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Proactive inhibition as a function of orienting task characteristics

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Two release from proactive inhibition experiments were conducted, in which orienting tasks were employed to direct subjects' attention to particular features of words. Experiment 1 employed two such tasks which emphasized either semantic or nonsemantic features, while both orienting tasks in Experiment 2 directed attention to semantic features of words. Although significant release was obtained with a change in task in these experiments, the level was considerably lower in Experiment 2 than in Experiment 1. The data were interpreted in terms of a theoretical orientation that emphasizes item differentiation as a major determinant of retrieval probability. It was argued that the degree of differentiation depends to some extent on the specific tasks employed and the extent to which they direct attention to different word features.

The release from proactive inhibition (PI) paradigm, developed by Wickens and others, has frequently been employed to identify important coding dimensions in short-term memory (see Wickens, 1972, for a review of this literature). The procedure involves a number of trials, during each of which several to-be-remembered (critical) items are presented, followed by some distractor task and a test for recall of the original items. Typically, the items presented on the first several trials share some attribute (e.g., they might be names of animals), and recall tends to decrease from trial to trial (presumably due to a buildup of PI). After several trials there is a shift so that the critical items share some different attribute (e.g., they might be names of trees), and, for a number of dimensions which have been tested, recall increases dramatically.

Theoretical attempts to explain this buildup and release of PI have generally focused on either storage difficulties or difficulties in retrieving the appropriate items (cf. Watkins & Watkins, 1975). In contrast to an emphasis on one or the other of these problems, Bird (1976) offered an account which emphasized the relationship between input (storage) and output (retrieval) events. According to this argument, successful retrieval of critical items at output is determined, at least in part, by the extent to which a subject can adequately differentiate critical items from other items in memory. Item differentiation, in turn, is partially determined by processing events which occur at input. Thus, in a release from PI paradigm, PI should occur when the most salient cues available at input (e.g., the semantic organization, temporal context, etc.) are no longer adequate to differentiate critical items from other items in memory. When a shift is made in the organization of the items, release from PI should occur only if the change is employed by subjects to provide increased item differentiation.

Bird (1976, Experiment 1) examined the effect of processing events at input on item differentiation in an experiment which employed orienting tasks to control processing. There was no formal dimension of organization for the critical items, but two tasks were employed which required subjects to generate either a rhyme or a modifier for each word. These tasks were adapted from a study by Johnston and Jenkins (1971) and were assumed to direct attention to different attributes of words. The prediction was that release from PI would be produced by a change in task after several trials, regardless of the direction of the change, because the subjects would attend to different information related to the critical items, and, hence, would have a more effective retrieval cue at recall. The results indicated substantial release on the final trial, and it was argued that release from PI in this setting was a function of processing requirements at input which determined the difficulty of retrieval at output.

The present study involved two experiments which examined the importance of item differentiation in a more systematic manner. Experiment 1 employed two different orienting tasks (pleasantness judgments and estimates of the number of letters in each word), adapted from a study by Hyde and Jenkins (1969). It was assumed that the pleasantness judgments task would direct attention to semantic features of the critical items, while the letter estimating task would not. In addition, a semantic organization dimension was included, in part to examine the relative effects of

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changes in orienting task and changes in semantic class on the final trial. Experiment 2 also employed two orienting tasks, but both tasks in this experiment were assumed to direct attention to semantic word features (pleasantness judgments and classification of items as active or passive). The objective was to determine whether the differentiation provided by a change in task depends on the specific tasks employed and the extent to which they direct attention to different word features.

EXPERIMENT 1

The pleasantness judgments and letter estimating tasks employed in this experiment were selected because they permit a faster presentation rate of the critical items than was possible in the previous study (2.5 sec onset to onset, as compared to 5.0 sec in the earlier study). The rapid presentation rate should increase the generality of the results, since most release from PI experiments employ a rapid rate. In addition, the faster rate should allow little time in which subjects might engage in coding activities unrelated to the specific orienting task. It was expected, based on the level of release obtained by Bird (1976), that changes in orienting task would produce a level of release comparable to that obtained with a change in semantic organization. It was also expected that a change in both organization and orientation would produce greater release than either change alone, since a shift along two dimensions should provide greater item differentiation.

Method

Design. The design was a 4 by 2 by 2 by 4 factorial, in which the factors were experimental condition, processing operation on the first three trials, semantic organization on the first three trials, and the within-subjects trials factor. Thus, on Trials 1-3, a given subject performed one of the two orienting tasks on items from one of the two semantic categories. The four experimental conditions were then determined by changes in processing or semantic organization on Trial 4: A no-release control condition continued with the same task and the words came from the same semantic category. A processing release condition and a semantic release condition received changes on Trial 4 in orienting task and semantic category, respectively. Finally, a double release condition received both a change in orienting task and semantic category on Trial 4. A cue slide presented at the beginning of each trial signaled subjects as to the appropriate orienting task for that trial.

