Study and Test Repetition Effects in Item Recognition Priming

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In 1980, McKoon and Ratcliff found that if subjects read a paragraph and then are given a yes/no recognition test for words from the paragraph, they respond quickly and accurately to words that are preceded in the test list by closely related words that also appeared in the paragraph. In three experiments, short paragraphs with a linear structure were used to test the limits of this priming effect. In the first two experiments, it was found that priming effects tend to go away when a given item is tested more than once and when accuracy feedback is provided after each response. A third experiment demonstrated that priming effects are not affected by the number of times paragraphs are studied and that a single repeated test of an item does not remove priming effects if accuracy feedback is not provided. The results are explained by postulating that two sources of information, paragraph and test list information, can be used in recognition decisions under some circumstances. Recommendations for the use of priming to study the structure of memory for paragraphs are offered.

Recently, Ratcliff and McKoon (1978) and McKoon and Ratcliff (1980) developed a technique for investigating the structure of memory representations for texts such as sentences and paragraphs. The technique employs priming in item recognition. After a subject reads a text, he or she is presented with words, one at a time, for a recognition test. The subject must judge whether or not each word was in the text. The basic assumption of the technique is that response time (RT) to make this judgment reflects the structure of the memory for the text. In particular, RT to a given positive test item will be decreased if the immediately preceding test item is closely related to the given test item, in terms of text structure. Moreover, the amount of this speed-up, or priming, reflects the distance between the preceding item (the prime or priming item) and the succeeding item (the primed item) in the memory representation of the text.

Ratcliff and McKoon (1978) used the priming technique to investigate the structure of single sentences. They found that the RT to the primed item was faster when the prime and the primed test items were from a single proposition than when the prime and primed item were from different propositions. This result was interpreted as support for the current orthodoxy that sentences are stored as propositions (e.g., Kintsch, 1974).

Using the same technique, McKoon and Ratcliff (1980) investigated the memory representation of short paragraphs. In particular, they tested the hypothesis that paragraphs are stored as a network of propositions with each proposition connecting to all other propositions with which it shares arguments. Consider, for example, the paragraph presented in Appendix A, which was used in their study. Each sentence, with the exception of the first and last sentences, shares a noun with the sentences before and after it. Each sentence represents a single proposition consisting of a relation (the verb) and two arguments (the nouns). Representing the paragraph as a propositional network involves the connection of those propositions that share arguments; the result is the linear structure shown in the bottom part of Appendix A. If this is indeed the structure of the memory representation for this paragraph, then N7 is closer to N6 than it is to N1. By the logic of the priming technique, N6 and N7 should prime one another to a greater extent than N1 and N7 do. This result was reported by McKoon and Ratcliff (1980). In addition, the hypothesis that paragraphs are stored as propositional networks was supported for a variety of paragraph structures. In sum, the priming technique appears to reveal the structure of learned material by allowing the researcher to map out the relative distances between the words that constitute the material. Moreover, the relationships revealed through priming seem to reflect properties of the memory representation iself, rather than subjects' retrieval strategies (Ratcliff & McKoon, 1981).

This paper explores some of the limitations on the use of priming in item recognition. Two specific questions are addressed. First, to what extent can one repeatedly test a given item and still obtain priming effects, and second, is priming affected by the degree to which the textual material is learned, as operationalized by the number of study trials. The first issue, that of the repeated testing of items, is of theoretical and methodological interest. In the theoretical realm, there is the issue of the contributions of different sources of information to recognition responses. If a subject reads a paragraph, is tested on a word from that paragraph, and then later is tested on the same

word, two sources of information are available for the response. There is paragraph information from the original presentation, and test list, or response, information from the earlier presentation of the word as a test item. How are these sources used, and what variables affect their relative strength of contribution to the memory? This question has been investigated with respect to recognition of isolated words (e.g., Ratcliff & Hockley, 1980) but not in the case where structured linguistic information co-occurs with test list information.

In the methodological realm the issue of the effect of repeated items is important because one would like to be able to repeatedly test items in the priming paradigm and still obtain information about paragraph structure. In psycholinguistic experiments, materials such as paragraphs are rarely presented to subjects more than once, because the goal of the research is an understanding of comprehension and memory processes for novel, grammatical word combinations. This creates a problem, though, in that because materials are often inordinately difficult to construct, each subject receives only a few sentences or paragraphs. So, very little data per subject is obtained. If one can repeatedly test an item for recognition from a paragraph or sentence and still obtain structural effects from priming, then research using this technique would be much easier.

