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ON THE LEARNING OF DISTRACTORS DURING CONTROLLED AND AUTOMATIC PROCESSING

Arthur D. Fisk and Walter Schneider

REPORT No. 8007

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Subjects performed an incidental learning task which consisted of scanning lists of words for either their own name, first names other than their own, words representing a unit of time, or words containing the letter G. Subjects completed all of the scanning tasks followed by a final free recall test. Recall performance was near floor ranging from 0 to 7 percent making interpretation somewhat problematic. In the own name search, none of the distractors were recalled. Other name distractors were best recalled
(over)

20. and distractor recall corresponding to searches for units of time and words containing G were equal. The data lend supportive evidence to the assumption that controlled processing is required for the modification of long-term memory. It is also concluded that task appropriate controlled processing determines coding efficiency. The data support the assumption that control processing is specialized to modify LTS, whereas automatic processing performs operations without modification of LTS.

On the Learning of Distractors during Controlled and Automatic Processing

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February 4, 1980

Running Head: Learning during automatic processing

Abstract

Subjects performed an incidental learning task which consisted of scanning lists of words for either their own name, first names other than their own, words representing a unit of time, or words containing the letter G. Subjects completed all of the scanning tasks followed by a final free recall test. Recall performance was near floor ranging from 0 to 7 percent making interpretation somewhat problematic. In the own name search, none of the distractors were recalled. Other name distractors were best recalled, and distractor recall corresponding to searches for units of time and words containing G were equal. The data lend supportive evidence to the assumption that controlled processing is required for the modification of long-term memory. It is also concluded that task appropriate controlled processing determines coding efficiency. The data support the assumption that control processing is specialized to modify LTS, whereas automatic processing performs operations without modification of LTS.

A currently active research paradigm in psychology assumes there are two qualitatively different forms of human information processing. In this paper these two forms will be referred to as automatic and controlled processing. Automatic processing is a fast, parallel, fairly effortless process which is not limited by short-term memory capacity, not under direct subject control, and performs well developed skilled behavior (see Schneider & Shiffrin (1977) and Shiffrin & Schneider (1977)). Controlled processing is a slow, serial, capacity-limited, subject controlled processing which deals with novel or inconsistent information. The two process approach has had a long history in psychology (e.g., James, 1890) and has received considerable interest in recent years (Posner and Snyder, 1975; LaBerge, 1973, 1975; Norman, 1976; Schneider and Shiffrin, 1977; Shiffrin and Schneider, 1977; Logan, 1978; Hasher and Zacks, 1979).[1]

An important issue to be resolved within the two process paradigm concerns the processing role of the two processes. Shiffrin and Schneider (1977, p. 160) proposed that control processing modifies LTS (long term store), develops new automatic processes, and deals with novel situations or ones requiring moment to moment decisions. Automatic processing is assumed to process well learned information sequences and not directly modify LTS. These assumptions imply that all learning takes place during controlled processing and no LTS modification occurs during pure automatic processing.[2]

The main goal of the present research was to test the assumption that all learning takes place during controlled processing. Evidence that learning does not occur during a pure automatic process is summarized in Shiffrin and Schneider (1977). Moray (1959) presented a list of seven words to the subject's unattended ear 35 times during a shadowing task. He found recognition of these items to be at chance. Gleitman and Jonides (1976) found that items used as distractors in a reaction time experiment were later recognized at chance if the reaction time task consistently mapped the target stimuli. Recognition was above chance if the stimuli and responses were varied in their mapping. Finally, Gorden (1968) showed that a set of four distractors were recognized at a level near chance even after 10 days of practice.

There are problems with these three studies with respect to testing the amount of learning of distractor items during a pure automatic process. Moray's procedure did not require the unattended channel to be processed (i.e., items presented to the unattended ear). Gleitman and Jonides required subjects in the consistently mapped condition to recall distractors from a different category than the targets (digits as targets versus letters as distractors). The category difference in addition to the distractor stimuli being relatively devoid of potentially codeable information may account for the chance level performance in the consistently mapped condition. Gorden used distractors that were patterns made up by four dots. An inability to encode these stimuli may have accounted for the results. Note that in this study some learning of the distractors did take place; that is, the subjects' performance level was not at chance. (See Underwood, 1976, chapter 4 for a review of incidental learning of unattended material.)

