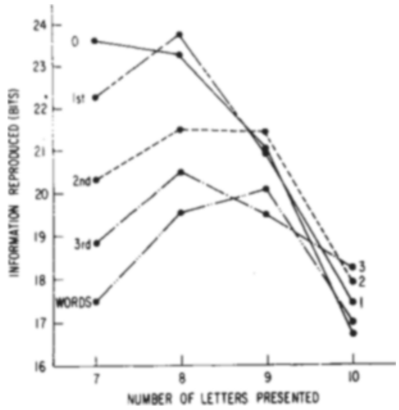

Fig. 2. **Mean amount of information reproduced (bits) as a function of sequence length and order of approximation to English.**

Mean percentage of letters recalled was then computed for each sequence and was correlated with acoustic confusability (Conrad & Hull, 1964) and predictability (Baddeley, 1964a) using the product-moment correlation. Results are shown in Table 1. It is clear that performance is highly correlated with predictability at all sequence lengths. Acoustic confusability of the sequences, on the other hand, shows no overall relationship to recall. A significant correlation occurs for sequences of length 10 but is in the direction of *better* performance on confusable sequences. This is probably due to a positive correlation between confusability and predictability ($r = .429$, $p < .01$) for this length of sequence, which, in turn, probably reflects the high frequency of confusable Ts and Es and of repetitions in long predictable sequences.

DISCUSSION

This result suggests that, although the sequences were presented as isolated letter names, Ss did not encode them in that way. It seems likely that they combined letters to form composite sounds (e.g., B-E-D will be recoded as the word "bed" rather than be stored as three independent letters). Under such conditions, the letter names become irrelevant. Predictable sequences that conform to S's language habits will be encoded more easily and into fewer chunks, and are hence more likely to be recalled (Miller, 1956). While such coding will be simplest with predictable material, recent failures to observe acoustic similarity effects (Adams, Thorsheim, & McIntire, 1969; Laverty & Turvey, 1970) suggest that it may also occur with consonant sequences, given appropriate conditions. Such results certainly indicate that Ss are not coding in terms of letter names; they do not, however, mean that the coding is nonacoustic, as Adams et al imply.

Table 1
Correlation with Mean Recall Score of Letter Sequence Predictability and Acoustic Confusability for Sequences of 7 to 10 Letters

	7	8	9	10	Overall
Predictability	.578**	.743**	.782**	.750**	.655**
Acoustic Confusability	.081	.022	.184	.338*	.050

$^{*}p < .05$, $^{**}p < .001$

In conclusion, it appears that language habits may have a marked effect on STM. This is reflected by the correlation between predictability and recall probability, which suggests that S is recoding the letter names presented into speech sounds. It does not imply that the coding is no longer phonemic.

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Vividness in the recall of English nominalizations*

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Rohrman (1968) presented data which purported to show that variations in deep structure could predict the recall of English nominalizations that had identical surface structures. Evidence is presented which suggests that semantic vividness was confounded with Rohrman's experimental manipulations, and it is argued that his results can be explained solely in terms of vividness.

Conventional wisdom has it that the difficulty of remembering a sentence is determined mainly by its deep structure (Garrett & Fodor, 1968). A dissenting view comes from Martin & Roberts (1966), who proposed that recall is predicted better by the surface than by the deep structure of a sentence.

In a most interesting series of experiments, Rohrman (1968) tested the relative merits of these two arguments by comparing word strings that had different deep structures but identical surface structures. Consider the subject nominalization *growling lions* and the object nominalization *digging holes*. Both are dominated by a NP node and both consist of a participle and a noun. They have identical surface structures. However, their underlying structures are not the same. The subject nominalization is derived from deep structures of the form (*lions growl*), whereas the object nominalization derives from (PRO(*dig holes*)), where PRO represents an indefinite nominal functioning as the subject. In addition to the difference in node complexity, the transformational histories of the nominalizations differ in that the object nominalization requires a deletion transformation to reach the surface form, whereas the subject nominalization

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requires a permutation transformation. Rohrman (1968) found that subject nominalizations were easier to recall than were object nominalizations, and asserted that "the effect is . . . real and has a substantial degree of generality [p. 910]." He concluded that since surface structure was of no help in predicting recall differences, an explanation must lie at the level of deep structure.

To see whether transformational history or node complexity is more important, Rohrman then compared nominalizations that were equated for complexity of deep structure but had different transformational histories. He used object nominalizations as before, but employed subject nominalization in which the verbs were transitive (e.g., *boring lectures*), thus possessing objects in the underlying structure. These subject nominalizations require two transformations applied to their deep structures, a permutation and a deletion transformation. Since he found no differences in recall between these two types of nominalization, Rohrman concluded that difficulty of recall was a function of deep structure node complexity rather than transformational history.