The second issue, that of the effect of degree of learning (number of study trials) is largely of theoretical interest. If differences in the degree of priming between words of a paragraph go away after material is well learned, it suggests that the structure has changed so as to become more "integrated." One might hypothesize that associations have developed between propositions that are distantly connected normally or that the propositional network has become augmented through the addition of extratextual knowledge.

The three experiments reported here explore the effects of repeated testing of items from paragraphs and repeated study of paragraphs on the relative size of priming effects. In all experiments, the paragraphs were six single-proposition sentences forming a linear structure as in the paragraph presented in Appendix A. For each trial, subjects read two paragraphs of this type and then were presented with single words for a recognition test. Subjects were to respond positively if the test word occurred in either paragraph and negatively if it was not in either paragraph. For each paragraph, six priming pairs were studied: two pairs that are *close* in the structure, N3-N2 (meaning that the primed item N2 is preceded by the priming, N3) and N5-N6; two pairs that are *far* apart in the structure, N5-N2 and N3-N6; and two *unprimed* controls, NX-N2 and NX-N6 where NX refers to a noun

from the other paragraph in the same study trial. Notice that each primed word participates in the close, far, and unprimed conditions, and that each priming word participates in the close and far conditions.

EXPERIMENT 1

Subjects in this experiment participated in three sessions on separate days. On each day subjects read and were tested on 54 paragraphs presented in 27 study-test trials of two paragraphs each. The second and third sessions used the same paragraphs as the first. In addition, during the test phase of each trial, each primed test word, N2 and N6, was tested three times, once in each of three blocks of that trial's test list. Each test of the primed word in the trial represented one of the three priming conditions — close, far, and unprimed — and all three priming conditions were tested in the test list. Thus, throughout the course of the experiment, each primed word was tested nine times, and each paragraph was read three times.

It was expected that RT would be shorter to close primed words than to far primed words, and that, in turn, RT would be shorter to far primed words than to unprimed words, for the first block of the test lists on the first day. This result would replicate that of McKoon and Ratcliff (1980). However, it was not clear whether the priming effects would be undiminished for the second and third blocks of the test list and for the second and third days of testing. If the priming effect is found to be unaffected by repeated study and testing over blocks and days, then one can draw three conclusions. First, the priming effect is independent of the level to which the material is learned, at least in the range studied here. Second, one could argue that information from the test list such as response information is not used in the recognition decision. Finally, such a result would suggest that one can repeatedly test the same items when using the priming technique to investigate linguistic structure.

METHOD

Materials

Fifty-four paragraphs, each six sentences long, were assembled. Each paragraph had a linear structure as shown in Appendix A. The critical nouns, N2, N3, N5, and N6 were selected so that they were not semantically related to one another. The paragraphs were arbitrarily divided into six groups of nine for purposes of constructing the study-test trials for each subject and day. For each session, the paragraphs from groups 1, 2, and 3 were

randomly paired with those of groups 4, 5, and 6, respectively, creating 27 pairs. A random ordering of these pairs created the order of the trials for the session. The 27 test lists that were associated with the 27 paragraph pairs were constructed as follows. Each list consisted of 72 test words arranged in three blocks of 24. In each block there were four priming word pairs, one with N2 and one with N6 as primed words for each of the two paragraphs. The priming condition associated with each primed noun was determined by a Graeco-Latin square design that ensured that, over a group of three subjects, N2 and N6 of every paragraph would be tested once under the three priming conditions (close, far, and unprimed), in each test list block, and on each day of testing. The four priming pairs for a given block were randomly placed in slots in the block, but not in the first two, or the last, slot. The prime item for the unprimed condition always was N4 from the other paragraph in the trial. The remaining 16 slots were filled with 8 negative items (words that did not appear in any of the paragraphs) and 8 positive fillers (other nouns and verbs from the two paragraphs of that trial).