In the current experiment the subjects participated in an incidental learning task. They performed a scanning task with the target words being defined by various orienting tasks. One of these tasks required the subjects to search for their own name. This task was assumed to be a task utilizing automatic detection. In automatic detection (Schneider & Shiffrin, 1977) it is assumed that the stimulus (e.g., person's name) automatically causes control processing to be allocated to the stimulus when it occurs. The cocktail party phenomenon (Cherry, 1953; Moray, 1959; Norman, 1975) demonstrates that attention can be drawn to a conversation when one's own name is heard. Evidence that one's own name is automatically detected may be found in the shadowing experiments by Moray (1959) and performance during a visual analogue of the auditory shadowing task developed by Neisser (1969). These studies indicate that a person's attention can be (and usually is) directed to to-be-ignored locations when that person's name occupies the to-be-ignored location. Also, since we generally respond in a consistent manner to the occurrence of our own name, the requirement of consistently mapping the stimulus to a response for the development of automatic processing (see Schneider & Shiffrin, 1977) seems to be satisfied.

The assumption of no learning during pure automatic processing would predict subjects should learn nothing about the distractors during own name search. However, this prediction implicitly assumes subjects are not concurrently control processing the distractors during automatic name search. Since theoretically subjects can concurrently automatic and control process the same stimuli, the presence of some distractor learning in the own name search could be due to automatic LTS modification, or concurrent control process modification.[3]

The selection of the other orienting tasks was based on the desire to select a task which normally yields good performance (semantic orienting) and a task which normally produces inferior performance (graphic orienting) during incidental learning (see Hyde and Jenkins, 1973). It was hoped that this would give a reference point for performance in the "own name" condition. Another orienting task was included as a control for the "own name" condition which required subjects to search for the occurrence of a male or female name other than their own. Naively, we may argue that three of the orienting tasks require semantic (or deep) processing and one task requires only structural (or shallow) processing. This ranking will be examined in the discussion.

Method

Subjects

Twelve students at the University of Illinois volunteered to participate in the experiment. The subjects were tested individually.

Materials

Five word lists were presented to the subjects. Four different 30-noun item lists were presented, the lists being the same for all subjects. Another list, the practice list, contained 66 male and female first names. Twenty of these names were the subject's own name. The words were chosen from the category norms of Battig and Montague (1969) with the rank order for each word being between 1-6, inclusive. The lists were constructed such that no words

