Effects of two components of syntax on rote verbal learning

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Effects of syntactical structure on rote learning of verbal strings were studied by introducing orthogonally two components, grammatical endings and function words, into an initial string of CVC syllables. With both components present, the string had the form of a complete sentence. Presence of either component of structure produced reliable facilitation, but the two did not interact. Additivity of the effects was interpreted as evidence against the hypothesis that the sentence functions as a unitary pattern or schema.

Recent research on the acquisition of grammatically structured verbal materials (Miller & Selfridge, 1950; Epstein, 1961, 1962; Marks & Miller, 1964) has shown a generally facilitative effect with respect to "unstructured" controls which are typically random permutations of the experimental strings. Such results are relatively uninformative in themselves, since they have such high prior probability, but the interpretations accorded them do raise certain interesting theoretical questions. It is sometimes assumed that the sentence, by virtue of its structure, constitutes a psychological unit, pattern, or schema, and that this is the basis for improved performance, a notion which may be termed the pattern hypothesis. Thus, Epstein (1962) concludes, "Instead, the effect seems to depend on the structural character of the series perceived as a unit, i.e., generalized linguistic form rather than sequential or semantic associations."

It is also conceivable, however, that all or part of the facilitation attributable to structure in the sense of syntax occurs at a much lower level. The presence of grammatical "tags" or endings, and function words such as articles, prepositions, conjunctions, or copulae, may serve to group elements of the sequence into familiar, recognizable, or encodable subsequences or "chunks" of a much smaller length than that of the sentence, perhaps at the level of phrase structure or even of word pairs. This proposition will be referred to as the component hypothesis.

This experiment was designed to distinguish between the pattern and component hypotheses by studying the acquisition of materials constructed by systematic variation of an initial neutral string of CVC syllables. Certain CVCs of this string were replaced by grammatical endings, function words, or other CVCs of meaningfulness rated as equal to that of the grammatical elements, according to a factorial scheme. Since it might also be conjectured that if response to the sentence structure as a whole is an important part of the process when such structure is present, then presentation of the sequence in its accustomed way, namely horizontally with an initial capital letter and a final period, would serve to cue this response, the method of presentation was included as a variable in the experiment. As control, the strings were presented vertically oriented, with neither capital nor period.

Under these conditions, then, there were two contrasts of primary interest. First, the pattern hypothesis would imply a significant interaction between presence of endings and presence of function words, since when both were present, the sequence had the form of a complete sentence. If there is response to the sentence as such, then the facilitation in this condition should be greater than the sum of the two component effects. Second, the pattern hypothesis would also imply that the aforementioned interaction would be enhanced when presentation was horizontal, leading to a three-factor interaction in the analysis. Under the component hypothesis, all effects should be additive.

Method

Each of 90 undergraduate Ss learned one of the nine sequences shown in Table 1 to a criterion of one perfect reproduction. Materials were constructed as follows: (a) Sequence 1 was composed of 15 CVCs from Noble's (1961) list, with mean $\underline{m}' = 2.53$; (b) Sequences 2-9 were formed from sequence 1 by replacing syllables 1, 6, and 11 either by function words or by CVCs equal in meaningfulness to those function words (Factor A: Function), or by replacing syllables 3, 5, 8, 10, 13, and 15 by grammatical endings or by CVCs of equal meaningfulness (Factor B: Endings); (c) the sequences were typed on 5 in. x 8 in. cards, either horizontally, as in Table 1, or vertically, with initial capital and final period omitted (Factor C: Presentation). Each trial consisted of a 10 sec. exposure of the stimulus card, followed by a 25 sec. test interval, during which S was required to write down as much of the sequence as he could on a response sheet with nine equal blanks, arranged either horizontally or vertically

Table 1. Experimental strings and levels of factors A and B*

	String							Levels
1.	Pab	tuldaw	zagbis	kor	vamjiv	daspek	rog nertav	sotlef. 00
2.	Pab	tulfay	zagtok	kor	vampen	daswol	rog nerpil	sotlaz. 01
3.	Pab	tulest	zagity	kor	vaming	dasily	rog nerful	sotion. 02
4.	Det	tuldaw	zagbis	sul	vamjiv	daspek	jan nertav	sotlef. 10
5.	Det	tulfay	zagtok	sul	vampen	daswol	jan nerpil	sotlaz. 11
6.	Det	tulest	zagity	sul	vaming	dasily	jan nerful	sotion. 12
7.	The	tuldaw	zagbis	was	vamjiv	daspek	for nertav	sotlef. 20
8.	The	tulfay	zagtok	was	vampen	daswol	for nerpil	sotlaz. 21
9.	The	tulest	zagity	was	vaming	dasily	for nerful	sotion. 22

* *See text for explanation.*

Table 2. Mean trials to criterion, total errors to criterion and errors on root CVCs, as a function of presence or absence of actual grammatical endings and function words.