Procedure

Each subject was tested individually in three 1-hour sessions on successive days. Each session began with two practice trials similar to the test trials. The practice was followed by that day's 27 test trials. The paragraphs and test lists were presented on a CRT screen which was controlled by a microcomputer system interfaced with Dartmouth College's time sharing system. Subjects began each trial by pressing the space bar on the CRT keyboard. The two paragraphs of the trial were presented one at a time for 10 sec each. The subjects were instructed to read them as they would read any simple story. Following the second paragraph, the test list began immediately. The test words were presented singly. Each remained on the screen until the subject made a response, by pressing either a "yes" key (the "/" on the keyboard) to indicate his or her judgment that the word was in either paragraph or a "no" key (the "Z" on the keyboard) to indicate that the word was new. If the response was correct, the next test word followed after 150 msec. If the response was incorrect, the word ERROR appeared on the screen for 2 sec before the next test word appeared. Between each block of the test list the subject received a 4-sec break.

Subjects

Nine Dartmouth students, volunteers from an introductory psychology class, participated for extra credit. This resulted in three complete replications of the experiment.

RESULTS AND DISCUSSION

RTs less than 100 msec or greater than four standard deviations from each individual subject's mean were discarded. Only correct responses to primed items preceded by correct responses to the prim-

ing item were included to maximize the chance that both the prime and primed items were in memory. Two separate analyses of variance were performed: one on the mean RTs for each condition for each subject (F_1 statistic) and one on the mean RTs for each condition for each paragraph (F_2 statistic).

The main result was that the priming variable strongly interacted with the block of the test list in which the priming pair appeared, $F_1(4, 32) = 3.9$, $p < .02$; $F_2(4, 96) = 3.6$, $p < .01$. In other words the effects due to priming differed depending on whether the item was tested for the first, second, or third time in the test list. The mean RTs shown in Table 1 reveal that this interaction reflects a pattern in which the differences between close, far, and unprimed RTs are reduced from the first to the second and third blocks. Consider the data from the first day. In the first block the unprimed condition is substantially slower than the far primed condition (58 msec) and the far primed condition is slower than the close primed one (26 msec). This pattern shows the predicted structure of the paragraphs and replicates the result of McKoon and Ratcliff (in press). However, in the second and third blocks, the difference between close and far primed RTs goes away and the difference between primed and un-primed RTs is much reduced. Although the difference between primed and unprimed RTs remains over the second and third days, the effect is small.

Table 1. Mean RT in msec and error rate (%) for priming condition over blocks and days, Experiment 1

Block	Priming condition		
	Close	Far	Unprimed
Day 1			
1	564 (4.3)	590 (4.0)	648 (9.0)
2	554 (1.2)	552 (1.5)	595 (1.5)
3	544 (0.9)	549 (1.2)	577 (1.9)
Day 2			
1	544 (2.2)	555 (2.5)	581 (5.9)
2	505 (0.0)	520 (1.2)	542 (0.3)
3	505 (0.6)	514 (0.9)	533 (0.6)
Day 3			
1	505 (1.5)	510 (3.7)	557 (5.9)
2	504 (0.3)	516 (0.6)	512 (0.9)
3	488 (0.6)	491 (0.0)	509 (0.9)

The main effects of priming condition, day, and block were all strongly significant, $F_1 > 8$ and $F_2 > 50$ in all cases. In addition, the priming condition interacted with days, $F_1(4, 32) = 2.8$, $p < .05$; $F_2(4, 96) = 3.4$, $p < .02$, illustrating that the overall effect of priming was reduced over days.

An analysis of the probability of an error showed a related but slightly different pattern. (Because the F_1 analysis proved to be the most conservative, only these statistics will be reported.) Priming condition interacted with the test block, $F(4, 32) = 8.6$, $p < .0001$. Essentially, all differences in error rate due to priming were present only on the first block of the test lists because error rates were reduced nearly to zero for the second and third blocks for all priming conditions. This pattern emerged on all three days of testing as shown by the absence of a triple interaction between block, priming condition, and days, $F(8, 64) = 0.5$, and by the absence of an interaction between days and priming condition, $F(4, 32) = 1.1$. Another feature of the error data was a main effect of whether the test noun was N2 or N6, with N6 leading to more errors, $F(1, 8) = 17.9$, $p < .01$. Like the differences due to priming, the differences between the two test nouns were present only in the first block of each day because of the floor effect on error rate in the second and third blocks, $F(2, 16) = 19.5$, $p < .0001$.