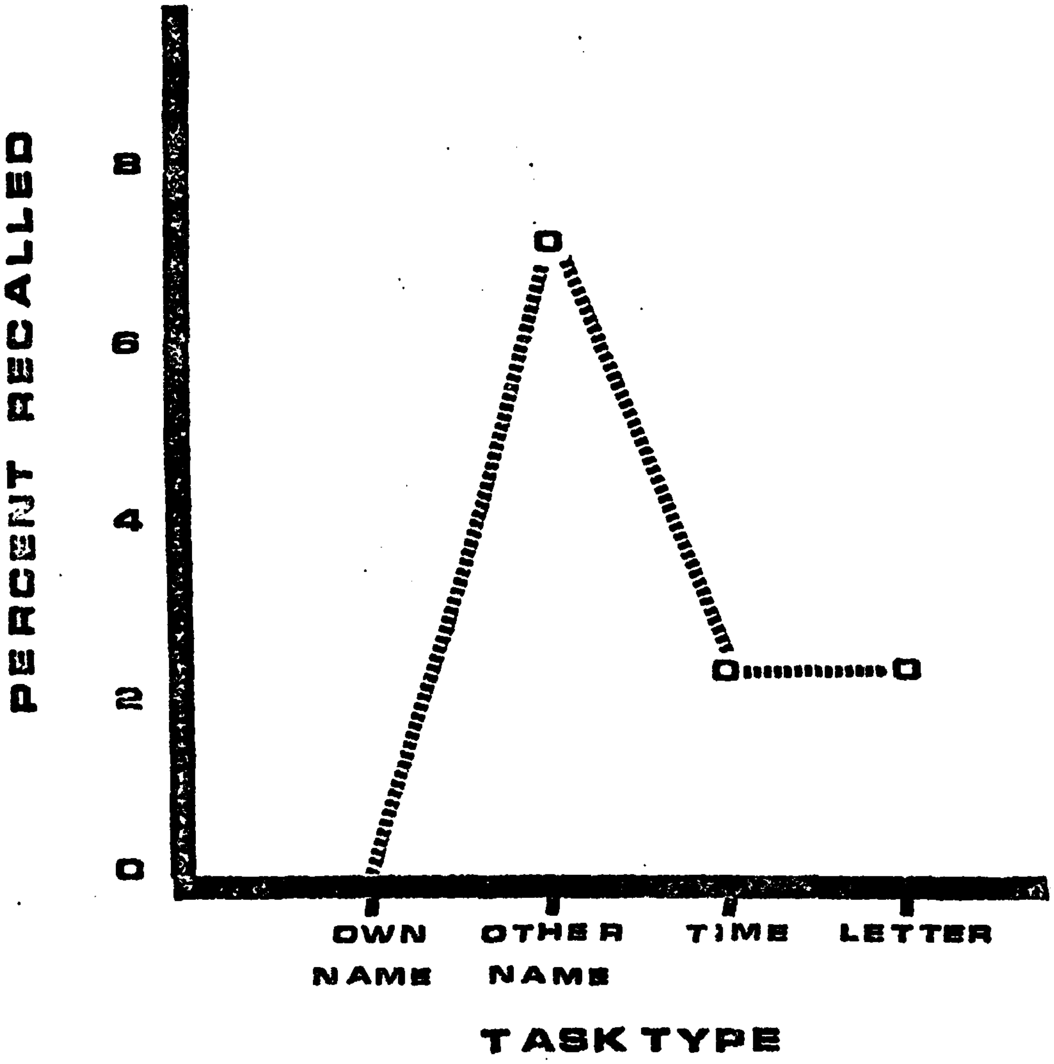

Figure 1: Average final recall of distractors for each of the search conditions. The percentage is based on total possible recall of 360 (12 subjects x 30 items) items per search category.

from a category of positive items for the orienting tasks were contained in the other lists. For example, the graphic orienting task required the subjects to search for words containing the letter G; therefore, no words containing the letter G were used as distractors in the other lists.

The lists were typed by a LA 120 DECwriter III computer terminal in upper case using the standard 5x7 dot matrix print head. Character width was .18 cm and height was .23 cm. Excluding the practice list, each list consisted of three columns of 10 words in each column. The columns were separated by aproximately 2.5 cm and each word within a column was spaced .7 cm from the word above or below it. Placement of target words within the lists was random. (There were five target words per list.)

Procedure

Since this was an incidental learning task the subjects were told that they were going to participate in an experiment designed to see how quickly they could search through lists of words for the occurrence of certain other words. Prior to each list the subjects were instructed to search for the occurrence of either their own name, a male or female first name other than their own, words containing the letter G, or words representing a unit of time. All subjects performed each orienting task. The subjects were instructed to place a check mark beside each occurrence of a target word. The subjects were also told to perform the task as quickly as possible but not to make any errors. A Latin square was used to control the order of list presentation and scanning task order. Scanning speed was timed by a stop watch. When the subject completed a list the experimenter wrote down the time and relayed this time to the subject.

At completion of all lists the experimenter engaged the subjects in conversation about differences between automatic and controlled processing. This conversation lasted two minutes and was followed by a request that the subjects write as many words from the previous list as they could remember excluding any first names.[4] The subjects were given as much time as desired for the final free recall test, but all subjects finished within three minutes.

Results

A moderately strict criterion was used for scoring the recall data. For example, words were considered correct if the plural form was substituted for the singular. In addition, since the subjects were told not to worry about spelling, a word was considered correct if the word was judged by the experimenter to correspond to a list item. Any word occurring as a positive (target) item was not considered in the analysis.