Function words	Absent		Present	
Endings	Absent	Present	Absent	Present
Trials	12.80	10.10	10.20	4.00
Total errors	55.93	38.25	38.30	11.10
Root errors	38.22	24.75	27.05	7.50

in accordance with Factor C. The complete experimental design was therefore 3 by 3 by 2, and was run in five randomized blocks of 18 Ss. Table 1 indicates the assignment of each of the nine stimulus strings to a combination of levels of factors A and B, in that order, by a two-digit number, with 0 corresponding to the original CVCs, 1 to replacement by CVCs of equal meaningfulness to the grammatical elements, as rated by independent judges according to Noble's (1957, 1961) methods, and 2 to replacement by the actual function word or ending.

Results and Discussion

Mean trials to criterion, errors to criterion, and errors on "root" CVCs, as a function of presence or absence of the actual endings and function words, are presented in Table 2. Root CVCs, which were elements 2, 4, 7, 9, 12, and 14 of the experimental strings, remained invariant over all conditions, and were so named because they were the first elements of the two-syllable compounds of which the endings, when present, were the second elements. Errors on these syllables were counted separately as a check on the possibility that the effects of the presence of grammatical elements were confined to performance on those elements themselves. The data in Table 2 are averaged over method of presentation and, where applicable, the two types of control CVCs, neither of which variables were significant sources of variance.

Analyses of variance of the three dependent variables revealed only two significant contrasts, namely, the difference between presence and absence of the actual endings and the difference between presence and absence of the actual function words. This was true of errors on root CVCs as well as total errors and trials to criterion, indicating that the facilitation which occurred was spread over all elements of the experimental strings. For Endings, $F = 14.86, 13.94, 18.23$, $df = 1/68$, for trials to criterion, errors to criterion, and errors on root CVCs, respectively. For Function, the corresponding values of F were 14.10, 13.87, and 13.22, $df = 1/68$. Probabilities associated with values greater than these were all less than .001. The interaction between the two contrasts was not significant at the .05 level, $F = 2.71$; $df = 1/68$; $p > .10$, for trials to criterion, and $F < 1$, $df = 1/68$, for errors to criterion and errors on root CVCs. None of the other contrasts, including the interaction of Endings, Function, and Presentation, were of appreciable magnitude.

Because of the theoretical importance of the interaction of Endings and Function, and since the experimental design permitted only ten replications of string number 9, which represented the condition in which both function words and endings were present, so that the possibility of a peculiar sample could not be ruled out, it was decided that further replication of this condition was desirable. Twenty more Ss were accordingly run on string 9. Mean trials to criterion and errors to criterion were 3.45 and 7.82 for horizontal presentation, and 4.70 and 11.20 for vertical presentation, respectively. The corresponding means for the original 10 Ss were 3.70, 8.33 horizontal, and 4.70, 15.67 vertical. The stability of these means over the two samples makes it appear likely that there was a small but consistent effect of method of presentation on string 9, considered alone. The question of peculiarity of the original sample was, however, answered in the negative, so that it must be concluded that the analysis was accurate and that there was no appreciable interaction between presence of endings and presence of function words in the experimental strings.

Leaving aside the question of truth of a null hypothesis, it may be asserted that while it is possible that the pattern effect is not strictly zero, it is certainly not of the same order of magnitude as the component effects, and consequently is not to be assigned a primary explanatory role. It is concluded, therefore, that in the present conditions, the facilitation produced by syntactical structure occurred at or below the level of the phrase, and was not significantly increased by the presence of a complete sentence. It is important to note, however, that this conclusion is specific to the effects of syntax. A quick extrapolation to situations in which true sentences are learned is likely to be incorrect, since sentences in the ordinary language are structured semantically and conceptually, as well as syntactically. Under such conditions it is entirely possible that pattern effects might be observed, even if the sequence in question were syntactically imperfect, as might occur in telegraphic speech or similar distortions which preserve the sense of the sequence.

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