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# Effects of divided attention on free and cued recall of verbal events and action events

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This experiment addressed the effects of divided attention on the remembering of subject-performed tasks (SPTs) and verbally presented sentences. Subjects were asked to memorize organizable SPTs or sentences under conditions of focused or divided attention, and their memory was tested by means of free and cued recall. Results indicated a higher overall recall level for SPTs than for sentences, and that beneficial effects of taxonomic cues were equal across materials and encoding conditions. In addition, free and cued recall of both SPTs and sentences deteriorated under conditions of divided attention, the deterioration being somewhat greater for sentences. This pattern of results replicates and extends previous research. It is suggested that the data reflect the involvement of effort and strategies in the encoding of both types of material.

In experiments with subject-performed tasks (SPTs), subjects are asked to perform a series of actions (e.g., roll the marble, nod in agreement), for purposes of later recall. The fact that SPT research has yielded results that, in part, deviate from what may be expected from verbal memory research has resulted in a theoretical debate about the processes underlying SPT remembering. This discussion has predominantly been concerned with (1) the issue of whether similar memory laws are applicable to verbal events and SPTs, and (2) the way in which SPTs are encoded (e.g., Bäckman & Nilsson, 1989; Bäckman, Nilsson, & Chalom, 1986; Cohen, 1985, 1989; Nilsson & Bäckman, 1989). These two issues converge in the sense that conceptualizations of the nature of SPT encoding differ in the extent to which they postulate differences between the encoding operations underlying SPT recall and those underlying recall of verbal materials.

In the early work of Cohen and his collaborators (Cohen, 1981; Cohen & Bean, 1983; Cohen & Stewart, 1982), it was argued that the encoding mechanisms supporting verbal memory are of little importance for SPT memory. In short, this view held that whereas the encoding of verbal materials is typically strategic, involving different forms of deliberate encoding operations (e.g., rehearsal, organization), the encoding of SPTs is nonstrategic. This account has received support from studies showing a dissociative pattern of verbal recall and SPT recall for a variety of factors (e.g., primacy, level-of-processing, rate of presentation, age of subject, intelligence, and prediction accuracy; see Cohen, 1985, for a review).

Cohen (1983) suggested that verbal events and SPTs may represent two anchor points on a continuum of memory events whose dimensions may be strategy use or automaticity in encoding. As Cohen (1983) alluded, this continuum resembles that proposed by Hasher and Zacks (1979), which progresses from automatic to effortful cognitive operations in the sense that the use of strategies is effortful, whereas the absence of the use of strategies points toward automaticity of encoding. It is important to note, however, as Cohen (1983) stated, that the fact that SPTs are held to be nonstrategic does not imply that they are acquired without attention.

On the basis of the results of a series of studies (Bäckman, 1985; Bäckman & Nilsson, 1984, 1985), we have argued that there are strategic components involved in SPT encoding. The most striking finding in favor of this notion is that SPT recall shows evidence of greater organization than does the recall of verbally presented sentences (Bäckman & Nilsson, 1984, 1985; Bäckman et al., 1986); clearly, organization is a deliberate encoding strategy. We have proposed that the facts that SPTs are multimodal (several sensory systems are activated at encoding) and contextually rich (a variety of features—verbal and physical—are available) account for the superiority in organization of SPTs over verbal events. That is, the multimodal and rich properties of SPTs enhance the possibility of detecting and utilizing the categories (e.g., taxonomic) on which organization may be based.

Bäckman et al. (1986) sought to examine whether verbal events and SPTs were differentially affected by requirements of division of attention, thereby providing additional information concerning the nature of SPT encoding. It is commonly held that automatic processes should allow

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other effortful processes to occur simultaneously with minimal disruption, whereas effortful processes are attention-demanding and, thus, limited in efficiency under conditions of divided attention (DA; Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977). The main results from the three experiments reported by Bäckman et al. (1986) can be summarized as follows. First, free recall of SPTs was generally superior to free recall of sentences containing the same verbal information as SPTs. Second, when items were organizable (according to taxonomic category), sentence recall decreased more than SPT recall under DA conditions, although DA resulted in a significant decrease for both types of material. Third, SPT recall decreased more than sentence recall when items were nonorganizable, as compared with organizable, although a significant decrease was observed for both types of material. Finally, SPT recall and sentence recall were equally impaired under DA conditions for nonorganizable items.

The overall pattern of results from this study was interpreted to mean that SPT encoding is attention-demanding, and that strategic components are involved during the acquisition of SPTs. The results concerning organizable items were interpreted to mean that the highly organizable nature of SPTs may, to some extent, have compensated for the detrimental effects of DA on recall. This hypothesis was supported by the findings that (1) removal of the option to organize the items was more detrimental to SPT recall than to sentence recall, and (2) both types of recall were equally affected by dual-task requirements when nonorganizable items were used.

