Phrases vs meaning in the immediate recall of sentences

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This study evaluated Johnson's (1965) measure of phrase independence in the recall of sentences. Twenty-five Ss were presented with groups of three sentences that differed in structure and were immediately asked to recall the sentences. Fewer errors were made on subject, verb, and object words for all sentence types, but the probability of a transitional error (TEP) at the phrase boundary was not always greater than at other transitions in the sentence. The results indicate that the TEP is a misleading measure and that sentence meaning is more appropriate as a unit of recall than is the sentence phrase. The number of underlying clauses in the sentence proved to be a valuable metric in predicting errors in recall.

Johnson (1965) has presented evidence that the major phrases of a sentence tend to be recalled independently and as units. Thus, when the first word of a phrase is recalled, the whole phrase tends to be recalled, and this does not affect the likelihood of recall of another phrase. When the first word of a phrase is not recalled, the whole phrase tends to be forgotten. Johnson's measure of independence is the transitional error probability (TEP), which is the conditional probability of a word's being incorrectly recalled given that the preceding word was correctly recalled. Johnson found that the TEP is highest at major phrase boundaries and approximately equal within phrases, and he concluded that the major phrases are stored and recalled independently.

Other studies, however, indicate that phrases are not always recalled independently. Rosenberg (1968) has shown that the between-phrase TEP is lowered when the two words of the transition are high associates, so that subject and predicate phrases are not recalled independently. Mandler & Mandler (1964) found that the words best recalled are the subject, verb, and object words of the sentence. This result suggests a strong dependence in recall of words that occur in difference phrases of the sentence.

The current study is concerned with an apparent contradiction between the Mandlers' position and that of Johnson. The Mandlers maintain that sentence meaning is the primary unit of recall, whereas Johnson maintains that the major phrases of the sentence are the units of recall. The question under examination is how information from one phrase can be completely forgotten when sentence meaning is the unit of storage and when this meaning occurs in different phrases of the sentence. There are differences in the two studies that could account for

the different results. First, the two studies differed in the structure of the sentences that were examined. It is possible that in sentences with the structure that Johnson used, the phrases are recalled independently, whereas in sentences with the structure that the Mandlers used, the sentence meaning is recalled as a whole. Secondly, the two studies differed in the methods of analysis used. Neither study used the method of analysis employed by the other. It is possible that the differences in the two studies are due to this difference in method of analysis. The current study examined recall of sentences of both structural types employed in the two studies and used both methods of analysis.

A secondary issue examined in the current study is related to a theory of sentence comprehension presented by Miller & Chomsky (1963). This theory states that in processing sentences, people first determine the underlying clauses of the sentence and then interpret them for meaning. The major clause in the underlying structure contains the major meaning relations and is likely to be recalled in some form if the sentence has been understood. Evidence for such a model of comprehension is provided by Sachs

(1967) and Blumenthal (1967). If sentences are stored in terms of their underlying structure, it follows that a more complex sentence, as measured by the number of underlying clauses, should result in greater difficulty in recall of the original sentence. This was investigated in the current study.

SUBJECTS

The Ss were 25 students in an undergraduate learning course at Wayne State University who served as part of a course requirement. The Ss were naive as to the purpose of the experiment.

MATERIALS

The twelve sentences shown in Table 1 were used. There were three types of sentences. Type I sentences were of the form "subject/prepositional phrase/verb." Type II sentences were of the form "subject/verb/object," with adjectives and articles modifying the nouns. Type III sentences were of the form "subject/verb/object," with adjectival modifiers only. Type I and Type II sentences are of the form used by Johnson (1965), and Type III sentences are of the form used by Mandler & Mandler (1964). All sentences were seven words in length. The sentences were presented in four groups of three sentences, each group containing one sentence of each type. Three groups of sentences contained only meaningful sentences, and one group contained only anomalous sentences. The sentences of Group A were taken directly from the studies by Johnson and by the Mandlers.