Materials and procedure. The experimental items were selected from the Battig and Montague (1969) categories of sports and occupations (20 items from each). The items in each category were assigned to groups of five critical items on a random basis, with the restriction that the total number of syllables in each group did not differ by more than one. The presentation order of the four groups of words seen by an individual subject was determined by a randomized 4 by 4 Latin square.

The words were printed in block letters on 2 x 2 in. slides. The interval between presentation of the words and recall was filled with a digit-reading task involving randomly chosen digits (0-9) printed in the form of a 5 by 5 array on 2 x 2 in. slides. All materials were presented by a Kodak Carousel projector, which was advanced by a Hunter timer, and the recall intervals were timed with a stopwatch.

Instructions were read by the subject and were the same in all conditions, so that all subjects were prepared to perform both processing operations. If the operation was "pleasantness," then as each word appeared on the screen the subject was to say aloud whether the word was pleasant or unpleasant. If the operation was "letter estimating," then the subject was to give an estimate of the number of letters in each word. Subjects were specifically instructed that it was not necessary to actually count the letters. No suggestion was made that the orienting tasks should be used to assist the subject in remembering the words, and no information was given with regard to the semantic organization of the items.

Each trial began with a 2.5-sec presentation of a slide, with either "pleasantness" or "letter estimating" printed in letters larger than those used for the experimental items. The five words for that trial were then presented one at a time, at a 2.5-sec rate (onset to onset). While each word was on the screen, the subject gave an appropriate response aloud. Following the five words, four number arrays were presented for a total of 18 sec (at a 4.5-sec rate), during which time the subject read the numbers aloud as quickly as possible from left to right across each row. Finally, a slide with three question marks was presented for 20 sec and the subject tried to recall the original five words aloud. The procedure continued in this manner for four trials.

Subjects. Students at Florida State University served as subjects, in partial fulfillment of a requirement of either the introductory psychology course or the undergraduate human learning course. There were 16 subjects in each of the four experimental conditions, making a total of 64 subjects. Subjects were tested individually and were assigned to conditions randomly, with the restriction that there were equal proportions of males to females and of students from the two different courses in the four experimental conditions.

Results and Discussion

Responses were scored as correct when they were given within the recall interval of the trial on which they first occurred, without regard to the original order of the words. Figure 1 presents the percentage of correct responses as a function of trials for the four experimental conditions. It may be seen that there was a general decrease in performance over trials, with a distinct increase on Trial 4 for the three release conditions. Although differences among the various release conditions on Trial 4 are not striking, the double shift condition tended to produce the greatest release, and performance in the processing shift condition tended to be greater than in the semantic shift condition.

A 4 by 2 by 2 by 3 analysis of variance, which was calculated for Trials 1-3, revealed a significant main effect of trials [$F(2,96) = 33.40$, $p < .001$, $MSe = 1.38$]. In addition, there was a reliable main effect for counterbalancing on orienting task [$F(1,48) = 23.25$, $p < .001$, $MSe = 1.26$], with the pleasantness task producing higher recall than the letter estimating task. Orienting task also interacted reliably with the trials factor [$F(2,96) = 4.12$, $p < .05$, $MSe = 1.38$], because the pleasantness task led to a proportionately greater decrease in performance over Trials 1-3 than did the letter estimating task. Finally, orienting task interacted reliably with experimental condition [$F(3,48) = 7.62$,

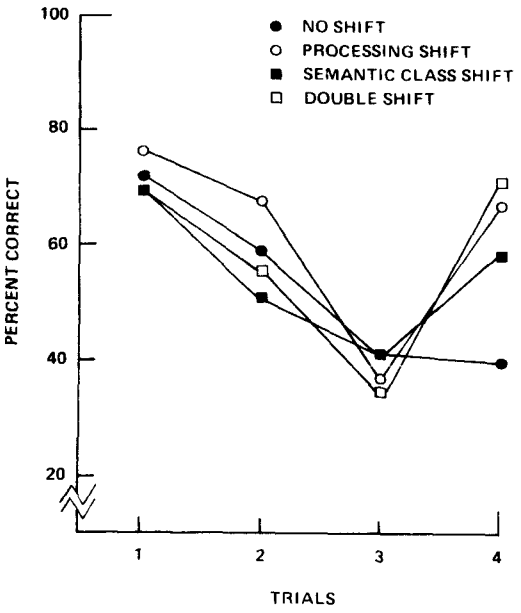

Figure 1. Percentage of correct responses as a function of the four release conditions and trials: Experiment 1.

