to end . . . No." The former is clearly a description of previously performed cognitive operations. However, the latter takes the form of a command, or plan to conduct an operation ("Put them end to end"), followed by a pause (. . .) during which S is presumably imagining the planned operation, followed by an evaluation of the results of the operation ("No"). (It should be remembered that no S was permitted to touch the problem materials, and therefore each S had to imagine any operations he wished to carry out on the materials).

The structure of the thinking aloud excerpt is very much like the structure of Miller, Galanter, & Pribram's (1960) TOTE mechanism. In the present case, the planning and evaluative phases of the mechanism are carried out in inner speech. This conception fits well with the notion that inner speech

plays an executive role in the conduct of cognitive operations (Luria, 1961).

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NOTE

1. This research was conducted under the support of a postdoctoral fellowship from the National Research Council of Canada.

digm permits S to anticipate the response item and is thus essential in the repeated presentation method of paired-associate learning. However, the studies under consideration here are all based on a single learning trial and, therefore, do not require the stimulus-alone presentation. In the study described here, this slide was eliminated and the interstimulus interval was accordingly shortened.

Another change from the original studies was based on informal observations of skin resistance patterns. Ss appear to have a relatively restricted range of GSR values when they are not relaxed. Typically, some Ss have few or no scorable GSRs. To reduce this problem in the present study, every effort was made to encourage the S to relax.

SUBJECTS

One-hundred eighty-nine undergraduates enrolled in the introductory psychology courses served as Ss. Of these, 96 were females and 93 were males. The Ss were randomly assigned to one of four conditions.

STIMULI AND DESIGN

Six of the eight items used by Kleinsmith & Kaplan (1963) were used: KISS, RAPE, VOMIT, EXAM, MONEY, SWIM. The response items were single digits from 2 to 7.

A slide projector with an exposure time of 4 sec was used to present the stimuli which were typed in capitals. Two color slides, containing four of six colors used, were interpolated between paired-associate slides in training and between stimulus-item slides in recall. A stimulus-only slide was not used in training in this study, and hence the interstimulus interval was 12 sec (in contrast to 16 sec in the Kleinsmith and Kaplan study). The first slide in the training list consisted of the word READY followed by two color slides.

The order of items in training was controlled by the use of four lists designed such that any item was followed by any other given item in only one list. The serial position of each item was also controlled. Two sets of responses (single-digit numbers) were used for each paired associate; thus, for half the Ss in each condition a particular stimulus was paired with one digit, while for the other half a different digit was used. Consecutive items were not paired with consecutive digits.

The orders of the items in the recall lists were arranged so that no item appeared in the same serial position in training and recall. Further, the number of items that intervened between the presentation of a given item in training and its presentation in recall was controlled such that for half the items that distance was three or four and for the other half it was six or seven.

PROCEDURE

The Ss were given a single learning trial

The arousal-retention interval interaction revisited: The effects of some procedural changes¹

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The arousal/time interaction obtained in the Kleinsmith and Kaplan studies apparently can be attenuated by set or motivational variables. A six-item paired-associate list was presented a single time to each of 189 Ss, who were then tested for recall at varying times (immediate, 6 and 18 min, or 2 days). The high arousal items showed significant reminiscence at 6 min, but the overall effects were not as strong as in previous studies. The role of motivational sets under incidental learning conditions is discussed.

The Kleinsmith & Kaplan (1963, 1964) studies of arousal and time interval in paired-associate learning appear to have played a role in the return of reminiscence to

verbal learning (Keppel, 1968). Since findings of this kind raise certain difficulties for most current theories of learning, establishing the generality of this phenomenon is of considerable importance. Levonian (1966) has studied arousal and reminiscence in the classroom with comparable results and his findings have been replicated by Kaplan, Kaplan, & Sampson (1968).

The present study concerns certain procedural modifications of the 1963 study. Since the overall recall level in that study was relatively low, the present study utilized only six items instead of eight. (The 1964 study where the stimulus items were nonsense syllables also employed six items.) Furthermore, since the method used in the early studies originates from the traditional paired-associate procedure, the stimulus element is presented alone prior to presentation of the paired associate. The stimulus-alone presentation in that para-

Fig. 1. Differential recall of paired associates as a function of arousal level and retention interval.

with the list of six word-number pairs. During the training list, the S was instructed to read out loud the contents of the paired-associate slide and to name the four colors when a color slide appeared. To avoid rehearsal, S was not informed that recall would be tested. To insure a wide range of GSR values, every effort was made to put S at ease.