PROCEDURE

The Ss served in groups of 3, 4, or 5 at a time. All Ss received the same sentences, but the order of presentation of the four groups of sentences varied from one group of Ss to the next. All Ss received the same order of sentences within a group of sentences.

The Ss were told that their task was to memorize a group of three sentences. The Ss read a group of three sentences from a booklet as the E read the sentences aloud in monotone

Table 1
Groups of Sentences Presented to Ss

	Type	
Group A	I	The house across the street burned down.
	III	Five laughing children built beautiful large ships.
	II	The tall boy saved the dying woman.
Group B	II	A small boat hit the sandy beach.
	I	The sailors from the west got out.
	III	Several armed soldiers fired various lethal weapons.
Group C	III	Soft chilling winds blew fallen dead leaves.
	II	The small acorns struck the damp soil.
	I	The trees in the forest were shaking.
Group D	I	The dog under the happiness got wet.
	II	A large bird carried the corrupt government.
	III	Old junky cars crossed long boring poems.

Table 2
Percentage Errors at Each Position by Sentence Type

Sentence Type	Position in Sentence						
	1	2	3	4	5	6	7
I	.25	.20*	.25	.25	.24	.15**	.16†
II	.39	.41	.21*	.39**	.23	.38	.30†
III	.34	.41	.25*	.33**	.63	.48	.33†

*Subject word

**Main verb

†Direct object or verb particle

Table 3
Average Errors for Core-Meaning Words and Other Words

Sentence Types		Core-Meaning Words†	Other Words
I	Meaningful	.22	.33
I	Anomalous	.01	.03
I	All	.17	.25
II	Meaningful	.29	.31
II	Anomalous	.33	.49
II	All	.30	.35
III	Meaningful	.30	.49*
III	Anomalous	.35	.45
III	All	.31	.48*

†Subject, main verb, and direct object words.

*Comparison with core-meaning words is significant, $p < .05$.

voice. The Ss then turned the pages of their booklets and were given 60 sec to write the group of three sentences as accurately as they could remember them. They were told to recall the three sentences in any order they wanted and to guess about words or sentences if they were not sure. After three such trials on the first group of sentences, the Ss were presented with the next group of sentences in the same manner.

RESULTS

The Ss' written answers were scored for the number of times each word of the original sentence was not correctly recalled in the right position. The results from the first trial of recall of each group of sentences were used in the analysis. The percentage errors at each position by sentence type are shown in Table 2. In general, fewer errors were made on the subject, verb, and object words than on other words of the sentence. Table 3 shows the average percentage errors for subject, verb, and object words and for other words for each sentence type and for

the anomalous and meaningful sentences separately. In all cases, the means are in the direction of fewer errors on the subject, verb, and object words than on other words. The difference is significant only for the meaningful Type III sentences ($t = 3.39$, $df = 148$, $p < .05$).

The probability of a transitional error was calculated for each S on each transition in the sentences. The average TEP at each transition by sentence type is shown in Table 4. Following Johnson (1965), the second and fifth transitions in Type I sentences and the third transition in Type II and Type III sentences were phrase boundaries. Inspection shows that the within-phrase TEPs for Type II and Type III sentences were not equal, contrary to Johnson's prediction. The average TEP at phrase boundaries and other transitions for each sentence type are shown in Table 5. The phrase boundary TEP was larger than other TEPs for Type I and Type II sentences, although this difference is not significant. For meaningful Type III sentences, the phrase boundary TEP was significantly smaller than other TEPs ($t = -2.74$, $df = 123$, $p < .05$).

Those sentences in which the results were in the direction as predicted by both Johnson (1965) and Mandler & Mandler (1964) were of particular interest. In Type I sentences, the phrase boundary TEP was greater than that at other transitions and the subject, verb, and object words were recalled more than other words, though neither difference was significant. Table 6 shows the percentage errors at each position and the TEP at each transition for only those cases when a transitional error occurred at the phrase boundary. For Type I sentences, there were 13

transitional errors at the phrase boundaries (the second transition, from subject to preposition, and the fifth transition, from object of the preposition to verb). Of these 13 transitional errors, 12 were on the second transition and 1 was on the fifth. In those cases in which transitional errors occurred on the phrase boundary, there was an average of 0.25 errors on subject, verb, and object words and 0.79 errors on other words. These data indicate that when a transitional error occurs at a phrase boundary, it is rarely on the transition to the main verb and the major sentence meaning is still recalled more often than less important information.