However, although the Bäckman et al. (1986) data suggest that attentional resources and strategies are used in SPT encoding, and that SPTs and verbal information may not differ qualitatively with respect to the encoding activity undertaken, it is possible that the actual recall test used (i.e., free recall) may have influenced the results obtained. Specifically, it may be that effects of DA at encoding are negligible in the case of SPTs, but that the retrieval support in a free recall test is not strong enough to activate the information encoded. Partial support for this notion comes from Karlsson et al.'s (1989) demonstration that benefits from the provision of taxonomic cues were substantially greater for SPTs than for sentences in two groups of older adults (73 and 82 years old). Although conditions of focused attention (FA) prevailed in the Karlsson et al. study, it might be that the pattern of results obtained applies to DA conditions as well. In other words, given that retrieval cues would be provided, SPT recall might not be affected by DA.

In order to examine this issue, we conducted an experiment modeled after Experiment 2 in Bäckman et al. (1986), with the modification that memory was assessed with both free and cued recall. Subjects were presented with SPTs or sentences under two encoding conditions: FA or DA. In the DA condition, the subjects were asked to count backwards during item presentation. Both types of material were organizable on the basis of taxonomic category, and, following a free recall test, the subjects were provided with the taxonomic names in a cued recall test.

In agreement with the results of Bäckman et al. (1986), we predicted that free recall of both types of material would suffer from dual-task requirements, although the recall decrease was expected to be more pronounced for sentences than for SPTs. Our main objective, however, was to extend the generality of previous findings by examining whether this pattern of data would also hold when the retrieval process was guided through the provision of taxonomic cues.

## METHOD

### Design and Subjects

The basic design was a 2 (material: SPTs, sentences) × 2 (encoding condition: FA, DA) factorial. Sixty-four students from the University of Umeå served as subjects, with random assignment of 16 subjects to each of the four conditions. All subjects were paid the equivalent of $10 for their participation.

### Materials

A list of 25 sentences in the imperative form was prepared. The list involved five different categories of imperatives, with five subordinates each: articles of clothing (e.g., *put on the hat*), office supplies (e.g., *lift the ruler*), toys (e.g., *shake the rattle*), kitchen utensils (e.g., *put the lid on the pot*), and tools (e.g., *turn the saw*). Items were counterbalanced, such that one item from each category appeared in each of five serial-position blocks. The order of items was randomized within blocks. Four presentation orders were used, each administered to one fourth of the subjects in each condition.

### Procedure

The list of items described above served as the basis for the two types of material. With an automatic slide projector, the sentences were presented consecutively on a screen; they were read aloud simultaneously by the experimenter. For SPTs, the subjects sat at a table screened from a second table on which the objects used were placed. For each SPT, the experimenter provided an object along with a task instruction. For example, a hammer was provided together with the instruction "move the hammer." For both types of material, the rate of presentation was 5 sec, and the interstimulus interval was 1 sec.

The subjects assigned to the FA conditions were told either that a list of 25 sentences would be presented on a screen and simultaneously read by the experimenter, or that they would be asked to perform 25 short and simple tasks. They were also told to remember as many sentences or SPTs as possible for a subsequent free recall test. No mention was made of the fact that the items belonged to different taxonomic categories, or that a cued recall test would be given.

In the DA conditions, the same instructions were given. In addition, the subjects were informed of a secondary task. Besides remembering the items, they were told to count backward during item presentation. The counting task consisted of subtracting 6 and 3, in alternation, from the number 600, which was given by the experimenter 7 sec before the first item was presented. These subjects were told that they had two assignments to fulfill: to memorize the items, and to reach as low a number as possible in their backward counting. They were also instructed that under no circumstances whatsoever were they to interrupt the backward counting during item presentation. A trial count from the number 300 was requested to ensure the subjects' understanding of the instructions.

After the last item had been presented, all subjects received a written immediate free recall test. A total of 6 min was allowed for this test. Following free recall, the subjects received the five category names in a written cued recall test. Six minutes were allowed for cued recall as well. The experiment took approximately 30 min to complete.