Before presentation of the recall list, Ss were instructed to call out the color name as they had before, but when a word slide appeared, to call out the number that was paired with it when they had previously seen the pair. Guessing was encouraged. Four time conditions were used: immediately after training, 6 min and 18 min after the READY slide, and 2 days. Each S served in only one recall condition.

In order to determine the arousal effects of each stimulus word, skin resistance was recorded during learning. A modified version of the Lykken zinc electrodes was used (Kaplan & Fisher, 1964) along with the recording apparatus described in Kaplan & Hobart (1964). To insure constancy of conditions, electrodes and recording apparatus were also used during the recall sessions.

In scoring, the maximal drop in S's skin resistance occurring within 8 sec of onset of a given stimulus item was scored and converted to percentages of basal resistance level. Each S's six GSR deflections were ranked and divided at the median into "high arousal" and "low arousal" categories.

RESULTS AND DISCUSSION

Figure 1 illustrates the relationship between high- and low-arousal recall as a function of time. The low-arousal items are recalled better initially than the high-arousal items. The high-arousal items show reminiscence by 6 min and recall of these items stays at a higher level. An analysis of variance of recall scores confirms this interaction ($F = 2.96$; $df = 3, 185$; $p < .05$).

The overall decrement in recall was also significant $F = 11.44$; $df = 3, 185$; $p < .001$.

The basic finding of reminiscence for high-arousal items is again confirmed. However, several differences between these data and those reported by Kleinsmith & Kaplan (1963) merit discussion. In the earlier data the reminiscence effect, while already evident at 20 min (there was no 6-min condition in that study), continued to increase, and, in fact, the high-arousal items showed no forgetting! Further, the overall recall (ignoring arousal level) was fairly stable, varying between 25% (at 45 min) and 18% (at a week). In the present study, by contrast, the overall recall at the immediate test was about 52%, and at 2 days it was 28%.

Some of the discrepancies in the results of these two studies are no doubt accounted for by the shorter list (six instead of eight items) and the shorter interstimulus interval (12 sec instead of 16 sec) making for a difference between 72 sec and 128 sec for the presentation of the training material. One might expect better recall at the immediate recall test in the present study since the interval between training and test was shorter. At the same time, the shorter interstimulus interval limits the time available for consolidation, with a resulting drop in long-term memory.

In retrospect, the most important change from previous studies appears to have been the effort to put the Ss more at ease. While this attempt was successful as far as increasing the average GSR magnitude is concerned, it may well have had an even greater effect on diminishing the arousal/time interaction. A striking difference between the present study and the Kleinsmith and Kaplan studies is the time course of recall ignoring arousal differences. Both of the previous studies show surprisingly flat functions; there is very little net forgetting over time, or more precisely, the forgetting of certain items is nearly balanced by the reminiscence of others. A recent replication of the Kleinsmith & Kaplan (1963) study by Shamp (1968) also shows a flat recall function and a strong arousal/time interaction. The present study, as well as several unpublished ones, show a substantial recall decrement over time and a comparatively weak arousal/time interaction. The importance of set or motivational state in the slope of the recall function was demonstrated by Alper (1946). She found that "ego-oriented" Ss (who were told their task was an intelligence test) showed no decline in recall after 24 h (they actually showed a small, nonsignificant increase). "Task-oriented" Ss, by contrast, showed the customary decline.

There is, in retrospect, substantial basis for believing that the Kleinsmith and Kaplan

Ss were to a substantial degree "ego-oriented." While the electrodes were being applied to the S's fingers, E explained that the purpose of the study was to determine S's skin resistance reaction to a variety of stimuli. This instruction had two purposes. It provided both an explanation for the electrodes and an honest description of the experiment that was believable without mentioning memory or recall (learning in all these studies was incidental to avoid problems of rehearsal). This part of the procedure did not appear in the method section of these studies since it was viewed as patter rather than design. Later communications with Ss revealed that they had interpreted the experiment as one which delved into their personalities by studying their reactions to the projected material, particularly, it is amusing to note, the color slides. This instruction has not been used since the initial studies in the interest of providing a more relaxed experience for the Ss.

This particular instruction, while probably exceptionally effective for studies of this kind, is certainly not a necessary condition for obtaining the arousal/time interaction. There are undoubtedly many factors that contribute to the degree of relaxation, or more likely, of involvement of the S. It is assumed that it is the relevant state of S, and not the method of inducing it, that plays an important role in enhancing or reducing the arousal/time interaction.

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NOTE

1. This investigation was supported by Research Grant MH-11599 from the National Institute of Mental Health, United States Public Health Service.