$p < .001$, $MSe = 1.26$]. There are no apparent theoretical implications of this interaction, however, and there was no three-way interaction of experimental condition, orienting task, and trials.

A separate 4 by 2 by 2 analysis was calculated for performance on Trial 4. The only significant factors in this analysis were the main effects of experimental condition and of counterbalancing on orienting task [$F(3,48) = 7.13$ and $F(1,48) = 16.00$, respectively, $p < .001$, $MSe = 1.00$ in both cases]. The absence of any interactions involving experimental condition suggests that any release was symmetrical, regardless of the direction of the change in task or semantic organization. A Newman-Keuls test, calculated for the four experimental conditions on Trial 4, revealed that the three release conditions differed reliably from the control condition ($p < .05$), but not from each other.

The release from PI obtained following a shift in orienting task replicated the previous study by Bird (1976). The results also demonstrated that a shift from a semantic to a nonsemantic task, or vice versa, may produce a level of release comparable to that obtained with a shift in semantic class. Performance in the double shift condition, which tended to produce the greatest release, suggests that a double shift allows for the greatest differentiation of critical items, although the differences did not approach statistical reliability.

It should be noted that the present study demonstrated the importance of input events in a PI paradigm. Any general account of the many PI studies will have to consider both input processing and the relationships between the cues employed at input and at retrieval. Further, the finding that release occurred even when the shift on Trial 4 was from pleasantness judgments (requiring semantic processing) to letter estimating (requiring nonsemantic processing) is inconsistent with the notion that retention is only a function of depth of processing (Craik & Lockhart, 1972). In both the present study and that by Bird (1976), performance was sometimes improved with a shift away from semantic processing. Thus, although semantic processing generally produces higher recall than nonsemantic processing, it is again necessary to consider a broader context of events and the importance of item differentiation.

EXPERIMENT 2

Experiment 2 involved the use of two orienting tasks, both of which required semantic processing. These tasks were adapted from a study by Hyde (1973), and they involved pleasantness judgments and judgments of whether each word was active or passive. There was no formal semantic organization of the items in this experiment. The objective was simply to determine whether the differentiation provided by a change in orienting task can be conceptualized as a continuum; that is, whether two tasks which require semantic processing provide less differentiation than is provided with a change from a semantic to a nonsemantic task.

The specific predictions were as follows: It may be that the use of a semantic task activates the semantic components of a word in memory and applies some temporal tag. If this is so, there should be no release from PI with a shift from one semantic task to another, since both tasks would presumably activate the same components. On the other hand, if the tasks involve tagging items with specific information related to that task, a change in requirements should produce release, although probably not as great as that obtained in Experiment 1. Finally, if the release obtained in Experiment 1 was due to some attentional factor (e.g., increased effort or rehearsal on Trial 4), then the specific tasks are not of primary importance, and the shift in task in this experiment should produce comparable release to that obtained in Experiment 1.

Method

Design. The design was a 2 by 2 by 4 factorial, in which the factors were experimental condition (release vs. no-release), counterbalancing on orienting task, and the within-subjects trials. Release conditions were produced with a change in orienting task on Trial 4 (Conditions pleasantness-active and active-pleasantness), whereas no-release conditions required the same task on all trials (Conditions pleasantness-pleasantness and active-active).

Materials and procedure. The experimental items were 20 nouns assigned to word groups of five, such that semantic or phonetic similarities were minimized, the mean frequencies were approximately constant (based on Kučera & Francis, 1967), and the total number of syllables in each group did not differ by more than one. The presentation order of the four groups of words was determined by a randomized 4 by 4 Latin square.

The apparatus and procedure were identical to that for Experiment 1. Thus, on each trial, a subject saw a cue slide

("pleasantness" or "active-passive") to indicate the appropriate task for that trial, followed by five words presented serially at a 2.5-sec rate. After responding aloud to each word, the subject performed the digit-reading task for 18 sec and then attempted to recall the five words. Both orienting tasks required a two-choice response to each item: pleasant-unpleasant or active-passive.

Subjects. Students at Florida State University served as subjects in partial fulfillment of a requirement of the introductory psychology course. There were 32 subjects in each of the four between-subjects cells, making a total of 128 subjects. Subjects were tested individually and were assigned to conditions randomly with the restriction that equal proportions of males to females participated in each of the four cells.