In Type II sentences, both Johnson's and the Mandlers' predictions were in the right direction, though neither difference was significant. Sentences of this type are especially important because the phrase boundary occurs between the subject and verb. There were 22 transitional errors at the phrase boundary in these sentences. Table 6 shows that there was a wide range in the percentage of words recalled in the predicate phrase when there was a transitional error at the phrase boundary. According to Johnson, when the first word of a phrase is forgotten, the whole phrase should be forgotten; this was clearly not the case, since the percentage errors ranged from 0.32 to 1.0. The object word, in particular, was recalled 45%. The table also shows that the TEPs within the predicate phrase were not equal, also contradicting Johnson's results.

The results for the Type III sentences are consistent with the meaning hypothesis and disconfirm the phrase hypothesis. The subject, verb, and object words were recalled significantly more often than other words of the sentence. The phrase boundary TEP was smaller than other TEPs, and for the meaningful Type III sentences, this result was significant.

Table 5
Average TEPs for Phrase Boundary and Other Transitions

Sentence Type		Phrase Boundary	Other
I	Meaningful	.14	.06
I	Anomalous	.02	.02
I	All	.08	.03
II	Meaningful	.30	.23
II	Anomalous	.28	.11
II	All	.29	.20
III	Meaningful	.18	.35*
III	Anomalous	.48	.22
III	All	.26	.32

*Comparison with phrase boundary TEP is significant, $p < .05$.

Table 4
Average TEPs at Each Transition by Sentence Type

Sentence Type	Transition in Sentence					
	1	2	3	4	5	6
I	.08	.11*	.01	.01	.05*	.01
II	.28	.03	.29*	.00	.22	.10
III	.22	.11	.26*	.55	.36	.08

*Phrase boundary

The relation between errors and number of underlying clauses was also analyzed. According to Chomsky (1965), sentences of the form of Type I have two underlying clauses (e.g., *the house across the street burned down* has in its underlying structure the clauses *the house was across the street* and *the house burned down*). Sentences of the form of Type II sentences have three underlying clauses (e.g., *the tall boy saved the dying woman* has in its underlying structure the clauses *the boy was tall*, *the boy saved the woman*, and *the woman was dying*). Sentences of the form of Type III have five underlying clauses (e.g., *five laughing children built beautiful large ships* has the clauses *the children were five*, *the children were laughing*, *the children built ships*, *the ships were large*, and *the ships were beautiful* in its underlying structure). The relation between the number of underlying clauses and number of errors in recalling a word in the correct position is shown in Table 7. Repeated-measures analysis of variance showed that the effect of number of underlying clauses is significant ($F = 5.79$, $df = 2,48$, $p < .01$), as was the effect of the context in which the sentence appeared ($F = 5.90$, $df = 3,72$, $p < .01$) and the interaction ($F = 4.10$, $df = 6,144$, $p < .01$).

DISCUSSION

The results indicate that the transitional error probability is not a measure of segmentation and that the phrase is not a unit of recall in the immediate recall of sentences. The probability of a transitional error at the phrase boundary was not significantly greater than that at other transitions, and for one sentence type, it was significantly smaller. According to previous interpretations of the TEP, the phrases were not recalled independently in the current study. In those cases in which the predicate phrase should be completely forgotten, i.e., when a transitional error was made at the phrase boundary, the remaining words in the phrases were not completely forgotten. The direct object was usually recalled, even though the verb was not. Thus, Johnson's (1965) unitization hypothesis, that phrases are recalled as units, was not supported.

Even when the TEP results are in the predicted direction, the interpretation of the TEP can be misleading. There are two reasons for this. First, the TEP does not account for changes in form which preserve the original meaning. Thus, a synonym or synonymous phrase can be given in recall, and these would be counted as transitional errors.