Final Free Recall

The percentage of words recalled, for all orienting conditions, is presented in Figure 1. Since there was not

Insert Figure 1 about here

homogeneity of variance across the orienting conditions, a Friedman Two-way

ANOVA by Ranks was performed on the recall data. This analysis revealed a significant main effect of orienting condition, [$\chi^2(3)=20.55, p < .001$]. Post hoc tests (Wilcoxon Matched-Pair Signed-Rank test) showed that the "own name" condition differed from all other conditions [$T=0, p < .001$, where $N=9$]. The comparison between "other name"/graphic orienting conditions was significant [$T=6, p<.05$, where $N=9$]; but the "other name"/semantic category (time) conditions did not differ. The graphic orienting condition did not differ from the semantic category condition. The most important result, for the primary purpose of this research, is that none of the subjects recalled any words from the list corresponding to the "own name" search condition.

Scanning Time

Table 1 shows the average time (in seconds) the

Insert Table 1 about here

subjects spent scanning the list during each orienting condition. Also presented is an estimation of the time spent per item. The main effect of orienting task type was significant [$F(3,33)=76.26, p < .001$]. The post hoc comparisons revealed that the "own name" condition was significantly faster than the semantic category condition [$F(1,11)=34.48, p < .01$], the "other name" condition differed from the semantic category condition [$F(1,11)=18.90, p<.01$] and the "other name" condition did not statistically differ from the graphic orienting condition $F < 1$.

Discussion

The experimental results of the present research support the assumption that long term memory is not modified when a person performs a task utilizing an automatic process. A needed qualification to this statement is that the automatic process must be an automatic attention response. The strongest support of the experimental hypothesis is the absolute lack of recall from the word list which corresponded to the "own name" search task.

An argument can be made that the differences in recallability were due to the differential scanning times for the various conditions. Following this argument, the reason no words were recalled when subjects searched for their own name lies with the scanning time and not the differential utilization of processing modes. This argument is somewhat attenuated when the scanning times are examined. There are conditions which differ in number of items recalled that do not differ in scanning time (the "other name" versus the graphic orienting task). Conversely, the semantic category and the graphic orienting condition both resulted in the same recall performance yet differed in scanning time. It would seem, from these present data, that scanning time is not the most significant variable determining recallability of list items. This conclusion is consistent with Craik and Tulving's (1975, Experiment 5) results. They concluded that a task requiring more time to perform does not necessarily lead to better recall performance than an easier and faster task. (Obviously extreme examples could be given where scanning time was the most critical variable determining probability of recall. These examples would require procedures that do not fit with the current methodology.) A threshold learning

Table 1: Average mean scanning time and time per item in each search condition.

	OWN NAME	OTHER NAME	TIME	LETTER
MEAN SCANNING TIME	8.04	12.95	11.70	13.18
AVR. TIME/ITEM	.201	.431	.390	.438

time model, which assumes that no learning occurs with scanning times of less than .3 seconds per item, could explain the present results. The present data do indicate that time alone is not the determining factor of recall. Note, future experiments will attempt to explicitly control the time variable.

Recently Hasher and Zacks (1979) reviewed existing evidence and concluded that some tasks which are performed automatically can lead to learning. For example, they suggest that word meaning can be accessed automatically. Also, some aspects of reading are performed automatically. Clearly learning occurs when one reads. It is important to stress that the reading process is composed of both automatic and controlled processes. Word encoding may well be automatic but modification of long-term memory requires controlled processing. For example, if one's mind wanders while reading, several paragraphs may be scanned without any long-term memory modification taking place. The word encoding may be automatic, but if controlled processing is not available (due to daydreaming) no long-term memory modification occurs. The present argument is that a pure automatic process, more specifically an automatic attention response, will not modify long-term memory. If an automatic attention response occurs and subsequent controlled processing is directed only to the stimulus causing the automatic attention response then no learning of the "distractor environment" will occur.

At the occurrence of an automatic attention response the subject's attention is directed toward the stimulus causing the automatic attention response. In the "own name" search condition it is assumed that the subjects can perform the task by relying on the occurrence of automatic attention responses. Therefore, in this condition, no controlled processing need be (or is) directed to any location except that of the target stimulus. Hence, no learning of distractors occurs with this type of processing.

In the other search conditions the subjects cannot rely on the occurrence of automatic attention responses to perform the task. So, controlled processing is directed to list items other than the target stimuli. Therefore, some learning of the distractors does occur.