The basic message of the data is that one cannot repeatedly test the same item in this procedure and still hope to obtain large differences in RT and error rate due to variables of linguistic structure. Responses in the first block of the test list on the first day of testing appear to reflect linguistic structure, but later responses to the same items do not, or at least not to the same extent. It is likely that subjects recognized the fact that they can, for retested items, base their response not on their memory for the item in the paragraph, but on their memory that the item had occurred before in the same test list, their previous response and on the resulting feedback from that response. This source of information — test list information as opposed to paragraph information — is available for items in blocks 2 and 3 and not for those in block 1. However, it could conceivably be available for items tested in the first blocks of the second and third sessions, since the items in these blocks had been previously tested. If it is assumed that subjects are using test list information when it is available, then the present results are explained. This assumption would account for the dramatic reduction in error rate in the second and third test list blocks and for the reduction in differences in RT due to priming that occur primarily across blocks and secondarily across days.

One way that subjects could use test list information would be to base their responses on how familiar each test item looks. Because each negative test item was completely new, this strategy would be successful. If test list information is used this way one ought to be able to discourage this strategy by changing the nature of the negative items in each test list so that negative items were not completely new. The next experiment did just this.

EXPERIMENT 2

METHOD

This experiment differed from the previous one in only two respects. First, only one session per subject was run. The sessions were equivalent to the first day sessions of Experiment 1. Second, the negative items were changed. For each test list, half of the negative items were sampled randomly (without replacement) from all the test items of the previous trial. (Half of the negative test items for the first experimental trial were sampled from the preceding practice trial.) Subjects were told that basing their response on each test item's familiarity would be a bad strategy and that they should concentrate on the paragraphs when responding to the test words.

Six subjects from the same population participated. This created two complete replications.

RESULTS AND DISCUSSION

The data were analyzed as before and are presented in Table 2. The pattern of results is nearly identical to that of Experiment 1 (Table 1) for the first day, with the exception that the RTs are longer and the error rates are higher in the present experiment. As before, the main effects on RT of priming condition and test block were significant, $F_1(2, 10) = 12.5$, $p < .01$; $F_2(2, 48) = 15.8$, $p < .0001$, for priming condition, and $F_1(2, 10) = 4.6$, $p < .05$; $F_2(2, 48) = 14.8$, $p < .0001$ for test block. More importantly, these

Table 2. Mean RT in msec and error rate (%) for priming condition over blocks, Experiment 2

Block	Priming condition		
	Close	Far	Unprimed
1	609 (5.1)	627 (6.0)	707 (13.9)
2	598 (3.7)	598 (4.6)	634 (5.1)
3	598 (2.3)	596 (6.0)	617 (5.1)

variables interacted in the same way, $F_1(4, 20) = 4.0, p < .02$; $F_2(4, 96) = 4.0, p < .01$. No other effect on RT was significant. Analysis of the errors showed significant effects of priming condition and test block, but their interaction failed to reach significance due to variability among the six subjects with respect to error rate.

The addition of repeated negatives clearly made the task more difficult, but it did not change the tendency for the priming effects to go away on the second and third blocks. A tentative conclusion is that subjects do not use test list information by relying on familiarity. Rather they are able to directly remember their response to a particular item in a particular test list and the feedback from that response. This suggests that it will be very difficult to employ the repeated testing of items in the same test list when using the priming technique to study linguistic structure.

So far, we have addressed the question of how priming is affected by the repeated testing of items. What about the effects of repeated study of paragraphs? In the first experiment each paragraph was studied three times over the 3 days, and there was a main effect of days and an interaction between days and priming condition. However, this result does not demonstrate that the effects were due to repeated study because the number of study trials for each paragraph was confounded with repeated testing of the items for the paragraphs. The third experiment looked at the effect of number of study trials independently of the number of test trials.

EXPERIMENT 3

The basic idea of this experiment is that subjects read each paragraph, or more specifically, each pair of paragraphs constituting a trial, either once, twice, or three times during the course of the experiment. However, only the last presentation of each paragraph pair was followed by a test list. The same priming conditions as before were used (close, far, and unprimed) and the question of interest is whether the paragraph structure as revealed by RTs in the priming conditions changes as a function of number of study trials. In addition, test items were tested only twice, rather than three times as before, in each test list, and the accuracy feedback was removed. It was thought that these changes would discourage the use of test list information for the recognition judgments on retested items and thus remove the interaction between priming condition and test block that appeared in the previous experiments.