Results and Discussion

Figure 2 presents the percentage of correct responses, as a function of trials, for each of the four between-subjects cells. The usual decrease in performance occurred over Trials 1-3, and there was a noticeable increase in performance on Trial 4 for the release conditions. There were no apparent differences in performance due to the counterbalancing on tasks.

A 2 by 2 by 3 analysis of variance was calculated for Trials 1-3 and revealed only a significant main effect of trials [$F(2,248) = 65.94$, $p < .001$, $MSe = .93$]. The counterbalancing on tasks did not produce reliable differences, nor did it interact with any other factor. A separate 2 by 2 analysis calculated for Trial 4 revealed only a significant effect of experimental condition [$F(1,124) = 10.85$, $p < .01$, $MSe = 1.04$], with subjects in the release conditions recalling more items than those in no-release conditions.

The results of Experiment 2 are most consistent with the hypothesis that the performance of an orienting task involves tagging an item with information related to the specific task. Thus, there appears to be a dimension of similarity among orienting tasks, with a shift from a semantic to a nonsemantic task providing greater differentiation than a shift from one semantic task to another. Since the semantic organization of the items differed in Experiments 1 and 2, a direct comparison of the two experiments is not possible. It is interesting to note, however, that, according to the formula employed by Wickens (1972) to calculate percent release from PI, the processing shift condition in Experiment 1 showed 81% release, while only 41% release was obtained in Experiment 2. Further, since the magnitude of the release obtained in the present experiments depended on the relationship between the tasks employed, it seems unlikely that the results of either study could be attributed to attentional factors, such as increased effort or rehearsal.

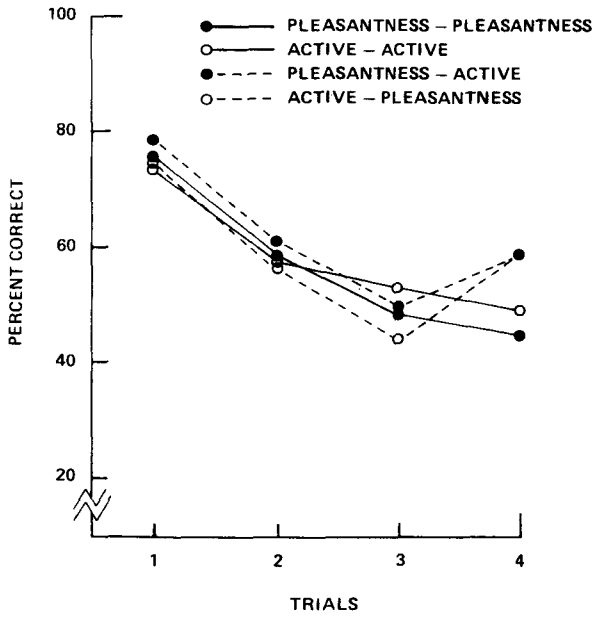

Figure 2. Percentage of correct responses as a function of the four between-subjects conditions and trials: Experiment 2.

GENERAL DISCUSSION

The present study has provided further support for the argument that at least part of the PI which develops over trials in short-term memory experiments is due to a lack of adequate differentiation among critical items. This conclusion is supported in general by the findings in both experiments that a change in processing orientation produced reliable release from PI and, specifically, by the finding in Experiment 2 that a shift from one semantic task to another produced considerably less release than a shift from a semantic task to a nonsemantic task (or vice versa).

It must be emphasized that the present argument differs from the Craik and Lockhart (1972) argument that retention is a function of processing depth. Although the present conception might include the notion that the possibilities for differentiation generally increase with increased processing depth, the results of Experiment 1 demonstrated that recall can sometimes be increased when processing becomes less "deep." A broader consideration of events which occur at input, during the retention interval, and at retrieval seems necessary.

An additional conclusion which follows from these data is that the release from PI paradigm could be used to develop a taxonomy of orienting tasks. That is, instead of making assumptions about the type of processing a particular task requires (e.g., semantic or nonsemantic), the similarity of various tasks can be established empirically. All other things being equal, the level of release produced by a change in orienting task should depend on the extent to which the tasks require different processing operations.

The overriding objective of this study, as well as that of Bird (1976), was to develop a research strategy which allows hypothesis testing under conditions in which the experimenter can have reasonable control over a subject's coding processes. This seems preferable to the more usual method of structuring experimental items in a manner that will encourage whatever orientation the experiment requires, since the orienting tasks might

be expected to provide greater consistency across subjects and increase the experimenter's confidence that subjects are attending to the appropriate feature of the items. For this reason, orienting tasks might be useful, not only as an independent variable to be studied, but as a means of reducing variability in experiments where some other manipulation provides the critical independent variable.

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