A possible explanation of Rohrman's results that does not implicate deep structure (as usually understood) emerges from a consideration of the semantic qualities of the nominalizations. If there were a systematic difference between object and subject nominalizations with regard to some variable like word frequency or the vividness of aroused imagery, then Rohrman's conclusions about the necessity of deep-structure explanations might be called into question. Paivio, Yuille, & Madigan (1968) have summarized several studies attesting to the importance of imagery in learning and memory. Rated imagery scores have been found to correlate with paired-associate learning, even with concreteness and meaningfulness controlled.

In order to assess the possibility that some semantic attribute of the nominalizations that Rohrman used might be confounded with nominalization type, an experiment was run in which Ss learned a set of nominalizations and, after being tested for recall, rated them with respect to the vividness of the images that they aroused.

SUBJECTS

Forty-one undergraduates at Yale University served as Ss in the experiment. They were run in groups of seven or fewer Ss each.

MATERIALS

Sixty-eight nominalizations, a subset of those used by Rohrman (1968), were used. They consisted of 20 intransitive subject nominalizations of the form *growling lions* and 20 object nominalizations of the form *digging holes*. In addition, each S received 7 of the 14 transitive subject and 7 of the 14 object nominalizations that were used in Rohrman's Experiment V (this experiment, referred to above, assessed the relative importance of deep structure node complexity and transformational history). Two lists of 54 nominalizations each were constructed so that all 28 of Rohrman's Experiment V nominalizations were included.

PROCEDURE

Each list of 54 nominalizations was printed in two columns on letter-size paper. Ss were instructed to learn as many items as possible in a period of 3 min and 10 sec (3.5 sec/item). They were told not to learn them in any particular order. Immediately after the learning period, Ss were required to write down as many of the nominalizations as they could remember. Following recall, Ss were asked to rate all of the items in the list for vividness on a 4-point scale. Ss were instructed that these nominalizations varied in their capacity to arouse vivid mental images of things or events, and that those which aroused an image quickly or easily should be rated highly, whereas those that aroused an image weakly and slowly should be rated low.

RESULTS AND DISCUSSION

Rohrman's findings were confirmed in that for the subject nominalizations derived from intransitive verbs, the mean number of nominalizations recalled was 5.37, whereas the mean number of object nominalizations recalled for each S was 3.93 [$t(40) = 3.51$, $p < .001$]. Rohrman's finding (from his Experiment V) that the recall levels of object nominalizations and transitive subject nominalizations did not differ was also confirmed. The mean number of transitive subject nominalizations recalled was 1.39, and the mean number of object nominalizations recalled was 1.46.

The vividness ratings for the subject and object nominalizations as well as those correctly and incorrectly recalled are shown in Tables 1 and 2. From these tables it can be seen that nominalizations that were correctly recalled were given higher vividness ratings and that intransitive nominalizations were rated more vivid than object nominalizations. There was no reliable difference between the vividness ratings of transitive subject and object nominalizations. For only 7 of the 41 Ss was the mean vividness rating of their incorrect responses greater than the mean vividness rating of their correct responses [$X(1) = 17.78$, $p < .001$].

Although the fact that incorrect intransitive subject nominalizations were rated more vivid than were correct object nominalizations is somewhat anomalous, the finding that vividness rating is directly proportional to recall and that intransitive subject nominalizations are more vivid than object nominalizations emerges quite strongly. It follows that Rohrman's conclusions about the role of deep structure must be severely qualified. Whatever the virtues of the position espoused by Martin & Roberts (1966), it is not necessarily impugned by Rohrman's study since his results may be accounted for in terms of a nonstructural semantic variable, vividness.

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Table 1
Mean Vividness Ratings of 20 Intransitive Subject and 20 Object Nominalizations for Incorrectly and Correctly Recalled Items

	Nominalization		
	Subject	Object	Row Mean
Correct	2.98	2.31	2.85
Incorrect	2.44	2.00	2.21
Column Mean	2.59	2.07	

Table 2
Mean Vividness Ratings of 14 Intransitive Subject and 14 Object Nominalizations for Incorrectly and Correctly Recalled Items

	Nominalization		
	Subject	Object	Row Mean
Correct	2.72	2.80	2.76
Incorrect	2.24	2.08	2.16
Column Mean	2.34	2.22	