Following the above logic, an argument could be made that all the present experiment has shown is that if one does not pay attention one does not learn. This is overly simplistic. The present discussion concerns distinct processing . If one performs a task by relying purely on the occurrence of an automatic attention response, then nothing else will be learned about the other events (words) occurring in the environment at that time. Since none of the own name targets are missed, subjects are "attending" to the distractors sufficiently to determine if they are targets. But since targets can be detected by automatic processing and automatic processing is assumed to not modify LTS, no learning of distractors is expected. This is not to say that other attributes, etc., will not be learned concerning the target stimuli. Quite the contrary. Since the occurrence of an automatic attention response directs controlled processing to the stimulus causing the automatic attention response, information can be accumulated concerning this stimulus. The amount of controlled processing of the stimulus causing the automatic attention response is task dependent. If stimuli which produce automatic attention responses occur in rapid succession little controlled processing of these stimuli will occur.

Tyler, Hertel, McCallum, & Ellis (1979) argue that learning is directly related to the amount of "cognitive effort" required by a given task. Cognitive effort is defined by the amount of secondary task decrement observed in a dual task situation. (The task of interest is always the primary task.) This measure of cognitive effort was proposed by Tyler, et al (1979) as an independent measure of levels (or depth) of processing. This proposal by Tyler, et al, is not supported in the literature. Clearly an orienting task could be developed that would require much cognitive effort (in the Tyler, et al (1979) sense) yet it would lead to poorer learning than another task requiring less effort (see Craik and Tulving (1975), Experiment 5). Shadowing is a task which requires a great deal of cognitive effort but results in very little learning of the shadowed message (Cherry, 1953).

It would seem more beneficial to replace the term cognitive effort by task appropriate controlled processing. Within certain limits, learning should be related to the amount of task appropriate controlled processing. Postman and Senders (1946) showed that subjects improved their learning of specific features they were instructed to attend to (e.g., physical appearance, details of wording, general comprehension) at the expense of the other characteristics. If the controlled processing required by the orienting task (or task situation in general) coincides with the subsequent learning test, then performance will be optimal. If there is a mismatch between initial controlled processing and the subsequent learning test then performance will be inferior. For example, performing a rhyming orienting task will lead to performance superior to that of a semantic orienting task if the subsequent learning test requires phonetic knowledge of the original items (see Morris, Bransford, and Franks, 1977).

In sum, the present conclusion is that a processing approach appears to be the most heuristic way to describe the nature of tasks that result in good and poor recall of meaningful material. If the initial task is structured such that performance of the task may be accomplished via reliance on automatic attention responses no learning of the "distractor environment" will occur. Otherwise, learning will depend on the amount of task appropriate controlled processing.

The conclusion is not that the individual item by item controlled processing is the only variable determining the amount of learning during intentional and incidental learning tasks (Postman and Kruesi, 1977). But, it seems that this is an important "first step" towards learning. Inappropriate controlled processing of individual words, events, etc. may preempt enough of the subject's processing capacity to prevent maximal learning.

In regards to the present data it is unclear why searching for a name other than your own would involve more task appropriate controlled processing than searching for words representing units of time. It is also unclear why the semantic orienting task (searching for words respresenting units of time) should yield learning that is the same as the graphic orienting task. Given the severe floor effects in the present experiment the answers to these questions must await further research.

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Footnotes

[1] Note different researchers have used different names for the two processes. Automatic processing is referred to as habit, automatic, unconscious, structural, and skilled behavior. Controlled processing is referred to as ideational, conscious, effortful, executive, and strategic processing.

[2] At this time what is an automatic or a controlled process is poorly defined. In this paper we will use two conditions which can be clearly categorized as automatic and controlled processing. In order to make a strong test of the assumption of no learning during automatic processing, a greater operational specification of an automatic process must be developed, as well as microanalysis of the presumed automatic tasks.

[3] Latter experiments will utilize secondary tasks to eliminate the potential confounding of concurrent distractor control processing.

[4] The first names were excluded to reduce the potential interference of the practice list first names. In pilot studies when subjects recalled names from the practice list, the recall of other distractors was reduced.

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