METHOD
Materials

The same 54 paragraphs were used, each one arbitrarily paired with another to make 27 trial pairs. These pairs were the same for every subject. The trial pairs were divided into three groups of nine with each group sharing the same number of study trials. So, for example, group 1 pairs might be studied only once, group 2 pairs, twice, and group 3 pairs, three times for a particular subject. Each subject, thus saw 54 [(9 × 1) + (9 × 2) + (9 × 3)] trial pairs. The number of study trials associated with each paragraph pair group was rotated for different subjects. The order of the trials was arranged so that each trial pair type that was presented more than once had 2–6 (mean = 4) other trial pairs intervening between the repetition of the pair.

The test lists were constructed as before, except that only two blocks of 24 test items each were presented in each test list. The four primed items, N2 and N6 for the two paragraphs, were tested once in each block. The particular priming condition associated with each critical test item was determined so that N2 and N6 in each paragraph were tested in both test blocks, in all three priming conditions, and, after one, two, or three study trials, an equal number of times throughout the experiment. The negative items were completely new in all test lists.

Procedure

The experiment consisted of one 50-min. session. The procedure was nearly the same as for the other two experiments, except that test lists were only presented following the final time that each paragraph pair was to be read. After each untested presentation the words NO TEST appeared on the CRT screen for two sec and were followed by the signal for subjects to begin the next trial. Subjects were told to expect that, after reading the two paragraphs of the trial, they might or might not receive a test list. A final change was the removal of accuracy feedback. If subjects erred on a test item, the next test item was presented just as if they had not erred.

Subjects

Eighteen subjects from the same population as Experiments 1 and 2 participated.

RESULTS AND DISCUSSION

As expected, RT was strongly affected by priming condition, $F_1(2, 34) = 18.2$, $p < .0001$; $F_2(2, 52) = 22.0$, $p < .0001$, with close priming faster than far priming, and far priming faster than unprimed (see Table 3 for mean RTs and error rates). The most important result, however, was that the differences among the priming conditions were

Table 3. Mean RT in msec and error rate (%) for priming condition as a function of number of study trials and test block, Experiment 3

Block	Priming condition		
	Close	Far	Unprimed
1 Study			
1	610	637	661
2	557	588	625
mean	584 (9.5)	612 (7.8)	643 (11.2)
2 Studies			
1	571	613	631
2	568	586	596
mean	569 (3.2)	599 (4.8)	613 (6.8)
3 Studies			
1	593	640	638
2	556	597	641
mean	574 (2.8)	618 (6.2)	639 (5.5)

the same regardless of whether paragraphs had been studied once, twice, or three times. The interaction between number of study trials and priming condition was not significant, $F_1(4, 68) < 1$; $F_2(4, 104) < 1$. Thus the amount of study did not affect the priming pattern.

The main effect of test list block was reliable; block 1 was slower than block 2, $F_1(1, 17) = 8.0$, $p < .02$; $F_2(1, 26) = 18.8$, $p < .001$, but unlike the two previous experiments, test list block did not interact with priming conditions, $F_1(2, 34) < 1$; $F_1(2, 52) < 1$. The single repetition of test items reduced RT but did not alter the relative differences due to priming.

The only other significant effect was a main effect of test noun, with RT to N2 (595 msec) faster than N6 (616 msec), $F_1(1, 17) = 7.1$, $p < .02$; $F_2(1, 26) = 12.9$, $p < .002$.

An analysis of the errors revealed an effect of number of study trials, $F(2, 34) = 14.9$, $p < .0001$, with error rates of 9.5%, 5.0%, and 4.8%, respectively, for paragraphs studied, once, twice, and three times. Although the structure of the paragraphs as shown by RT differences in priming did not change with amount of study, the overall level of learning did, as shown by the reduction in error rate.

Other error rate effects included the following. There were more errors on N6 (8.2%) than on N2 (4.6%, $F(1, 17) = 13.9$, $p < .005$. The effect on error rate of priming condition was in the expected

direction but not reliably so, $F_1(2, 34) = 2.5$, $p < .10$, with the close, far, and unprimed conditions associated with error percentages of 5.2, 6.3, and 7.8 respectively. In contrast to the sharp reduction of errors over test block in the other experiments, there was only a modest reduction between block 1 (7.2%) and block 2 (5.8%), and this was only marginally significant, $F(1, 17) = 3.9$, $p < .07$.

