54	2.19	1.81
No change	2.53	2.38	1.91	2.68	2.19	1.98	2.62	2.30	2.06
Mean	2.60	2.31	1.94	2.64	2.25	2.00	2.57	2.18	2.06

Replication of PI buildup and release phenomena

The buildup of interference as subjects continue to receive instances from the same category and the dissipation of that interference as the category changes are well-documented experimental findings (cf. Wickens, 1970). Our data present no exception, as can be seen in Table 1, with all 4 conditions showing a significant buildup of interference on trials 1–3, 4–6, and 7–9 and also significant release effects on trials 4 and 7. There are 2 noteworthy aspects of these results: For one, all subjects on the category-change trials (4 and 7) had been warned, via the expectancy slide, that instances from a new category would be forthcoming. When these instances appeared, 5 sec later, they theoretically should have confirmed the subjects' experimentally induced expectancies. These were both situations in which no disconfirmation occurred, yet recall improved. Second, the extent of release did not diminish much from the first category change trial (4) to the second (7) even though on this latter occasion subjects had more experience with the validity of the expectancy slide.

Critical trial performance

Performance on trial 10 was analyzed using a 2 (confirmation versus disconfirmation) by 2 (category change versus no change) analysis of variance. This analysis, easily confirmed by an inspection of Figure 1,

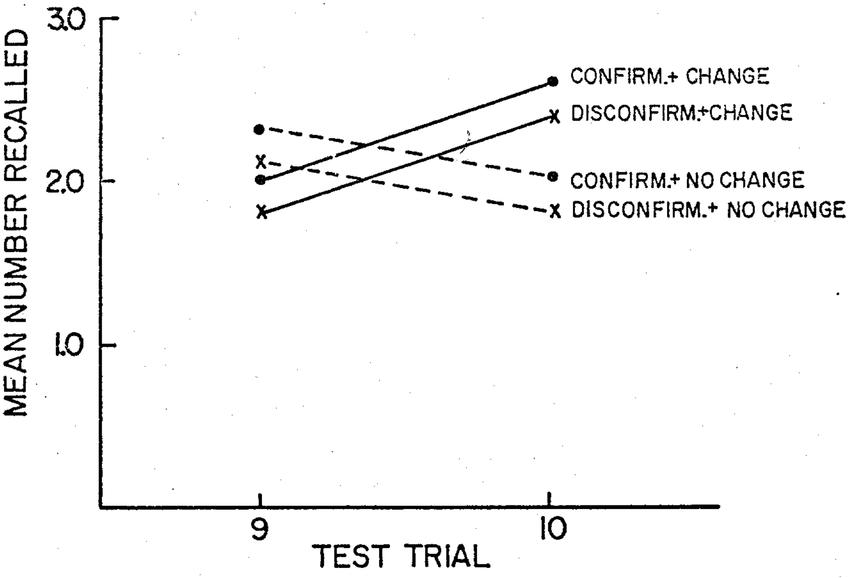

Figure 1. Mean number of words recalled on trials 9 and 10

shows clearly that performance of the 2 conditions that received a category change was superior to that of the 2 conditions that received no change, $F(1, 187) = 22.80, MS_e = .82$. Whether a subject's expectancy was confirmed or disconfirmed had no significant effect on performance, $F(1, 187) = 2.49$. While the mean recall (2.12) for the disconfirmed groups was lower than the mean recall (2.32) for the confirmed groups, a trend in the same direction was also present on trial 9, prior to the introduction of the discrepancy manipulation. Finally the expectancy procedure did not interact with the category procedure, $F < 1$.

A comparison of performance on trial 9 with that on trial 10 (Figure 1) also shows clearly that improved recall is associated only with the introduction of a category change. Expectancies play no significant role in influencing performance. An analysis of variance that included trials as an additional factor confirmed these conclusions.

It is clear from these results that release from interference in the Brown-Peterson task cannot be attributed to a presumed disconfirmation of the expectancy that the new instances will be members of the old category; subjects whose expectancies for a new category were violated by the maintenance of an old category did not show "release." It is also clear that the continued presence of interference for the typical control subjects in this task — subjects who continue to receive instances of the old category — is not induced simply by minimal processing that is the result of the confirmation of a category expectation; subjects whose category expectations were confirmed with instances from a new category did in fact show "release."

With regard to the Lockhart, Craik, and Jacoby model, one must either conclude that recall is not a function of the elaborateness of the trace (but see Craik and Tulving, 1975), or that disconfirmations of expectancies do not produce more elaborate traces than do confirmations of expectancies, at least when those expectancies concern the categorical membership of new groups of words in the Brown-Peterson task.

Notes

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