Table 6
Percentage Errors and TEP at Each Transition When a Transitional Error Occurred at the Phrase Boundary

Sentence Type	Entry	Position in Sentence						
		1	2	3	4	5	6	7
I	Errors	.62	.0 ^a	.92	.85	.77	.38 ^b	.38 ^c
	TEP	.0	.92 ^d	.0	.0	.33 ^d	.0	
II	Errors	.36	.50 ^a	.0 ^a	1.0 ^b	.32	.68	.55 ^c
	TEP	.5	.0	1.0 ^d	—	.53	.29	
III	Errors	.26	.26	.0 ^a	1.0 ^b	.79	.47	.38 ^c
	TEP	.21	.0	1.0 ^d	—	.0	.0	

Note—Cells showing a dash (—) have no entry because the first word of the transition was never recalled in these cases.

^aSubject word ^bMain verb ^cDirect object or verb particle ^dPhrase boundary

More importantly, the TEP does not include all of the data: it does not count those cases in which the first word of a transition is forgotten and the second word is recalled. Such cases certainly are instances of independence in recall. Because these cases have not been included in the TEP measure, two TEPs can be equal but there can actually be vast differences in the levels of recall of the words of each transition. For example, two within-phrase TEPs may be 0.05, with one being the result of 100 correct recalls on the first word and 5 incorrect on the second and the second being a result of 20 correct recalls on the first word and 1 incorrect on the second word. Thus, recall of these words would be quite varied (100%, 95%, 20%, and 99%), but since these within-phrase TEPs are low and equal, Johnson would claim that the phrase was forgotten as a whole. The recall results would show just the opposite, that three of the words of the phrase were recalled quite well.

A high phrase boundary TEP, then, does not necessarily mean that phrases are recalled independently and as units. It is necessary to look at the pattern of recall of words within the phrase when a transitional error occurs at the phrase boundary. If there is not uniformly poor recall of all words in the phrase, the phrase cannot be a unit of recall. Johnson's (1965) and Rosenberg's (1968) results might have been interpreted differently if they

had analyzed for uniformity of recall within phrases.

The analysis of phrase boundary transitional errors in sentences with prepositional phrases showed that the prepositional phrases were recalled as a unit and independently of the rest of the sentence. The TEP was higher at the prepositional phrase boundary than at other transitions, and when a transitional error at the phrase boundary occurred, the level of recall of words within the phrase was uniformly low. Such a result could be consistent with the position that phrases are stored independently, or it could be consistent with the position that underlying clauses are stored independently. According to Johnson (1965), however, the TEP at the prepositional phrase should be less than that at the predicate phrase, since the break between adjacent phrases in the phrase structure tree is lower for the former transition than for the latter and therefore represents a less severe break between the two phrases in memory. The results showed that a transitional error was much more likely at the prepositional phrase than at the predicate phrase. Thus, the results are inconsistent with Johnson's position but consistent with the Miller & Chomsky (1963) position.

According to Miller and Chomsky, part of the process of comprehension involves the determination of the grammatical relations of the sentence, which in turn requires the determination of the underlying clauses. These clauses are then interpreted for meaning and the meaning is stored in memory. It follows that a sentence with a greater number of underlying clauses should require more "space" in memory and more errors should be made in recall of these sentences. This prediction was supported in the current study, although there was wide variation within the groups of sentences presented to the Ss (cf. Table 7). This result is consistent with the interpretation that the prepositional

Table 7
Average Errors as a Function of Number of Underlying Clauses

Group	Number of Underlying Clauses			
	2	3	5	Average
A	0.56	1.76	2.68	1.67
B	2.64	1.16	2.68	2.16
C	2.60	3.40	3.04	3.01
D	0.16	2.96	2.76	1.96
Average	1.49	2.34	2.79	2.21

phrase in sentences of Type I form is recalled as a unit because it represents another underlying clause, and this underlying clause is stored somewhat independently of the main clause.

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