The principal result of this experiment was that priming condition did not interact with the number of study trials. Although substantial learning did take place as a function of amount of study, the structure revealed by priming condition RTs did not change. A secondary result was that test list block did not interact with priming condition. This is inconsistent with the presence of such an effect in the other experiments. However, in the third experiment, the size of the test list was reduced from three blocks (72 items) to two blocks (48 items) and feedback was removed. From the subjects' point of view, the repetition of items from block to block was probably not as blatant in the present experiment as it was in the other experiments, and subjects may have used mostly paragraph rather than test list information to respond. Hence, each response, whether in the first or second block, reflected the structure of the paragraphs. This interpretation is supported by the absence of a strong reduction in error rate from block 1 to 2. If subjects had been using test list information in the second block, one would expect substantially fewer errors as in the previous experiments.

GENERAL DISCUSSION

To summarize, the main results of the experiments were first, that the differences among the priming conditions tended to go away as items were tested an increasing number of times, and second, that the repeated study of paragraphs did not alter the differences due to priming, although it did lead to better performance in terms of error rate. In discussing these results we will first put forward an account of them by discussing the nature of paragraph information, test list information, and the ways in which these information sources might combine. Then we will offer recommendations regarding the use of the priming technique to study linguistic structure.

To the extent that paragraph information is used by subjects for their recognition responses, RT and error rate are under control of the structure of the paragraphs being tested. A preceding priming item will influence the strength or availability of a test item in such a way that items close together in the propositional network (the paragraph

microstructure in terms of the theory developed by Kintsch & Van Dijk, 1978) will prime one another to a greater extent than distant items will. The structure of the paragraph does not appear to change as the paragraph becomes better learned. Thus there is no evidence that learning modifies the basic distance relations between propositions as might be expected if learning implied integration through the development of remote associations. Of course, we cannot make a strong claim on this point because the level of learning attained was not particularly high.

Test list information seems to consist of the subject's memory for his or her earlier responses and the feedback from these responses. It does not reflect a simple familiarity variable that is increased with repeated testing, because, in Experiment 2, highly familiar negative items did not induce subjects to ignore test list information. The third experiment was able to isolate a set of circumstances in which subjects did not use test list information. Items were retested only once, and accuracy feedback was eliminated in this experiment. Thus, the processing system appears to be flexible in the ways in which different kinds of information are used. When subjects expect an item to be retested and are provided feedback on their responses, better performance can be attained if use is made of this response information, and subjects do so. In the absence of these conditions, response information is not as useful, and it does not appear to be used.

Given that both paragraph and test list information can be used in the recognition task, it becomes important to ask how the two sources are combined. Two possibilities are suggested, both of which are consistent with the present data. First, the two sources could add together in some way, with the response determined by a single decision process operating on this combination. A single process random walk model whose drift parameter is a function of the two information sources would be an example (e.g., Ratcliff & Hockley, 1980). Alternately, the two sources could be assessed independently, with the first to reach a criterion determining the response; in other words, a horse-race model. Each of these models would account for the gradual speed-up of responses and the reduction of differences due to priming with repeated testing. Similarly, they would explain the reduction of error rates and the loss of error rate differences due to paragraph structure as test list information becomes increasingly available. If models of this type were to be worked out in detail, the present data might be used to discriminate between them.

The final point of discussion concerns the use of priming to investigate linguistic structure. Clearly, the researcher must discourage

subjects' reliance on test list information if items are to be retested. Our suggestion is that items be retested no more than once in the same test list, and that, if retesting is used, accuracy feedback not be provided. This should maximize the contribution of paragraph information to the response and thus reveal the structure of the memory representation for the paragraphs or sentences being studied.

Appendix A. Sample paragraph from McKoon and Ratcliff (in press) with proposition list, linear propositional network, and distance relations among the nouns

PARAGRAPH
The youth stole a car.
The car sideswiped a pole.
The pole smashed a hydrant.
The hydrant sprang a leak.
The leak sprayed water.
The water flooded the flowers.

PROPOSITIONS

P1	STEAL, YOUTH, CAR
P2	SIDESWIPE, CAR, POLE
P3	SMASH, POLE, HYDRANT
P4	SPRING, HYDRANT, LEAK
P5	SPRAY, LEAK, WATER
P6	FLOOD, WATER, FLOWERS

PROPOSITIONAL NETWORK

P1 — — —P2 — — —P3 — — —P4 — — —P5 — — —P6

CONNECTIONS BETWEEN NOUNS

N1————————N2————N3—————————N4—————————N5—————————N6—————————N7
YOUTH   CAR   POLE   HYDRANT   LEAK   WATER   FLOWERS

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