## RESULTS

A lenient scoring procedure for measuring recall performance was adopted. That is, responses were accepted

**Table 1**
**Mean Number of Subject-Performed Tasks (SPTs) and Sentences Recalled Under Conditions of Focused and Divided Attention**

| | Focused Attention | | | | Divided Attention | | | |
|---|---|---|---|---|---|---|---|---|
| | Free Recall | | Cued Recall | | Free Recall | | Cued Recall | |
| | *M* | *SD* | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| SPTs | 16.25 | 2.02 | 18.75 | 2.44 | 13.19 | 2.97 | 15.19 | 2.46 |
| Sentences | 10.56 | 1.75 | 13.06 | 2.49 | 4.63 | 2.33 | 7.63 | 2.25 |

if their meaning was correct (Bäckman et al., 1986; Cohen, 1981). Mean free and cued recall performance across materials and encoding conditions is shown in Table 1. The data were analyzed with a 2 (material) × 2 (encoding condition) × 4 (presentation order) × 2 (test) mixed analysis of variance, with repeated measures on the last factor. No order effects were obtained; thus, the data were collapsed across this variable. There were significant main effects of material, encoding condition, and test: SPTs ($M$ = 15.84) were recalled better than sentences ($M$ = 8.97) [$F(1,60)$ = 156.94, $MS_e$ = 9.64, $p < .0001$]; performance was higher under FA conditions ($M$ = 14.66) than under DA conditions ($M$ = 10.16) [$F(1,60)$ = 67.24, $MS_e$ = 9.64, $p < .0001$]; and cued recall ($M$ = 13.66) was higher than free recall ($M$ = 11.16) [$F(1,60)$ = 131.87, $MS_e$ = 1.52, $p < .0001$].

In addition, the material × encoding condition interaction was reliable [$F(1,60)$ = 4.68, $MS_e$ = 9.64, $p < .05$]. An a posteriori Tukey test showed that recall of both types of material decreased significantly under DA conditions ($ps < .05$). An inspection of Table 1 indicates that the interaction was due to the fact that the recall decrease was more pronounced for sentences than for SPTs. This pattern of results replicates exactly that obtained by Bäckman et al. (1986). With regard to the main objective of the present study, however, it is important to note that there were no significant interactions involving the test factor ($Fs < 1$).

## DISCUSSION

In agreement with past research (e.g., Bäckman & Nilsson, 1984, 1985; Bäckman et al., 1986; Nilsson, Cohen, & Nyberg, 1989), the present results indicated that the level of recall was higher for SPTs than for sentences depicting the same verbal information. The superior recall of SPTs is attributed to the multimodal and rich properties of this task. These properties are assumed to result in a richer representation of the information to be remembered as compared with what is available in the sentence task, in which only verbal information can be encoded.

Furthermore, there was no material × test interaction; that is, the overall improvement from retrieval cues was equal for SPTs and sentences. In a recent study, Karlsson et al. (1989) found that cue benefits were greater for SPTs than for sentences among older adults. Karlsson et al. interpreted their data to mean that the richness of SPT encoding makes SPTs more amenable to cuing effects than verbally presented sentences. The fact that the young adults examined in the present investigation did not benefit selectively from cues in the SPT task suggests that their encoding of verbal information may have been richer and more elaborate compared to that of older adults. This interpretation is in agreement with the contention that the adult aging process is associated with deficits in self-initiated recoding operations (e.g., Bäckman, 1989; Craik, 1983).

The free recall data regarding the manipulation of attentional demands were identical to those initially reported by Bäckman et al. (1986). Although both SPT recall and sentence recall deteriorated under DA conditions, the deterioration was somewhat greater for sentences than for SPTs. We interpret this pattern of outcome to mean that (1) both types of material are encoded effortfully and strategically, and (2) the highly organizable nature of SPTs partly counteracts the negative effects of DA on encoding and subsequent recall.

Perhaps the most interesting finding in this research was that the provision of cues did not alter the pattern of data concerning the effects of DA. That is, in both DA conditions, memory performance increased when cues were provided, but there was no disproportionate increase from cues in the SPT task. These results indicate that more information is encoded under DA conditions than that which is revealed in free recall for both SPTs and sentences. However, there is no evidence that the provision of cues activates less accessible traces formed under DA conditions to a greater extent for SPTs than for sentences, or that performance differences between encoding conditions would be reduced in cued recall for SPTs. Thus, with regard to the chief objective of this study, we conclude that the decrease of SPT recall under DA conditions is not due to poor retrieval information being provided in free recall. Rather, the present data suggest that DA affected SPT recall because the backward counting interfered with the strategic and effortful encoding of SPTs.

We have speculated that the encoding of SPTs may be conceptualized in dual terms (Bäckman et al., 1986). Specifically, this view assumes that whereas the verbal task component (i.e., the imperatives) may be encoded with effort and strategies, various physical task features (e.g., color, weight) may be encoded relatively automatically. Although there is some tentative evidence in favor of this differentiated view of SPT encoding (Bäckman & Nilsson, 1989), further empirical inquiry is needed before any definite conclusions can be drawn regarding its validity.

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